Semantics II.UT. January 2012.

General concerns:

• This is going to be a course on formal semantics of natural language.

• That means: We will be making use of formal methods in dealing with linguistic problems.

But note well: The linguistic analysis must always come first.

• Strictly speaking a formal treatment can never improve on the informal analysis it implements. But it can help to clarify what the informal analysis really amounts to and to make clear how a particular analysis of a particular problem affects the semantic theory over-all.

• The ultimate aim of semantics is to come up with comprehensive descriptions of the semantics of a natural language; for

(a) it is the comprehensive understanding that speakers have of how the meanings of words and constructions combine to yield meanings for all the meaningful sentences (and sentence combinations) of the language that the theory should account for; and

(b) a semantic theory that can serve as theoretical foundation for automated language processing including interpretation must be comprehensive.)

• We need to know something about formalisms used in formal semantics today not only to have the tools at hand we want to be in a position to use when formalizing our own analysis, but also in order to be able to read and appreciate the formal semantics literature. The situation is complicated by the fact that there are a number of different formalisms currently in use. There are close connections between those formalisms, but also differences and that can be confusing. More about this later.

A quite detailed summary of some of most commonly used formalisms is given added under ‘course documents’.

• First a remark on “formalization” as the term is typically understood in “Formal Semantics”. This is not quite the same as what is understood by “formalization” elsewhere, for instance in philosophy of science.

• In philosophy of science formalization normally means formalization of the language in which a given scientific theory is formulated. This kind of formalization typically requires formalisms (or “formalized languages” or “formal languages”) with considerable expressive power, e.g. first order logic + set theory. Examples: Formalization of various branches of mathematics (number theory, theory of vector spaces, abstract topology, ..); bits of physics, e.g. elementary mechanics. In such formalizations all consequences of the theory become logical consequences (in the strict formal sense of the term) of the theory’s basic assumptions.

This is often referred to as “formalization of the metalanguage.”
In semantics we use formalisms to either

(a) provide “canonical” descriptions of the semantic values (or denotations) of linguistic expressions, or

(b) to assign logical forms to the expressions that represent their content in a canonical, logically transparent way.

This is different from formalizing semantic theory in the sense mentioned above. Formalization of semantic theory in that sense is something that could be undertaken in principle, and in certain contexts there is a point to doing so (e.g. in connection with the semantic paradoxes). Such a formalization would involve

(i) a strictly formalized way of talking about linguistic expressions and their syntactic properties; and

(ii) a strictly formal treatment of the models of model-theoretic semantics and of the denotation definition that connects expressions with models (e.g. by assigning to each expression in each model a certain denotation.)

But in actual practice semanticists rarely if ever bother with this. In this course we won’t either.

The beginnings of compositional semantics

• The basis of all systematic semantics of natural language semantics: *Reference, Predication and Quantification*.

• Predicate Logic is a good formalism in which to state truth conditions that arise from these three mechanisms.

Example:

(1) a. Two languages are spoken by everybody in this room.
    b. Everybody in this room speaks two languages.

Questions relating to (1):

(i) What is the intuitive difference between (1.a) and (1.b) as far as their truth conditions are concerned?

(ii) How do we represent the truth conditions of these sentences in first order predicate logic?

(iii) How can we account for these truth conditions in a systematic, compositional way? Can we use predicate logic for this purpose?

In connection with question (iii) it helps to look at some simpler sentences:
Every man suffers.

John suffers.

John loves a dachshund.

Every man loves a dachshund.

John offended every linguist.

1. Predicate Logic is not a particularly good tool when it comes to constructing a systematic compositional semantics for a natural language. More effective is some form of the lambda calculus. This allows us to assign different syntactic categories logical types that reflect their semantics. We will look at the formal details as we go along. (Reference: Heim & Kratzer: *Semantics in Generative Grammar*

Montague’s basic intuition about the denotations of quantifying noun phrases was that these must be of type \(<e,t>,t>\) (or, in simplified notation, \(<et,t>\)). This works fine when such phrases occur in subject position, as in (2.a). For instance the subject DP of that sentence can be assigned the following semantics:

\[
\text{[every man]} \Rightarrow \lambda Q. (\forall y)(\text{man}'(y) \rightarrow Q(y))
\]

and every, as an ‘operator, which acts on expressions of type \(<e,t>\), such as the NP man, should then be given the obviously corresponding value as ‘semantic lexical entry’:

\[
every \Rightarrow \lambda P. \lambda Q. (\forall y)(P(y) \rightarrow Q(y))
\]

This will work out fine for a sentence like (2.a): is first applied to the semantic value man’ of the noun man (which is of type \(<e,t>\)) so as to get the value \(\lambda Q. (\forall y)(\text{man}'(y) \rightarrow Q(y))\) and this value is then applied to the semantics suffer’ of the intransitive verb suffer to obtain \((\forall y)(\text{man}'(y) \rightarrow \text{suffer}'(y))\), which captures the truth conditions of (2.a) correctly.

But these semantic values for every and every-phrases do not work (or at least not in any straightforward way), when they occur in other positions. Consider for instance (2.e)

(2.e) John offended every linguist.

Here the object DP must combine with a two-place relation (an entity of type \(<e,<e,t>,t>\), or, simplified, \(<e,et>\) rather than with one of type \(<e,t>\). With the DP value given above functional application isn’t possible.

2. One way to try and deal with this problem is to assign to quantifying DPs in object position a different denotation. For instance, *every linguist* could be given the denotation:

\[
every \text{ linguist} \Rightarrow \lambda R. \lambda u. (\forall y)(\text{linguist}'(y) \rightarrow R(u,y))
\]

where R is of type \(<e,et>\).

This denotation for *every linguist* can be obtained by providing *every* with the
alternative lexical entry:

\[
\text{\textit{every}} \quad \Rightarrow \quad \lambda P. \lambda R. \lambda u. (\forall y)(P(y) \rightarrow R(u,y))
\]

Exercise: Show that this gives the right truth conditions for (2.e) given the following syntactic tree for the sentence:

```
S
   DP       VP
  John     V
       DP
      offended       Det       NP
            every       N
                            \textit{linguist}
```

3. But what are we going to do about quantifying DPs that occur as innermost arguments to three-place relations (e.g. ditransitive verbs like \textit{give} or \textit{send})?

Here we need yet another entry for \textit{every}, which involves a variable of type \texttt{<e,<e,<e,t>>}. And so on in case we have to deal with relations of even more places.

A theory that wants to treat all these phrases in situ must have an account of all the different entries for the determiners that may come up and how to choose the right one for each given occurrence of a quantifying DP.

4. This problem becomes worse once we realize and accept that sentences with two or more quantifying DP can be scopally ambiguous. For instance, (3) arguably allows (at least with the right intonation) for both an \textit{\exists\forall}-reading and an \textit{\forall\exists}-reading.

(3) Some philosopher offended every linguist.

How do we get the \textit{\forall\exists}-reading for (3) if we treat \textit{every linguist} in situ (and thus before we get to \textit{some philosopher})?

There is a way to do that by choosing yet another, carefully gerrymandered, entry for \textit{every}:

\[
\text{\textit{every}} \quad \Rightarrow \quad \lambda P. \lambda R. \lambda Q. (\forall y)(P(y) \rightarrow (Q(\lambda u. (R(u,y))))
\]

This gives us the intended truth conditions for the \textit{\forall\exists}-reading for (3), but only by reversing the lambda-application when the subject phrase combines with the VP; and the entry seems terribly ad hoc. What general account of possible entries for determiners will be needed for this to work in general?

One way in which we might try to cope with this explosion of different semantic
values for determiners like *every* (and for the DPs they head) is to adopt a *type-shifting* mechanism, of the kind first proposed by Partee and Rooth. Such theories allow the position of a phrase to influence the choice of semantic value for it, ideally by assuming that one of the semantic values can be treated as basic and that the value which is needed on for a particular occurrence of the expression can, in case it differs from the base value, be computed from it, given the information about its position.

##

5. Heim and Kratzer propose an alternative, based on “Quantifier Raising” – moving quantifying DPs to higher positions in the syntactic tree preparatory to semantic interpretation.

For instance they offer the following analysis for (2.e).

(2.e) John offended every linguist.

(4) Syntactic tree:

```
S
   DP
     1
       S
     Det    NP
every    N    DP    VP
     linguist    John    V    DP

offended    t_1
```

To make the semantics work for this syntactic analysis of (2.e) H&K add a notational device to the version of the lambda calculus they use. It looks like this:

\[ [[\alpha]]^a \]

Here \( \alpha \) is an expression and \( a \) is a partial assignment from numbers to individuals (= entities in \( D_0 \)). (For instance, \( a \) could be “\( 1 \to b \)”, the assignment with domain \( \{1\} \) and such that \( a(1) = b \). Or \( a \) could be the empty assignment \( \emptyset \); etc.).

This notation becomes relevant only in cases where the syntactic tree contains indices, i.e. subscripts like the “\( 1 \)” on in \( t_1 \). For instance, \( [[t_1]]^1 \to b = b \); and \( [[\text{linguist}(t_1)]]^1 \to b \) denotes the truth value \( 1 \) iff \( b \) is a linguist.

With this notation we can assign to the VP of (4) the denotation
\[[\lambda u. \text{offended}'(u,t_1)]\] \rightarrow b,

where b is a variable of type e of the present version of the lambda calculus.

But we can also assign it the denotation \[[\lambda u. \text{offended}'(u,t_1)]\]∅. Note however that this expression does not have a proper denotation, since ∅ does not assign a value to t_1. We identify \[[\alpha]\]∅ with α.

\(\lambda\)-abstraction comes into action in determining the denotations of nodes whose left daughter is a binding index (like the node between the two S’s in (4)).

The denotation of such a node is obtained by lambda abstracting over the denotation term of the right hand daughter with respect to a variable x of type e. But the binding must capture the coindexed constituents in the denotation of the right hand daughter. This is achieved by adding the binding index to the domain of the assignment and assigning the abstraction variable to that index.

In the case of (4) this functions as follows. The lower S node gets the denotation

\(\text{offended}'(\text{john}',t_1)\), which is the same as \[[\text{offended}'(\text{john},t_1)]\]∅. Lambda abstraction now gives us for the next node, say:

\(\lambda y. ([\text{offended}'(\text{john}',t_1)] \rightarrow y)\). This term is equivalent to \(\lambda y.\text{offended}'(\text{john}',y)\).

Applying the \(<\text{et},\text{t}>\) denotation of every linguist to this gives us what we want.

Exercise: check the computation for (4).

Note how the way in which assignments can be built into the denotation terms gives a way of keeping track of the connection between the binding index and the constituents in the binding target that are coindexed with it!

6. In (4) only the quantifying DP every linguist was moved. What about non-quantifying DPs like John? As H&K point out, we can do this, if we want to, by giving such DPs the denotation proposed first by Montague.

E.g. John is assigned the denotation \(\lambda P.P(\text{john'})\) (= the property of being a property that John has).

Here john’ is a constant of type e that denotes John.

As H&K note, raising non-quantifying DPs is not going to make any difference to what truth conditions are assigned. In the case of (2.e) raising John gives the same truth conditions we obtained for (4), irrespective of whether John is raised above or below every linguist.

7. Using the technology shown in this example it is now also possible to deal with
scopally ambiguous sentences like (3):

(3) Some philosopher offended every linguist.

We can assign two syntactic trees to this sentence:

(5) First syntactic tree for (3):

\[
\begin{array}{c}
S \\
DP \\
Det & NP & 2 & S \\
\text{some} & N & \text{DP} \\
\text{philosopher} & 1 & S \\
& \text{Det} & \text{NP} \\
& \text{every} & N & \text{DP} & \text{VP} \\
& \text{linguist} & t_2 & V & \text{DP} \\
& \text{offended} & t_1 \\
\end{array}
\]

(6) Second syntactic tree for (3):

\[
\begin{array}{c}
S \\
DP \\
Det & NP & 1 & S \\
\text{every} & N & \text{DP} \\
\text{linguist} & 2 & S \\
& \text{Det} & \text{NP} \\
& \text{some} & N & \text{DP} & \text{VP} \\
& \text{philosopher} & t_2 & V & \text{DP} \\
& \text{offended} & t_1 \\
\end{array}
\]

Exercise: Show that the compositional methods used before give the $\exists \forall$-reading and the $\forall \exists$-
reading of (3), respectively.

8. Dealing with the semantics of sentences containing quantifying DPs via Quantifier Raising has additional benefits. Among these are the cases of “inversely linked” quantifiers, (which were among the main motivations for introducing Quantifier raising in the first place (Robert May *The Grammar of Quantification*, doctoral dissertation, MIT, 1977, *Logical Form: Its Structure and Derivation*, 1985).

In fact, the sentences in question tend to ambiguous between a “inversely linked” and a not “inversely linked” interpretation:

(7) One apple in every basket is rotten.
(8) No student from a foreign country was admitted.

In (7) the inversely linked interpretation is more prominent. (The other interpretation is highly implausible given world knowledge.)

In (8) the somewhat preferred reading is the non inversely linked one.

One way to obtain the inversely linked reading of (7) is to first raise the entire subject phrase One apple in every basket and then raise the DP embedded within the subject phrase out of it. This gives us (9).

(9) S
    DP
    Det NP 2 S
    N every DP
    basket
    Det NP 1 S
    one N PP DP VP
    apple P DP t1 V
    in t2 is rotten

Computing the truth conditions from (9) in the way we did before gets us the inversely linked interpretation of (7).

As a matter of fact, for reasons that have to do with the intricate ways in which syntax and semantics interact in the H&K system, this cannot be quite the right solution there. At least for the time being we forego the interesting but somewhat hairy details.
One important methodological controversy concerns the treatment of third person pronouns. There are at least five different uses of the 3rd person pronouns of English that can be distinguished according to elementary criteria:

i. Deictic uses.

Here the pronoun refers to an individual salient in the context, e.g. because it is the one the speaker is pointing at.

Example: “He is the one.”, said by a speaker who points at a person in a police line-up.

ii. Discourse-anaphoric uses to particular individuals.

Examples: “John works as a salesman. He is miserable.”
“If John works as a salesman, then he is miserable.”

iii. Discourse-anaphoric uses to ‘indefinite individuals’.

Example: “John has bought a goat. It is not allowed inside the house.”

iv. Uses as ‘donkey pronouns’.

Example: “If John has bought a goat, then apparently it is not allowed inside the house.”

v. Uses as ‘bound pronouns’.

Example: “Every man who fancies a woman hopes she fancies him too”

(Here she is used as a donkey pronoun but he as a bound pronoun.)

Heim & Kratzer treat pronouns as ambiguous between bound pronouns – these are pronouns that get an index in the syntactic structure – and referential pronouns. The latter category includes both deictic uses of pronouns and pronouns that are ‘anaphoric’ to antecedents which may be either inside our outside the sentence containing the pronoun, but without being bound.

So the cut-off here is between (v) and the four other categories (i)-(iv).

Other examples of donkey pronouns are the occurrences of it in (10)-(12).

(10) If Pedro owns a donkey, then he beats it.
(11) If a farmer owns a donkey, then he beats it.
(12) Every farmer who owns a donkey beats it.

(The occurrences of he in these sentences all belong to different categories according to our five-fold classification: he in (10) belongs to category (ii), he in (10) belongs to
category (iv) and he in (12) belongs to category (v).

H&K treat donkey pronouns (of category (iv)), and presumably also those of category (iii), as ‘E-type pronouns’.

The term ‘E-type pronoun’ goes back to G. Evans. It is used to refer to a family of ways to deal with the semantics of sentences like (10)-(12), which all come to this:

(i) Replace the pronoun by a definite description, which must be constructed from other material in the sentence or must be reconstructed from the context, or a combination of both.

(ii) Then treat the sentence obtained from this substitution using some already established account of definite descriptions.

(At the time when Evans made the first proposal of this kind (the late seventies) it was thought that a satisfactory account of the semantics of definite descriptions was available. So the reduction of pronouns to descriptions looked like true progress.)

• A rather different way of dealing with donkey sentences and related problems is proposed by D(iscourse)R(epresentation)T(heory).

We begin by showing how this problem is dealt with by DRT in its original form. (See Kamp & Reyle: *From Discourse to Logic*)

10. **Discourse Representation Theory**

DRT is different from H&K’s approach in a number of ways:

• DRT started out as an attempt to grasp a way of capturing the systematic semantic connections between successive sentences in a discourse.
One striking example of such connections are those established by anaphoric pronouns whose antecedents occur in earlier sentences. So the behavior of such pronouns was one of DRT’s first targets.

(Another domain where discourse connections are systematic and important is temporal reference. (See also SDRT in this connection.) More about this later.

- DRT tried for a long time to remain neutral between different theories of syntax. So there was an attempt to formulate the syntax-semantics interface (the so called “DRS construction algorithms) while making minimal assumptions about the syntax. The price one pays for this is that cannot take advantage intricate interactions between syntax and semantics in the way that I done in the system of H&K.

- One important aim of DRT is to define a semantic representation formalism that allows semantic representations to serve

(i) as discourse contexts for what is to be interpreted next.

(ii) as premises for logical inferences (including those that are needed to advance the interpretation of the given discourse or sentence for which a representation is being constructed

Since pronouns were central to the original conception of what the theory was meant to accomplish the very first detailed accounts of the theory included them.

For now we will focus on (mini-) discourses like (13) and sentences like (10) –(12).

(13) Pedro owns a donkey. He beats it.

In looking at some of these examples we will consider both the original top down construction algorithm of From Discourse to Logic and newer bottom up construction methods.
Today’s program:

I. Finish up comparison H&K-DRT

II. Questions about plurals

I.

• Last week we considered a few examples of the top-down construction method for building DRSs. Our last example was the donkey sentence

(11) If a farmer owns a donkey, then he beats it.

In this case the procedure was based on the assumption that the conditional operator that connects if-clause and main clause has widest scope and is the first for the construction to deal with. It sets up a representation of the form “R1 \( \Rightarrow \) R2”, in which R1 and R2 are, to start with, the syntactic structures of if-clause and main clause, respectively. Applying the construction algorithm to these structures then yields the desired DRS. (In order to get at this DRS it is necessary to first convert R1 and then R2, for in this way one has the DRS K1 for the antecedent of the conditional that can serve as context for the interpretation of the consequent (R2), and is needed to give the right interpretation to the pronouns contained in it.)

Principle: the antecedent of a conditional can serve as interpretation context for its consequent.

• The next example in line was the “donkey sentence”:

(12) Every farmer who owns a donkey beats it.

To construct the DRS for this sentence top down we first deal with the subject-VP combination. This leads, given that the subject is a universally quantifying DP, to a structure

(14) \([x \ y \ | \ farmer'(x), donkey'(y), own'(x,y) ] <\forall x> [R2]\)

where R2 is the syntactic structure of (12) except that the subject phrase has been replaced by x. Since the restrictor of a quantificational condition can serve as interpretation context for its nuclear scope, the pronoun \(it\) of (12) can be resolved as before and we get

(15) \([x \ y \ | \ farmer'(x), donkey'(y), own'(x,y) ] <\forall x> [u \ | \ u = y, beat'(x,u)]\)

Principle: the restrictor of a quantifier can serve as interpretation context for its nuclear scope.

• Already in the eighties bottom up DRS-construction algorithms were proposed. (Asher, Zeevat).
Here we will illustrate one way of constructing DRSs bottom up which has been designed to deal also with presuppositions (in line with the work on presupposition of Van Der Sandt and Geurts).

- First consider the bottom up construction for

(2.e) John offended every linguist.

The syntactic structure for (2.e) without quantifier movement, but with the semantic predicate for the verb inserted and its arguments linked to the DPs that fill it, is given in (16):

(16)

\[
\begin{array}{c}
S \\
DP_1 & VP \\
   & \text{John} \ V \ \text{DP}_2 \\
   & \text{offended}'(x_1,y_2) \ Det \ NP \\
   & \text{every} \ N \\
   & \text{linguist}
\end{array}
\]

We start with the construction of a representation for the object DP. The representation of the head noun \textit{linguist} of the DP is

(17) \[< y_{\text{ref}} | < y | \text{linguist}'(y)>>\]

The part to the left of the first | is a store in which we put discourse referents that still need to be bound. The part following the first | is a DRS (with universe consisting of just y). “ref” marks y as the referential argument of the represented expression. (It is this which tells the determiner \textit{every} that it is y that it should bind and inserted into the argument slot coindexed with the DP.)

Combining (17) with every sets up the quantificational structure (18)

(18)

\[
\begin{array}{c}
S \\
y \ \forall \ y \\
\text{linguist}'(y) \ \text{DP}_1 \ VP \\
\text{John} \ V \ \text{(DP}_2) \\
\text{offended}'(x_1,y)
\end{array}
\]
The next steps concern (i) interpretation of the DP John and (ii) combining that interpretation with that of the VP. (i) For the proper name John we adopt the representation in (19).

\[ (19) \quad < x_{\text{ref}} | \{<x | \text{John}(x)>\}_{\text{pr.na.}}, < | >> \]

The DRS within \{\} represents the referential presupposition triggered by the proper name.

The underlining of \( x \) in the universe of the presupposition DRS indicates that this is a referential presupposition which requires finding an antecedent for \( x \) in the context. The subscript “\( \text{pr.na.} \)” indicates that the presupposition is triggered by a proper name.

(ii) Combining (19) with the VP representation involves inserting the referential argument \( x \) of the subject DP into the coindexed argument slot of “offended’”. Moreover, the empty non-presuppositional DRS of (19) gets unified with the DRS resulting from the insertion. So we get as representation of the S-node of (18). (The representation of the VP in (18) is the DRS \(< | \text{offended’}(x_1,y) >> \).)

The result of this is the DRS with empty universe and whose condition set only has \( t \) condition in (20)

\[ (20) \quad \forall y \quad < \{<x | \text{John}(x)>_{\text{pr.na.}}, < | \text{offended’}(x,y) >> \]

Justification of the presupposition contributed by John (in the global context as is standard for proper names) turns (20) into (21)

\[ (21) \quad x \quad \text{John}(x) \]

\[ \forall y \quad \text{offended’}(x,y) \]

\[ \text{linguist’}(y) \]

Note that when we construct DRSs bottom up, we can no longer resolve pronouns with sentence-internal antecedents at the very point when they come up for interpretation. For their antecedents are always “higher up” and so no representing discourse referents have yet been introduced for them.

For instance consider again sentence (12)

\[ (12) \quad \text{Every farmer who owns a donkey beats it.} \]

If we construct the DRS for (12) bottom up, then we will first have to deal with the
combination of the verb *beats* and its direct object DP *it*. The only way in which we can proceed is to assume that the pronoun (like proper names and, we will assume later, all definite noun phrases) a “referential” presupposition. In the case of a pronoun there are other resolution conditions on the presupposition than for e.g. proper names. In particular, pronouns may be resolved “anaphorically”, i.e. in the (global or local) discourse context.

So we assume that in particular, the *it* of (12) gets the representation in (22). (The subscript is again a shorthand for the relevant constraints on justification of the presupposition. With pronoun presuppositions resolution to accessible discourse referents in the discourse context is a permissible form of resolution.)

(22) \[ \langle v_{ref} | \langle \langle v \mid \neg \text{person}(v) \rangle \rangle_{\text{pron.}}, \langle | \rangle \rangle \]

**Exercise:** Give a bottom up construction of the EA reading for (3).

(3) Some philosopher offended every linguist.

Note that neither the top-down construction nor the bottom up construction for (3) gives the inverse scope (AE) reading for (3). To get this we must either allow the construction to change the argument insertion operations or else work from syntactic structures in which the quantifying DPs have been moved in the desired (inverse) order.

**Exercise.** Construct bottom up DRSs from the syntactic representations (5) and (6) for (3).

- Interesting in the present context are inverse linking sentences like (7) and (8).

(7) One apple in every basket is rotten.
(8) No student from a foreign country was admitted.

As it stands, the top down method yields, when applied to a syntactic structure in which the quantifiers have not been raised, the non-inversely linked interpretation (the one that is natural for (8) but bizarre for (7)).

To see this consider the variant (7’) of (7) in which we have replaced *one* by *every*.

(7’) Every apple in every basket is rotten.

This sentence is ambiguous in just the same way as (7), and here too the non-inversely linked reading is absurd. (It would require every apple to be in every basket.) (I will explain the reason for replacing *one* by *every* below.

Now let’s see what happens when we start the top down approach on a syntactic structure for (7’) in which the quantifying DPs have not been raised.

(9’) \[ S \]

The first step of this algorithm deals with the subject DP and creates the duplex condition to capture the meaning of the determiner. This gives a structure like that in (10').

(10')

\[
\begin{array}{c}
\text{DP} \\
\text{Det} \quad \text{NP} \\
\text{every} \quad \text{N} \quad \text{PP} \\
\text{apple} \quad \text{P} \quad \text{DP} \\
in \quad \text{Det} \quad \text{NP} \\
\text{every} \quad \text{N} \\
\text{basket} \\
\end{array}
\]

is rotten

It is clear that if we continue the construction the quantifier every basket will eventually give rise to a duplex condition within in the restrictor box of the duplex condition in (9''), and thus that we get the non-inversely linked reading.

What about doing the construction bottom up? This time we have to build the representation of the complex subject DP of (9') before we combine it with the VP. Our first step in dealing with the DP concerns the embedded DP every basket. The question is: What does processing this phrase come to? What is the nuclear scope of this quantifying phrase? This is essentially the same question as the question t where this phrase should be raised, assuming that its scope should remain within the Larger DP. The most plausible answer would seem to be that the
nuclear scope of every basket within the DP of (9’) should include just the predication of which the phrase is an argument. This is the predication involving the preposition in. This choice corresponds to the option that H & K create by allowing for raising every basket to a position in which it is adjoined to PP.

What happens is seen more clearly if we replace the proposition in by (a constant in our representation formalism for) the binary relation in denotes, complete with the linking information according to which every basket is its non-referential argument. To do this we need a representation for in, which is on the one hand like the representation we adopted earlier for linguist in that it explicitly introduces, in a similar manner, the referential argument position of in, and on the other hand like offended in that it links the non-referential argument of in to the DP every basket that fills that position. The representation I propose is that in (11’)

(11’) \( <z_{\text{ref}} | <z| \text{in’}(z, w_2)>> \)

By the same token we might as well also make the linking explicit of the subject DP with the one argument position of is rotten (which for simplicity’s sake we treat as a simple intransitive verb, with a semantics given by “is-rotten’(x)”’. (12’) gives the representation of (9’) after insertion of (11’) for in and “is-rotten’(x)” for is rotten, and with the linking information that can now be made explicit.

(12’)

\[
\begin{array}{ccc}
\text{S} & \text{VP} \\
\text{Det} & \text{NP} & \text{is-rotten’(x_1)}\\
\text{every} & \text{N} & \text{PP} \\
\text{apple} & \text{P} & \text{DP_2} \\
<z_{\text{ref}} | <z| \text{in’}(z, w_2)>> & \text{Det} & \text{NP} \\
\text{every} & \text{N} & \text{DP_2} \\
\text{basket} & & \\
\end{array}
\]

Giving every basket as nuclear scope just the predication in which it is an argument means that we take its nuclear scope to be (11’). So assuming that basket gets the same form of representation as linguist in (2.e) – the direct analogue of (17), e.g. \( <w_{\text{ref}} | <w| \text{basket’}(w)>> \) - the described processing step involving every basket leads from the DP of (12’) to the representation in (13’)

(13’)

\[
\begin{array}{c}
\text{DP_1} \\
\end{array}
\]
In the next step the PP will combine with the lexical head apple in the sense of predicate conjunction (H &K’s P(redicate)M(odification)). We assume that the N apple gets the representation given in (14’).

\[(14') \quad \langle x_{\text{ref}} | \langle x | \text{apple}'(x) \rangle > \]

Predicate conjunction binding of the referential argument of the modifier through identification with that of the head: the referential argument of the modifier is removed from its store and all other occurrences of it in the representation of the modifier are replaced by the referential argument of the head. In the case of (13’) this operation leads to the structure in (15’).

\[(15') \quad \text{DP}_1 \]

\[
\begin{array}{c}
\text{Det} \\
\text{every} \\
\text{apple} \\
\langle x_{\text{ref}} | \langle x | \text{apple}'(x) \rangle > \\
\langle w | \forall x < z | \text{in}'(z, w) \rangle > \\
\text{basket } ' (w)
\end{array}
\]

Again we have obtained the narrow scope reading for every basket.

Of course, what we might have done in the first construction step of the bottom-up construction procedure is to give every basket wide scope over the remainder of the structure. This would give the result we want. But the move seems utterly ad hoc, motivated solely by the urge to get to the interpretation we want. If the subject DP is not a scope island for the embedded DP, then there must be a good explanation for why that is so. That, in large part, was what motivated the quantifier raising principles in the first place. If we cannot come up with anything as good as that, then the best we can do is to buy into that analysis, and construct our DRSs from syntactic structures in which quantifier raising has taken place. But
this puts the approach at a disadvantage vis-à-vis H & K as long as we have nothing to offer that can compare with the way in which syntactic and semantic principles interact in their approach.

On the other hand, DRT has something to say about many phenomena that the H & K approach (in the form in which it is known to me) does not seem to cover. So perhaps some kind of compromise of these two approaches is still something to strive for.
Plurals

1. Plural vs. singular pronouns.

Main claim:

The antecedents for anaphoric singular pronouns are present ("ready-made") in the discourse context when constructed according to the principles of Ch.s 1 and 2. Notorious example to show this (Partee):

(23) (i) √ One of the ten balls is not in the bag. It is under the sofa.
(ii) # Nine of the ten balls are in the bag. It is under the sofa.

The antecedents for anaphoric plural pronouns often have to be “manufactured” from material that the discourse context makes available.

Examples:

(4.4) (i) John took Mary to Acapulco. They had a lousy time.
(ii) John took Mary to Acapulco. Fred and Suzie were already there. The next morning they set off on their sailing trip.

(4.5) (i) √ Two of the ten balls are not in the bag. They are under the sofa.
(ii) # Eight of the ten balls are in the bag. They are under the sofa.
(iii) Freddie took one ball out of the bag. Andy took out another one. They are under the sofa.

(4.6) Susan has found every book/most books/ only few of the books that Bill needs. They are on his desk.

(24) Susan has found only few of the books Bill needs. He is disappointed, for he badly needs all of them.

(25) You don’t see hedgehogs in winter. They hibernate.

Empirical generalization:

Summation and Abstraction are permissible operations for creating antecedents for plural pronouns. Subtraction is not.

This suggests:

i. The rules that govern the interpretation of plural pronouns are like rules of logic, but they do not exhaust these: antecedent construction for plural pronouns is not like ordinary logical deduction.

ii. These rules govern the behavior of a particular type of expression and thus must be considered as part of the grammar of the language.

iii. The scope of these rules extends beyond the limits of the single sentence.
Remark about the representation of generalized quantifiers (pp. 316, 317)

2. Distributional and collective interpretations of sentences with plural DPs.

(4.27) (i) The men carried the piano upstairs.
(ii) The lawyers hired a new secretary.
(iv) Martin connected the computers.
(v) The newspaper tycoon left his children a huge fortune.

(4.28) Both the professors and the lawyers decided to get private secretaries.
But there was a difference. The lawyers hired a secretary they liked. The professors
hired a secretary they could afford.

(4.31) (i) The lawyers hired a secretary.
(ii) Few lawyers hired a secretary.
(iii) The villagers built a town hall.
(iv) Many villagers built a town hall.

(4.33) (i) √ The crowd gathered in the square.
(ii) √ The men gathered in the square.
(i) # The man gathered in the square.

(4.34) (i) √ Many men gathered in the square.
(ii) √ Few men gathered in the square.

(4.35) The lawyers hired a new secretary they liked.
(4.40) Few lawyers hired a new secretary they liked.

3. Dependent Bare Plurals

(4.48) Most of my friends own cars.

(4.49) Most students bought books that would keep them fully occupied during the next two
weeks.

(4.51) Most students bought a book that would keep them fully occupied during the next two
weeks.

(4.52) Most students bought several books that would keep them fully occupied during the
next two weeks.

4. “They as individual variable”

(4.66) Fred admires Susan. They are writing a paper on plurals.
(25) Fred admires Susan. They are writing papers on plurals.

(4.87) Few lawyers hired a new secretary they liked. They had discussed the applicants
beforehand.
5. Dependent bare plurals (again) and dependent plural pronouns

(4.89) (i) The women bought cars which had automatic transmissions.
(ii) The women bought a car which had automatic transmissions.
(iii) The women bought cars which they liked.
(iv) The women bought a car which they liked.

(4.93) German civil defense workers spotted those planes.
(4.94) The boys gave the girls nickels/gave nickels to the girls.
(4.95) (i) Weak men tend to drive strong cars.
(ii) Strong cars tend to be driven by weak men.

(4.115) Every director gave a present to a child from the orphanage.
They /Some/Two (of them)/None of them opened them right away.

6. The distributivity and collectivity properties of nouns and intransitive and transitive verbs.

(4.161) Three lawyers hired five cleaners.

7. Singular and Plural denotations: individuals and sets vs. atomic and non-atomic individuals.

Three options:

(i) Singular DPs denote individuals; (referential) plural DPs denote sets
(with $\geq 2$ members) (Winter)

(ii) Both singular and referential plural DPs denote sets. Singular DPs denote
singleton sets, plural DPs sets of cardinality $\geq 2$. (Scha)

(iii) Both singular and referential plural DPs denote “individuals”. Singular DPs
denote atomic individuals, plural DPs sets non-atomic individuals. (Link)

- Further twists to this: groups (Landman); covers (Schwarzschild)
- Arguments for a “same type” treatment of singulars and plurals:

(a) The behavior of the (and other definite determiners in English and other
languages).

(b) The similarities between plural DPs and (singular) mass DPs.
(c) The complicated relations between grammatical number and atomicity structure.

Compare for instance:

i. water, air, magma, butter, cheese
ii. rubbish, sand, sugar
iii. furniture, foliage
iv. drags, odds and ends, remnants
v. parts
vi. dogs, chairs

Further possible topics within the general area of plurals:

• Reciprocals (Heim et al), (Dalrymple et al.)
• Distributive and collective reading of verbs with one or more non-distributive plural DP arguments. (Scha, Landman)
• Polyadic quantifiers (Quantifiers that (seem to) bind more than one variable at once) (Keenan, Peters and Westerstahl); same, different, together.
Febr. 19 2010: More on Plurals

In particular: Landman (Groups I) and Schwarzschild (Types of Plural Individuals)

I. Landman

1. Mereology vs. Set Theory.

According to Link (1983) the semantics of singular and plural count nouns and mass nouns is better modeled by “Mereology” than by Set Theory.

Def. A mereological structure is an upper semi-lattice \(<U,\leq>\), i.e. a weak partial ordering (reflexive, anti-symmetric and transitive) which is closed under sums

\(<U,\leq> is closed under sums: for every \(V \subseteq U\) there is an element \(s \in U\) such that

(i) for all \(v \in V, v \leq s\);  
(ii) if \(w \in U\) is such that for all \(v \in V, v \leq w\), then \(s \leq w\).

(So \(s\) is the “least upper bound” of \(V\). \(s\) is denoted as \(\Sigma V\))

Difference between the denotations of count nouns and mass nouns (very roughly):

Denotations of count nouns are atomic mereological structures; denotations of count nouns are atomless mereological structures.

Def. Let \(<U,\leq>\) be a mereological structure.

(i) \(u \in U\) is an atom of \(<U,\leq>\) iff for no \(v \in U\), such that \(v \neq u\), then \(v \leq u\).

(ii) \(<U,\leq>\) is atomic iff for all \(v \in U\) \(v\) is the sum of all atoms \(u\) such that \(u \leq v\).

(iii) \(<U,\leq>\) is atomless iff \(<U,\leq>\) has no atoms.

(iv) Suppose \(<U,\leq>\) is atomic.

(a) \(<U,\leq>\) is complete iff for any set \(V\) of atoms \(\Sigma V\) exists.

(b) \(<U,\leq>\) is free iff for any two sets \(V, W\) of atoms, if \(V \neq W\), then \(\Sigma V \neq \Sigma W\).

N.B. Every free atomic mereological structure \(<U,\leq>\) is isomorphic to a set structure \(<\mathcal{P}(U') \setminus \emptyset, \subseteq>\), were \(\mathcal{P}(U')\) is the powerset of some set \(U'\) and \(\subseteq\) is the set-theoretic inclusion relation on \(\mathcal{P}(U')\).

Claim: Let \(N\) be any count noun, \(<U,\leq>\) the denotation of \(N\). The extension of the singular form of \(N\), \(N^{sg}\), is the set \(N^{at}\) of atoms of \(<U,\leq>\). The extension of the plural form of \(N\), \(N^{pl}\), consists of the non-atomic elements of \(<U,\leq>\), also called sums or pluralities.

(The extension of \(N^{pl}\) is often denoted as \(N^{+}\). \(N^{*} = df N^{+} \cup N^{+}.\))

Def. The language of plurality, \(LP\), is a formal language for describing mereological structure. \(LP\) is a language of first order predicate with some extra features:
(i) an abstraction operator $\sigma$, which when applied to a formula $\varphi$ and an individual variable $x$, forms a term $\sigma x.\varphi$, in which $x$ is bound by $\sigma$; ("$+X$" is short for "$\sigma x.x \in X$")

(ii) two predicate modifiers $*$ and $D$, operating on 1-place predicates (i.e. if $P$ is a 1-place predicate, then so are $*P$ and $DP$).

Moreover, LP has two special predicates, AT (1-place) and $\subseteq$ (2-place) as well as a 2-place operation constant $+$. Models for LP: atomic, complete mereological structures $M = <A, +, \subseteq, AT>$

Interpretation of $\sigma x.\varphi$, $*P$ and $DP$:

[[\sigma x.\varphi(x)]] = the least upper bound of the $d$ in $M$ which satisfy $\varphi(x)$;
[[*P]] = \{y \in A: (\exists X \subseteq [[P]]) y = +X\}
[[DP]] = \{y \in A: (\forall z)(z \subseteq y & AT(z) \rightarrow P(z)\}

N.B. If [[P]] is a set of atoms, then [[*P]] = [[DP]].

2. Reasons (Link, Landman and others) why mereological structure by itself is not enough and needs to be enriched with groups:

(L21) The talking Heads gave a concert in Holland.
(L22) David, Chris, Jerry and Tina gave a concert in Holland.
(L26) Groenendijk and Stokhof presented a paper at the conference.

(L27) The cards below seven and the cards seven and up have been separated.
(L31) The cards below seven were separated from the cards seven and up.
(L32) The men and the women who were married still had to sleep in different dorms.
(L33) The Leitches and the Latches the each other.

3. Link’s way of introducing “groups” into LP:

Add to LP two 1-place operators $\uparrow$ and $\downarrow$. $\uparrow$ forms groups out of pluralities and $\downarrow$ turns a group into the plurality of its members.

One way to model this extended LP is set-theoretical:

(i) atoms are singleton sets;
(ii) non-atoms are sets of more than one element;
(iii) $\sigma$ is used to form sets out of formulas (defining conditions);
(iv) $\uparrow$ forms the singleton of the argument set $x$ to which it is applied: $\uparrow x = \{x\}$;
(v) $\downarrow$ turns any singleton set $\{x\}$ into $x$: $\downarrow\{x\} = x$.

- This particular model of extended LP structure is not sufficient, since it does not make room for more than one group with the same members.
4. Landman’s simplification.

Landman proposes that on the other hand the system can be simplified as follows:

(i) The extensions of all predicates (verbs as well as nouns) consist solely of atoms.
(ii) collective readings are always group readings; when a predicate applies to a plurality it always distributes
(iii) * now takes over the role of D, which can be discarded; the new clause for *:

\[
[[*P]] = \{y \in A: (\forall z)(z \subseteq y & AT(z) \rightarrow P(z))\}
\]

• Involvement. Landman argues that (L44.a) does not entail (L44.b) (even though David, Chris, Jerry and Tina are the members of The Talking Heads):

(L44)  a. The Talking Heads gave a concert in Holland
    b. David, Chris, Jerry and Tina gave a concert in Holland.

The reason is that (L44.b) seems to imply that all four were present at the concert. (L44.a) does not seem to carry this entailment.

The only way that the difference between (L44.a) and (L44.b) can be accounted for now that the system has been simplified in this way is by insisting that “The Talking Heads” and “David, Chris, Jerry and Tina” denote different groups.

Landman(?): Conjunctive DPs as in (L44.b) and also phrases like four boys, many boys, a group of four boys, as in

(1) Four boys/Many boys/A group of four boys built a boat together.

strongly suggest involvement of all their members in the collective predication expressed by the verb.

Questions: How do we account for this tendency? How plausible is a purely pragmatic account of the relevant differences?

• Application of the new system:

(L64) The cards below seven and the cards from seven up form a deck (together).

\[F(\uparrow ((\sigma x.x < 7) + (\sigma x.x \geq 7)))\]

(L66) The cards below seven and the cards from seven up are shuffled.

One reading: *SH(\( \uparrow (\sigma x.x < 7) + \uparrow (\sigma x.x \geq 7)\))

(L27) The cards below seven and the cards from seven up are separated.

\[S(\uparrow (\uparrow (\sigma x.x < 7) + \uparrow (\sigma x.x \geq 7)))\]
The boys and the girls had to sleep in different dorms, met n the morning at breakfast, and were then wearing their blue overalls.

To be dealt with using type shifting, here using the operations LIFT and LOWER.

Let B&G be the term “\(\uparrow (\uparrow (\sigma x.*B(x)) + \uparrow (\sigma x.*G(x)))\)”. And let “\(\downarrow^2 (a + b)\)” be short for “\(\downarrow(a) + \downarrow(b)\)”. Then (L71) translates into:

\[
S(B\&G) \land M(\uparrow (\downarrow^2 (\downarrow (B\&G)))) \land \ast W((\downarrow^2 (\downarrow (B\&G)))
\]

II. Schwarzschild.

• Main thrust of the paper:

There are two approaches to the semantics of plurals, the “sums approach” and the “groups approach”.

There appears to be strong evidence in favor of the group approach.

However, when the evidence is considered more carefully, this is no longer quite so clear.

• A general methodological problem:

How do we tell whether two plural terms t and t’ are coreferential or not?

Prima facie test for non-coreferentiality: Find a (linguistic) predicate P so that the combination of t with P is a true sentence in a given situation and the combination of t’ with P a false sentence. But this is not fool-proof:

(S1) a. [George and Mike] [are running with Dan and Lloyd, respectively].
   b. [Mike and George] [are running with Dan and Lloyd, respectively].

Suppose (1.a) is true and (1.b) is false. Does that show that “George and Mike” and “Mike and George” are non-coreferential?

• A second methodological issue. Schwarzschild excludes “distributive” readings of conjunctive NPs. What he means is this:

When it is used to conjoin NPs and is ambiguous between:

   (i) its general polymorphic use as a (shifted) sentence conjunction, and
   (ii) a “sum” operator, which forms the sum, or perhaps the group consisting of, the denotation of the conjuncts.

On the first reading, (1.a) is to be analyzed as (1.b):

(1) a. The Titans and the Martians are strong.
    b. The Titans are strong and the Martians are strong.
Schwarzschild excludes this use of *and*. Note however that in many cases “distributive” interpretations (in this sense) of conjoined NPs lead to the same truth conditions as “Non-distributive” readings.

N.B. That and allows for the “sum” interpretation when conjoining NPs is a remarkable fact. The possibility is found only marginally with other grammatical categories, and it is not found at all with, for instance, *or*. For instance (2.a) only has an analysis on which it reduces to (2.b).

(1) a. The Titans or the Martians are strong.  
b. The Titans are strong or the Martians are strong.

- Arguments in favor of groups:

(S5)  
a. The cows and the pigs were separated.  
b. The young animals and the old animals were separated.

(S8)  
a. [[Blücher and Wellington] and Napoleon] fought against each other near Waterloo.  
b. [Blücher and [Wellington and Napoleon]] fought against each other near Waterloo.

(S9)  
a. The pigs from the two communities hated each other.  
b. The pigs from the two parties hated each other.

(S11)  
a. The animals filled the barn to capacity.  
b. The cows and the pigs filled the barn to capacity.  
c. The young animals and the old animals filled the barn to capacity.

(S12) Upward Closure Phenomenon

If a predicate of English is true of a group G of first order, it has a homonym that is true of all higher order groups that are formed using all the members of G (are “related” to G).

(S13) If α is a one-place predicate of English that translates as α’, then it also translates as LIFT(α’), where

\[ ||\text{LIFT}(P)|| = \{ Y \in D: x \in \text{IN}: x \in * Y \in ||P|| \} \]

(\(\in *\) is the transitive closure of \(\in\))

(S16) Mereological Generalization

If a predicate of English is true of a group G of any order, it has a homonym that is true of that first order group G’ which is composed of the individuals.
used to generate $G$.

(S17) If $\alpha$ is a one-place predicate of English that translates as $\alpha'$, then it also translates as $\text{LOWER}(\alpha')$, where

$$||\text{LOWER}(P)|| = \{Y \subseteq \text{IN}: (\exists K)(K \in ||P|| \& \{x \in \text{IN} : x \in^* K\} = Y)\}$$

($\in^*$ is the transitive closure of $\in$)

N.B. Always $\text{LOWER}(\text{LIFT}(\alpha')) = \alpha'$, but in general not $\text{LIFT}(\text{LOWER}(\alpha')) = \alpha'$.

Question: Do the principles (S12) and (S16) lead to an inconsistency?

Schwarzschild: This is not as obvious as it might seem at first sight. Consider (S19.a-f):

(S19) a. The young animals and the old animals are just the cows and the pigs.
   b. The young animals and the old animals were separated.
   c. The animals were separated.
   d. The animals were separated by age.
   e. The cows and the pigs were separated by age.
   f. The cows and the pigs were separated.

So, doesn’t this show that (S19.a,b) entail (S19.f) after all?

Question: Could it be that the interpretation for (S19.f) on which it is entailed by (S19.a,b) can be obtained only when the intermediate sentences make that interpretation available? If that is so, what does that tell us about entailment within natural language?

More examples to show how hard it is to be sure that certain interpretations are not possible:

(S26) Despite their current membership in a common market, only 45 years ago, Germany and England and France and Italy were fighting each other in one of the worst wars in history.

(S8') Blücher and Napoleon and Wellington (listed in alphabetical order) fought against each other near Waterloo.

• What enables the interpreter of a sentence that requires making a partition of the denotation of a plural DP to make the intended partition?

(S28) In this neighborhood the upper class children and the lower class children did not hate each other, but the adults do.

(S29) The various children couldn’t get along with each other nor could the men and women.

• Doing without groups.

(S31) a. The cows and the pigs were involved in a debate. The former were in favor of rebelling but the latter were not.
b. The young animals and the old animals were involved in a debate. The former were in favor of rebelling but the latter were not.

(S34) The prisoners on the two sides of the room could see each other.

(S37) Farmer Smith and Farmer Jones said that although their cows could stay together the pigs had to be separated.

Question: Is the resolution of the partition problem that such sentences pose the same as the resolution problem for pronouns?

Schwarzschild: Not quite, it seems. Decisive in the case of partitioning are properties that are made salient in the discourse. (e.g. the property of belonging to Smith and the property of belonging to Jones)

Question: What is the role by the by-phrases of sentences like (3)?

(3) The animals were separated by age.

Why does (4) seem so very bad (and not just redundant)?

(4) The old pigs and the young pigs were separated by age.

Another general question that Schwarzschild’s discussion raises:

What in meaning and interpretation has to do with denotation and what with representational form?
Some reasons why mereological structure is to be preferred over set-theoretical structure.

Reason 1: We want to be able to analyze *hate each other* in (1) and *were separated* in (2) as relations between two groups, rather than applying to a single plurality.

(1) The Montagues and the Capulets hate each other.
(2) The cows and the pigs were separated.

Reason 2: The name “The Talking Heads” of the pop group behaves differently from the plurality denoting NP “David, Chris, Jerry and Tina” that enumerates its members

(3) a. The Talking Heads has four members.
   b. ?? David, Chris, Jerry and Tina has/have four members.

Reason 3:

(4) (= L6) Who made a mess of the living room?
Intuitively: Answer could specify a single individual or

Fourth reason: Number-neutral uses of plural descriptions like *the books* in

(5) The books the students bought would be enough to keep them busy for the next two weeks.
At last: some real work.

We have seen how the sentences in (1) can be translated into first order logic. But what do we learn from this. We may learn how to translate English into logic – as one is typically taught, in some way or other, in introductory formal logic courses. But what we would really like is an understanding of what is behind translation skills. We would like to be able to define the translation function, which maps arbitrary expressions of a natural language or natural language fragment into logical formulas that correctly capture their content. And something more: We would like to be able to define such a translation function compositionally: assuming a certain way in which each expression is built up syntactically, we would like to (i) define translations for the basic expressions (words and morphemes) and (ii) give rules that determine how the translations of constituents of an expression can be put together to obtain a translation of that expression. In other words: the definition of the translation function should be recursive in terms of the constituent structure of the expressions to which it applies.

It is these desiderata that led to Montague Grammar.

So far we only considered the pair of examples in (1).

(1)  
- a. Two languages are spoken by everybody in this room.
- b. Everybody in this room speaks two languages.

But these are already quite complicated, and it will be useful to first look at some simpler ones, involving at most one quantifier. To see what this involves let us look at a few examples.

(2)  
- a. Every man suffers.
- b. John offended every linguist.
- c. John loves a dachshund.
- d. Every man loves a dachshund.

The main problem that these sentences present for a recursively defined translation function and that concerns us right now has to do with quantification. Connected with the architectural features of natural languages discussed above is the circumstance that one of the ways in which quantification is expressed takes the form of nominal constituents (noun phrases, `Determiner Phrases' (DPs) in current more technical jargon) which contain the quantifier expression as one of their parts (for instance every man in (2.a)). But semantically the quantification expressed by a clause containing such a DP involves not only the DP itself but also the predicate of which the DP occupies an argument position.

Montague’s solution of this problem was a version of an idea going back to Frege, according to which quantifiers are higher order predicates: In (2.a) the VP suffers denotes a property (or, alternatively: a set, the extensional counterpart of a property) and a quantifying DP like every man denotes a property of properties (or alternatively, of sets).

In particular, every man denotes the property that is true of property P iff P is a property that is true of every man.
However, if this is how we want to define the translation of *every man*, then we cannot stay within first order logic, but must move to Higher Order Logic. Montague’s choice was the typed $\lambda$–calculus. (More exactly: the intensional version of the $\lambda$–calculus known as HOIL; but for the time being we will ignore intensionality.) Recall that the typed $\lambda$–calculus subsumes higher order predicate logic.

Briefly: Montague’s account of (2.a) comes in essence to this:

i. (non-relational) nouns and intransitive verbs are translated into terms of type $<e,t>$.

ii. DPs are translated into terms of type $<<e,t>,t>$ (or, in slightly simplified notation, $<et,t>$).

iii. Determiners are translated into terms of type $<et, <et,t>>$

iv. *every* translates into the term $\lambda P. \lambda Q. (\forall x)(P(x) \to Q(x))$

• This strategy works well for quantifying DPs in subject position. But as it stands, it doesn’t work for quantifying DPs in other positions. For instance consider (2.b).

(2.b) John offended every linguist.

Here the object DP must combine with a two place relation (entity of type $<e,<et>>$, rather than with one of type $<e,t>$. Functional application isn’t possible in either direction.

• One way to try and deal with this problem is to assign to quantifying DPs in object position a different denotation. For instance, *every linguist* could be given the denotation:

*every linguist* $\Rightarrow \lambda R. \lambda u. (\forall y)(\text{linguist}(y) \to R(u,y))$

(Here $R$ is of type $<e,et>$.)

This denotation for *every linguist* can be obtained by providing *every* with the alternative lexical entry:

*every* $\Rightarrow \lambda P. \lambda R. \lambda u. (\forall y)(P(y) \to R(u,y))$

Exercise: Show that this gives the right truth conditions for (2.b) given the following syntactic tree for the sentence:
But what are we going to do about quantifying DPs that occur as direct objects to three-place verbs such as *give* or *send*? (I am making the standard assumption here that the direct objects of such verbs are combined with the verb before the other arguments are, so that they are combined with 3-place predicates.)

Apparently we need yet another entry for *every*, and further entries are needed on the assumption that clausal predication can involve even larger numbers of arguments.

As observed in Heim-Kratzer, this semantic multiplicity of determiners like *every* need not worry us too much, since the multiplicity seems to be systematic, and thus a language learner would have to learn the principle only once.

**Exercise** (Recursive definition of the different lexical entries for a determiner like *every*)

The cases just considered suggest that the different meanings that are needed for a determiner such as *every* only involve what we may call ‘first order predicate types’. The first order predicate types can be obtained from the ‘basic’ type <<e,t>> of 1-place first order predicates by the rules (i) and (ii):

(i) if β is the type of an n-place first order predicate, then <e, β> is the type of an n+1-place first order predicate;

(ii) β is the type of a first order predicate if β is the type of an n-place first order predicate for some n.

Let Every_<e,t> be the standard lexical entry for *every* (which is right for every phrases in subject position). That is, Every_<e,t> = λP. λQ. (∀x)(P(x) → Q(x))

Recursively define lexical entries Every_β, where β is any type of a first order predicate; that is, define Every_<e,β> in terms of Every_β, starting from Every_<e,t>.

(Check that your definition verifies in particular:

Every_<e,<e,t>> = λP. λR. λu. (∀y)(P(y) → R(u,y)) )
The problem of in situ treatment of quantifier phases becomes worse once we realize and accept that sentences with two or more quantifying DPs can be scopally ambiguous. Our first examples of this were (1.a) and, arguably also (1.b). Another example is (3), which allows for both an “∃∀-reading” and an “∀∃-reading”. (As in other such cases, when the sentence is spoken, the reading one gets strongly depends on the prosody, but we ignore this here.)

(3) Some philosopher offended every linguist.

How do we get the ∀∃-reading for (3) if we treat every linguist in situ (and thus before we get to some philosopher)?

One way to do that is to adopt yet another entry for every:

\[ \text{every} \Rightarrow \lambda P. \lambda R. \lambda Q. (\forall y)(P(y) \rightarrow (Q(\lambda u. (R(u,y)))) \]

This gives us the intended truth conditions for the ∀∃-reading for (3), but it uses the trick of reversing the lambda-application: we first combine ‘every P with the verb and then combine the result with the subject DP. But this seems terribly ad hoc. What if an object phrase is interpreted as having scope over two other quantifiers?

A way to avoid these difficulties is to allow for ‘quantifier raising’ in the syntax – a syntactic operation that puts the quantifier phrase in the semantically right argument position. This is the strategy Heim and Kratzer adopt and they give a number of good arguments for it, some of which we briefly rehearse. We first illustrate the method in relation to (2.b)

(2.b) John offended every linguist.

(4) Syntactic tree for (2b) with quantifier raising of the object DP.

A special feature of the H&K version of quantifier raising is the node with the index ‘1’, which is just below the moved DP and thus between it and the trace t₁, which the DP leaves behind in its base position.
[Interlude on H&K’s treatment of assignments]

H&K use an adapted version of the λ-calculus. (It allows for λ-terms with presuppositions, whose values are in general partial rather than total functions. However partiality plays no part in the present example.) The expressions they use in computing the λ-terms that describe the meanings of expressions look like this:

$$[[\alpha]]^a$$.

Here α is an expression and a is a partial assignment from numbers to individuals (= entities in D_e). (For instance, a could be “1 → b”, the assignment with domain {1} and such that a(1) = b. Or a could be the empty assignment ∅; etc.).

Assignments become relevant only in cases where the syntactic tree contains indices. i.e. subscripts like the “i” on in t_i and the `1` below the moved DP. For instance, $$[[t_1]]^1 \rightarrow b = b$$; and $$[[\text{linguist}'(t_1)]]^1 \rightarrow b$$ denotes the truth value 1 iff b is a linguist.

With this notation we can assign to the VP of (4) as denotation the term offended’(t_1)))[1] \rightarrow b. This term is equivalent to the term $$[[\lambda u. \text{offended}'(t_1)(u)]]^1 \rightarrow b$$. This last term is also often written as $$[[\lambda u. \text{offended}'(u, t_1)]]^1 \rightarrow b$$, to conform to the tradition of representing verbs like offend as 2-place relations with the subject argument in first and the direct object argument in second position (rather than as functions from individuals to functions from individuals to truth values, as one does in the λ-calculus).

offended’(t_1)]^1 \rightarrow b denotes the function which maps each individual of the universe to the truth value of the proposition that that individual offended b.

The empty assignment is often omitted: instead of `[[[\alpha]]^\emptyset' we often simply write $$[[\alpha]]$$.

λ-abstraction comes into action in determining the denotations of nodes whose left daughter is a binding index (like the node between the two S’s in (4)).

The denotation of such a node is obtained by lambda abstracting over the denotation term of the right hand daughter with respect to some variable x of type e. But the binding must capture the coindexed constituents in the denotation of the right hand daughter. This is achieved by adding the binding index to the domain of the assignment and assigning the abstraction variable to that index.

In the case of (4) this functions as follows. The lower S node gets the denotation offended’(john’,t_1), which is the same as $$[[\text{offended}'(\text{john},t_1)]]^\emptyset$$. Lambda abstraction now gives us for the next node, say:

$$\lambda y. ([[\text{offended}'(\text{john}',t_1)]]^1 \rightarrow y)$$. This term is equivalent to $$\lambda y.\text{offended}'(\text{john}',y)$$. Applying the <et,t> denotation of every linguist to this gives us what we want.
**Exercise:** check the computation for (4).

Note how the way in which assignments can be built into the denotation terms gives a way of keeping track of the connection between the binding index and the constituents in the binding target that are coindexed with it!

- In (4) only the quantifying DP *every linguist* was moved. What about non-quantifying DPs like *John*? As H&K point out, we can do this, if we want to, giving such DPs the denotation proposed first by Montague.

  E.g. *John* is assigned the denotation $\lambda P. P(\text{john}')$ (= the property of being a property that John has).

  Here john’ is a constant of type e that denotes John.

  As H&K note, raising non-quantifying DPs is not going to make any difference to what truth conditions are assigned. In the case of (2.e) raising *John* gives the same truth conditions we obtained for (4), irrespective of whether *John* is raised above or below *every linguist*.

- Using the technology shown in this example it is now also possible to deal with scopally ambiguous sentences like (3):

  (3) Some philosopher offended every linguist.

  We can assign two syntactic trees to this sentence:

  (5) First syntactic tree for (3):

  $S$

  $DP$

  $Det \quad NP \quad 2 \quad S$

  $some \quad N \quad DP$

  $philosopher \quad 1 \quad S$

  $Det \quad NP$

  $every \quad N \quad DP \quad VP$

  $linguist \quad t_2 \quad V \quad DP$

  $offended \quad t_1$
(6) Second syntactic tree for (3):

\[
\begin{array}{ccccccc}
\text{S} & \text{NP} & 2 & \text{S} \\
\text{DP} & N & \text{DP} & \text{VP} \\
\text{Det} & \text{NP} & \text{DP} & \text{VP} \\
\text{every} & \text{linguist} & \text{t}_2 & \text{V} & \text{DP} \\
\end{array}
\]

\[
\begin{array}{ccc}
\text{offended} & \text{t}_1 \\
\end{array}
\]

**Exercise:** Show that the compositional methods used before give the \(\exists \forall\)-reading and the \(\forall \exists\)-reading of (3), respectively.

- Dealing with the semantics of sentences containing quantifying DPs via Quantifier Raising has additional benefits. One of these are the cases of “inversely linked” quantifiers, (which were one of the main motivations for introducing Quantifier raising in the first place (in Robert May’s doctoral dissertation.

In fact, the sentences in question tend to ambiguous between a “inversely linked” and a not “inversely linked” interpretation:

(7) One apple in every basket is rotten.
(8) No student from a foreign country was admitted.

In (7) the inversely linked interpretation is more prominent. (The other interpretation is highly implausible given world knowledge.) In (8) the somewhat preferred reading is the non inversely linked one.

One way to obtain the inversely linked reading of (7) is to first raise the entire subject phrase *one apple in every basket* and then raise the DP embedded within the subject phrase out of it. This gives us (9).
Computing the truth conditions from (9) in the way we did before gets us the inversely linked interpretation of (7).

As a matter of fact, for reasons that have to do with the intricate ways in which syntax and semantics interact in the H&K system, this cannot be quite the right solution there. At least for the time being we forego the interesting but somewhat hairy details.

• H&K also offer a detailed account of pronouns. We will not go into this here. In a nutshell their treatment distinguishes between `bound pronouns’ – these are pronouns that get an index in the syntactic structure – and referential pronouns. The latter category includes both deictic uses of pronouns and pronouns that are anaphoric to antecedents inside our outside the sentence, but without being bound (in the sense of binding relevant here, which is in essence that of variable binding in predicate logic and the \( \lambda \)-calculus). Among such pronouns are in particular so-called “donkey pronouns”, as in

(10) If Pedro owns a donkey, then he beats it.
(11) If a farmer owns a donkey, then he beats it.
(12) Every farmer who owns a donkey beats it.

Such anaphoric but unbound pronouns are treated as “E-type pronouns”. E-type pronouns are interpreted as if they were shorthand for certain definite descriptions, which makes them into referential expressions of a sort.

**Discourse Representation Theory**

DRT is different from H&K’s approach in a number of ways:

• DRT started out as an attempt to grasp a way of capturing the systematic semantic connections between successive sentences in a discourse.
One striking example of such connections are those established by anaphoric pronouns whose antecedents occur in earlier sentences. So the behavior of such pronouns was one of DRT’s first targets.

(Another domain where discourse connections are systematic and important is temporal reference. (See also SDRT in this connection.) More about this in our next block.

- One important aim of DRT is to define a semantic representation formalism that allows semantic representations of sentences and bits of discourse to serve

(i) as discourse contexts for what is to be interpreted next.

(ii) as premises for logical inferences (including those that are needed to advance the interpretation of the given discourse or sentence for which a representation is being constructed.

Pronouns were central to the original conception of what the theory was meant to accomplish, and close attention was paid to them from the start.

- In the original formulation of DRT semantic representations of sentences and bits of discourse (so-called *Discourse Representation Structures*, or ‘DRS’s) were constructed from syntactic trees by breaking the tree up into its constituents, starting from the top (strictly speaking: from the root of the tree). This is the so-called ‘top-down’ construction algorithm.

As a first illustration of how this works consider sentence (2.b) (*John offended every linguist.*)

We assume the syntactic structure in (13.a).

(13) a. 

\[
\begin{array}{c}
\text{S} \\
\text{DP} & \text{VP} \\
\text{John} & \text{V} & \text{DP} \\
\text{offended} & \text{Det} & \text{NP} \\
\text{every} & \text{N} \\
\text{linguist} \\
\end{array}
\]

The first step in the construction of the DRS decomposes the tree into its subject DP and its VP. The subject DP is a proper name. The processing rule for such DPs says: ‘(i) Introduce a *discourse referent* for the DP (its ‘referential argument’), (ii) place the discourse referent into the universe of the DRS (the top tier of the diagram in (13.b), (iii) replace the DP in the
syntactic tree by the discourse referent and (iv) add a condition to the effect that the discourse referent stands for the referent of the name.

For now we will assume that the condition mentioned in (iv) takes the form of making the discourse referent an ‘argument’ of the name; here, if \( x \) is the discourse referent chosen, the condition is ‘\( \text{John}(x) \)’. The full story is much more complicated. More later.)

This gives us (13.b).

\[
\begin{array}{c}
\text{x} \\
\text{John(x)} \\
\text{S} \\
\text{x} \\
\text{VP} \\
\text{V} \\
\text{DP} \\
\text{offended} \\
\text{Det} \\
\text{NP} \\
\text{every} \\
\text{N} \\
\text{linguist}
\end{array}
\]

In the present case only one further decomposition is required, that of the VP into the verb and the object DP. This time the DP is quantificational and its processing rule differs in certain ways from that for proper names. Common to the two cases is that in both (i) a discourse referent is introduced as referential argument for the DP and (ii) this discourse referent replaces the DP in the syntactic tree. But a quantificational DP like every linguist binds its referential argument, and that leads to a quantificational representation. This representation is given in the form of a so-called duplex condition, in which the quantifier, contributed by the Determiner of the DP, sits in the middle, between the restrictor, given by the DP sister of the Determiner, and the nuclear scope, given by the structure into which the new discourse referent is inserted.

Both restrictor and nuclear scope are represented as DRSs. So duplex conditions are complex DRS-conditions that have DRSs as components.

The new discourse referent is inserted both into the universe of the restrictor DRS and into the quantifier in the middle.

The result is as in (13.c).
c. 

\[
x \quad \text{John}(x)
\]

\[
y \quad \forall \quad \text{NP}(y) 
\]

\[
N \quad x \quad \text{VP} 
\]

\[
\text{linguist} \quad V \quad y 
\]

\[
\text{offended} 
\]

Since the remaining bits of syntax express elementary predications we can rewrite (13.c) more simply as in (13.d).

d. 

\[
x \quad \text{John}(x)
\]

\[
y \quad \forall \quad \text{NP}(y) 
\]

\[
\text{linguist}(y) \quad \text{offended} \ (x,y) 
\]

In a similar vein we can construct the semantic representation for (13.a) (*Every man suffers.*) Here there is just one construction step, to deal with the quantificational subject DP. The syntactic structure of (2.a) is given in (14.a).

(14)  

a. 

\[
S 
\]

\[
\text{DP} \quad \text{VP} 
\]

\[
\text{Det} \quad \text{NP} \quad V 
\]

\[
\text{every} \quad N \quad \text{suffers} 
\]

\[
\text{linguist} 
\]
The quantificational subject of (14.a) is dealt with in the same way as in (13), leading to (14.b), or the streamlined version in (14.c).

b.  
\[
\begin{array}{c}
\forall \ x \ NP(x) \\
\quad \quad \quad \quad \quad \quad \quad \quad x \ VP \\
\quad \quad \quad \quad \quad \quad \quad \quad N \ V \\
\quad \quad \quad \quad \quad \quad \quad man \ suffers \\
\end{array}
\]

c.  
\[
\begin{array}{c}
\forall \ x \ man(x) \\
\quad \quad \quad \quad \quad \quad \quad x \ suffers(x) \\
\end{array}
\]

Note that the mismatch problem that arises for the occurrences of quantifying DPs in different syntactic positions does not arise with this method. In that respect it is like the H&K method involving Quantifier Raising. The difference is that the H&K treats all quantifiers as applying to predicates (expressions of type <e,t>), whereas the present method treats them as combining with ‘formulas’ (i.e. expressions of type t).

In the light of the way the DRT top-down construction algorithm works for (2.a) and (2.b) one might hope that it would allow us to do without QR. Unfortunately that isn’t so. Without QR inversely linked quantifiers do not come out right using the top-down algorithm; and the same is true of the bottom-up construction algorithm, which will be considered shortly.

But first let us see how the top-down algorithm fares with the sentences in (10)-(12). Before we consider those, we first construct a representation for the 2-sentence discourse in (15). This will give us an opportunity to see how a DRS (that for the first sentence of (15) can at the same time represent the content of what it is constructed from and serve as context for the interpretation of what comes next.

(15) Pedro owns a donkey. He beats it.
First sentence:

Step 1:  
\[ S \]
\[ \text{DP} \quad \text{VP} \]
\[ Pedro \quad V \quad \text{DP} \]
\[ owns \quad \text{Det} \quad \text{NP} \]
\[ a \quad \text{donkey} \]

Step 2:  
\[ x \]
\[ \text{Pedro}(x) \]
\[ S \]
\[ x \quad \text{VP} \]
\[ \text{V} \quad \text{DP} \]
\[ owns \quad \text{Det} \quad \text{NP} \]
\[ a \quad \text{donkey} \]

Step 3:  
\[ x \quad y \]
\[ \text{Pedro}(x) \quad \text{donkey}(y) \]
\[ S \]
\[ x \quad \text{VP} \]
\[ \text{V} \quad y \]
\[ owns \]

Simplification:

\[ (K_{15},i) \]
\[ x \quad y \]
\[ \text{Pedro}(x) \quad \text{donkey}(y) \]
\[ owns(x,y) \]
Second sentence, steps 1,2.

\[
\begin{array}{ccc}
\text{x} & \text{y} & \text{u} \\
\text{Pedro(x) donkey(y)} & \text{u = x} \\
\text{owns(x,y)} \\
\end{array}
\]

\[S\]
\[
\begin{array}{ccc}
\text{u} & \text{VP} \\
\text{V} & \text{DP} \\
\text{beats} & \text{it} \\
\end{array}
\]

Step 3:

\[
\begin{array}{ccc}
\text{x} & \text{y} & \text{u} & \text{v} \\
\text{Pedro(x) donkey(y)} & \text{u = x} & \text{v = y} \\
\text{owns(x,y)} \\
\end{array}
\]

\[S\]
\[
\begin{array}{ccc}
\text{u} & \text{VP} \\
\text{V} & \text{v} \\
\text{beats} \\
\end{array}
\]

Simplification:

\[(K_{(15)})\]

\[
\begin{array}{ccc}
\text{x} & \text{y} & \text{u} & \text{v} \\
\text{Pedro(x) donkey(y)} & \text{u = x} & \text{v = y} \\
\text{owns(x,y)} & \text{beats(u,v)} \\
\end{array}
\]

The DRSs \((K_{(15).i})\) and \((K_{(15)})\) are *simple* DRSs, whose conditions are all atomic predications. They can be thought of as partial models of the world that the sentence \((15.i)\) and the discourse \((15)\) purport to describe:
These DRSs model the world correctly in case the world contains individuals corresponding to the DRs of the DRS such that these individuals satisfy the conditions that the DRS specifies for the corresponding DRs. In this case we also say that the DRS is true (of the world). Thus

**Def. 1** A simple DRS is true (of the world) iff there exists a function f that maps the discourse referents of its universe to entities (of the world) which satisfy the conditions that the DRS specifies for the DRs to which they correspond under f.

Formally, we may think of DRSs as the ‘formulas’ of some logical formalism, like predicate logic or the λ-calculus. One task of DRT has been to develop such formalisms – so-called ‘DRS-languages’ – suited for the representation of natural language (and some related purposes, such as the representation of thought). And the specification of a DRS-language involves, like the full specification of predicate logic or the λ-calculus, not only the syntax of the language – which specifies which combinations of symbols are ‘well-formed formulas’ (i.e. well-formed DRSs) – but also of a model-theoretic semantics, which specifies a class of models for the language, and a ‘truth definition’, which determines for each DRS K of the language and each model M whether or not K is true in M.

For DRS languages the truth definition always follows the pattern of Def. 1. For instance, the simplest DRS language whose ‘formulas’ include the DRSs (13.d) and K_{15} comes with a model-theory in which the models are like the models for first order predicate logic: each model M is a pair <U,F>, where U, the universe of M, is a non-empty set of individuals and F is a function that assigns the predicates of the language extensions within U. Given models of this kind, Def. 1 can be restated as a definition that relates DRSs and models:

**Def. 2** A simple DRS K is true in a model M iff there exists a function f that maps the universe of K into the universe of M, so that for each condition P(d_1,..., d_n) in the condition set of K f(d_1),...,f(d_n) satisfy P in M.

This definition can be extended to cover all DRSs of the language (not just the simple ones) by providing ‘recursive clauses’ for the different types of complex DRS-conditions of the given DRS-language. For details see (Kamp & Reyle, 1993, Chs. 1,2).

So far we have seen only one complex DRS-condition, viz. the one condition of (14.c). Our next example leads to another (but closely related) complex condition form, which we use to represent the content of conditional sentences.

The top-down DRS construction for the conditional sentence (10).

We assume the following syntactic structure:
(16) a.

S

SC
Conj S DP VP
if DP VP he V DP
Pedro V DP beats it
owns Det NP
a donkey

DRS construction:

Step 1: Turn if-clause and main clause of (16.a) into antecedent and consequent of a conditional DRS-condition:

b.

S

S

DP VP ⇒ DP VP
Pedro V DP he V DP
owns Det NP beats it
a donkey

Steps 2,3: deconstruct the syntactic structure in the antecedent.

c. (step 2)

x

Pedro(x)

S

S

x VP ⇒ DP VP
V DP he V DP
owns Det NP beats it
a donkey
d. (step 3):

\[
\begin{array}{c}
x \\
\text{Pedro}(x) \\
y \\
donkey(y) \\
\end{array}
\]

\[
\begin{array}{cc}
S & S \\
x & \Rightarrow & \text{DP} & \text{VP} \\
V & y & he & V & \text{DP} \\
\text{owns} & & & \text{beats} & it \\
\end{array}
\]

Steps 4,5: deconstruct the syntactic structure in the consequent.

e. (step 4)

\[
\begin{array}{c}
x \\
\text{Pedro}(x) \\
y \\
\text{donkey}(y) \\
\end{array}
\]

\[
\begin{array}{cc}
S & S \\
x & \Rightarrow & u & \text{VP} \\
V & y & V & \text{DP} \\
\text{owns} & & \text{beats} & it \\
\end{array}
\]
(step 5)  

Pedro(x) 

\[ u = x \quad v = y \] 

donkey(y) 

S 

\[ x \quad \text{VP} \Rightarrow u \quad \text{VP} \] 

\[ V \quad y \quad V \quad v \] 

owns \quad beats 

Simplification:  

\[ ((K_{(10)}) \] 

Pedro(x) 

\[ u = x \quad v = y \] 

donkey(y) \Rightarrow owns(x,y) 

beats(u,v) 

Next the DRS construction for a sentence with a paradigmatic ‘bound variable’ occurrence (for those who distinguish between bound variable uses and referential uses of personal pronouns).

(17) Many a man has been in love with a woman who disliked him.

a. (Syntax)  

\[ S \] 

\[ \text{DP} \quad \text{VP} \] 

\[ \text{Det} \quad \text{NP} \quad V \quad \text{DP} \] 

\[ many \quad a \quad man \quad has \quad been \quad in \quad love \quad with \quad a \quad N \quad RC \] 

\[ woman \quad who_1 \quad S \] 

\[ t_1 \quad \text{VP} \] 

\[ V \quad \text{disliked} \quad \text{DP} \quad \text{him} \]
Step 1: create quantificational DRS-condition. (‘Duplex Condition’)

b.

\[
\begin{array}{c}
\text{x} & \text{S} \\
\text{man(x)} & \text{x} & \text{x} & \text{VP} \\
\text{V} & \text{DP} \\
\text{has been} & \text{Det} & \text{NP} \\
\text{in love with} & \text{a} & \text{N} & \text{RC} \\
\text{woman} & \text{who}_1 & \text{S} \\
\text{t}_1 & \text{VP} \\
\text{disliked} & \text{DP} & \text{him} \\
\end{array}
\]

c. (step 2)

\[
\begin{array}{c}
\text{x} & \text{y} \\
\text{man(x)} & \text{x} & \text{NP(y)} \\
\text{N} & \text{RC} \\
\text{woman} & \text{who}_1 & \text{S} \\
\text{DP}_1 & \text{VP} \\
\text{t}_1 & \text{V} & \text{DP} \\
\text{disliked} & \text{him} \\
\end{array}
\]

\[
\begin{array}{c}
\text{x} & \text{VP} \\
\text{V} & \text{y} \\
\text{has been} & \text{in love with} \\
\end{array}
\]
d. (step 3):

\[
\begin{array}{ccc}
\text{man}(x) & \text{Many} & \text{woman}(y) \\
\text{x} & \text{y} & \\
S & \\
y & \text{VP} & \\
v & \text{DP} & \\
\text{disliked} & \text{him} \\
\end{array}
\]

\text{has-been-in-love-with}(x,y)

e. (step 4)

\[
\begin{array}{ccc}
\text{man}(x) & \text{Many} & \text{woman}(y) & \text{u} \\
\text{x} & \text{y} & \text{u} = \text{x} & \\
S & \\
y & \text{VP} & \\
v & \text{u} & \\
\text{disliked} & \\
\text{has-been-in-love-with}(x,y) \\
\end{array}
\]

Simplification:

\[
\begin{array}{ccc}
\text{man}(x) & \text{Many} & \text{woman}(y) & \text{u} = \text{x} \\
\text{x} & \text{y} & \text{u} & \\
\text{disliked}(y,u) & \\
\text{has-been-in-love-with}(x,y) \\
\end{array}
\]

The very same DRS-construction principles lead to the following representation for the ‘quantificational donkey sentence’ (12). (Exercise: Check this!)
Quantifier Scope Ambiguities in DRT.

The construction algorithm of standard DRT offers no means of dealing with scope ambiguities like those found in (1) or (3). One way in which we can get the missing scope readings is by allowing direct object DPs to be processed before subject DPs, but this is ad hoc and carries a danger of overgenerating. The alternative is to prepare for the different scope readings at the level of syntax via quantifier raising. (This of course also holds the threat of overgeneration, but at least we can exploit the considerable amount of work that syntacticians have put into formulating motivated constraints to prevent this.)

Quantifier raising also seems the best option to deal with inversely linked quantifiers within DRT. For instance, a DRS giving the natural reading of (7) can be obtained by applying the construction rules we have used so far to the syntactic structure in (9). We give the decisive steps of the construction, starting with a syntactic structure in which the traces of moved DPs are coindexed with the DPs themselves (rather than with indices just below the target sites of the DRS, as in Heim-Kratzer; cf. (9) above). We slightly simplify matters by replacing one by some.

(18) a.

\[
\begin{array}{cccc}
\text{S} & \text{DP}_2 & \text{S} \\
\text{Det} & \text{NP} & \text{DP}_1 & \text{S} \\
\text{N} & \text{Det} & \text{NP} & \text{t}_1 & \text{VP} \\
\text{every} & \text{basket} & \text{some} & \text{N} & \text{PP} & \text{V} \\
\text{apple} & \text{P} & \text{t}_2 & \text{is rotten} \\
\text{in} & \\
\end{array}
\]
b. (step 1)

\[
\begin{array}{c}
\forall \text{basket}(x) \quad \text{DP}_1 \\
\end{array}
\]

S

\[
\begin{array}{c}
\text{Det} \quad \text{NP} \\
\text{some} \quad \text{N} \\
\text{apple} \quad \text{P} \\
\end{array}
\]

S

\[
\begin{array}{c}
t_1 \\
\text{VP} \\
\text{is rotten} \\
\text{in}
\end{array}
\]

c. (step 2)

\[
\begin{array}{c}
\forall \text{basket}(x) \quad \text{NP}(y) \\
\end{array}
\]

S

\[
\begin{array}{c}
y \\
\text{VP} \\
\text{is rotten} \\
\text{in}
\end{array}
\]

Simplification

d.

\[
\begin{array}{c}
\forall \text{basket}(x) \quad \text{apple}(y) \\
\end{array}
\]

is-rotten(y)

Exercise:

Show that if the top-down algorithm is applied to a syntactic structure for (7) in which the DPs are kept in situ the resulting DRS will represent the counterintuitive reading according to which there is some apple that is rotten and is in every basket.
Before we leave this discussion of the top-down algorithm a remark is in order about complex conditions like those in \((K_{10})\), \((K_{1.c})\) and \((K_{12})\). What do these conditions contribute to the truth conditions of the DRSs of which they are parts. As an example consider

\[(K_{10})\]

\[
\begin{array}{ccc}
  & x & \\
  \mbox{Pedro(x)} & y & u & v \\
  \mbox{donkey(y)} & \Rightarrow & u = x & v = y \\
  \mbox{owns(x,y)} & & \mbox{beats(u,v)}
\end{array}
\]

This is a DRS with a single DR, x, in its universe and two conditions, the atomic ‘Pedro(x)’ and the \(\Rightarrow\)-condition, in its condition set. As we saw, a DRS is true in a model \(M = \langle U, F \rangle\) iff there is an embedding \(f\) of its universe into the universe \(U\) of \(M\) such that the conditions of the DRS are all verified in \(M\) by the \(f\)-values of the DRs they contain. What it means for \(f\) to verify ‘Pedro(x)’ we already saw: that is the case iff \(f(x)\) is the referent in \(M\) of the given use of ‘Pedro’. But what is it for \(f\) to verify the \(\Rightarrow\)-condition? This is something we haven’t addressed yet and that doesn’t follow from anything we have said. By articulating the verification requirements for \(\Rightarrow\)-conditions we fix the semantic contributions that such conditions make, and therewith we also the semantics we assign to the locutions that give rise to \(\Rightarrow\)-conditions. (According to the construction rule applied in the case of (10) these are sentences consisting of an if-clause and a main clause.)

The verification cause for \(\Rightarrow\)-conditions is as follows. Let \(C\) be a \(\Rightarrow\)-condition of the form \(K_1 \Rightarrow K_2\), where \(K_1\) and \(K_2\) are DRSs, let \(M\) be a model and let \(f\) be an embedding function that is not defined for the DRs occurring in \(K_1\) and \(K_2\). Then

\[(19)\quad f \text{ verifies } K_1 \Rightarrow K_2 \text{ in } M \text{ iff for every embedding } g \text{ which extends } f, \text{ whose domain } \text{Dom}(g) \text{ is equal to } \text{Dom}(f) \cup U_{K_1} \text{ and which verifies all the conditions of } K_1 \text{ can be extended to an embedding } h \text{ such that } \text{Dom}(h) = \text{Dom}(g) \cup U_{K_2} \text{ and which verifies all the conditions of } K_2.\]

It is not hard to check that (19) assigns to \((K_{10})\) truth conditions that correspond to the following formula of predicate logic:

\[(20)\quad (\exists x) (\text{Pedro}(x) \& (\forall y)((\text{donkey}(y) \& \text{owns}(x,y)) \rightarrow \text{beats}(x,y)))\]

Two things should be noted about these truth conditions:

(i) This time the quantificational force of the indefinite a donkey is universal rather than existential. This is as it should be. (At least to significant number of natural language speakers, and as far as I can tell, a substantial majority). But note that again this quantificational force is imposed by the verification conditions in (19), which require that every extension \(g\) of \(f\) that verifies \(K_1\) can be extended to a verifying embedding of \(K_2\). In fact, this universal force is only imposed on indefinites in the if-clauses of conditional
sentences. An indefinite in the main clause gets an existential interpretation, imposed by the existential requirement that there be an extension \( h \) of \( g \) which verifies \( K_2 \). An example is the sentence in (21).

(21) If Pedro owns a donkey, then he has rented it to some merchant.

It is important to keep in mind that the possibility of interpreting \( it \) in (10) as anaphoric to \( a \) donkey rests on the accessibility of the DR \( y \) that \( a \) donkey has contributed to the antecedent-DRS \( K_1 \) is accessible to pronouns that have to be interpreted as part of the consequent-DRS \( K_2 \). That \( y \) is accessible as antecedent for anaphoric expressions in the consequent-DRS is formally independent from the particular verification conditions we choose for \( \Rightarrow \). But of course there is a conceptual connection: the antecedents of conditional make their DRs available for anaphoric reference in the consequent, because it is the function of an antecedent to describe a certain type of situation about which the consequent then says more, because of this it is natural that one should choose to phrase one’s consequent clauses in ways that depend for their interpretation on the way in which the situation type is presented in the antecedent, and natural languages allow their speakers to make ample use of this.

(ii) (19) may look complicated when compared with the clause for the conditional connective that we find in classical predicate logic, which treat the conditional as material conditional: \( A \rightarrow B \) is true (or verified by some embedding function \( f \)) if either \( A \) is false (or not verified by \( f \)) or \( B \) is true (or verified by \( f \)). However, the complications only have to do with getting the connections between anaphoric elements and their antecedents right. When there are no such connections, then (19) reduces to the material conditional clause. One can check this by applying (19) to a sentences like (22.a,b), in which there are no such connections.

(22) a. If John is angry, then Frieda is satisfied.
   b. If Pedro owns a donkey, then he is rich.

It is possible to replace (19) by other verification conditions that assign \( \Rightarrow \)-conditions a non-classical interpretation, e.g. one that makes it into a strict conditional (in the cases where there are no anaphoric links between antecedent and consequent, and by extrapolation also for the cases were there are).

What goes for \( \Rightarrow \)-conditions also goes for the ‘duplex conditions’ introduced by quantifying determiners like \( every \) or \( many \ a \). Each of these comes with its own verification requirement. For details, see From Discourse to Logic, Chs. 1,2,4.

We will soon switch form the top-down construction algorithm to a bottom-up algorithm, which is more natural in relation to the distinction between referential and non-referential argument positions. Moreover, we will find that the benefits that the top-down algorithm seems to have for the ‘on line’ treatment of anaphoric pronouns disappear once we extend the DRT-approach to cover presupposition and treat pronouns as one type of presupposition trigger.

But first we turn to some informal considerations about the semantics of tense and aspect.
Tense and Aspect

The semantics of temporal reference in English is notoriously tricky. (And the same is true for many other human languages; quite possibly it is true for all, if sometimes in quite different ways and for different reasons.)

There are a number of reasons why the semantics of temporal reference for languages like English—which have elaborated tense morphology on the verb—is complicated. A number of these we will encounter as we proceed. But by way of a first impression, here in a nutshell are some.

First, temporal reference—the location of the eventuality (event or state) a clause describes on the time axis—often results from the joint effect of several elements in the clause—the tense of the verb, but also temporal adverbs and/or temporal subordinate clauses. But the aspectual properties of the verb itself—its so-called ‘Aktionsart’—plays an important part as well, and so do aspectual operators that may change its lexical aspect as the meaning of a clause is compositionally constructed from its constituents. A further important dimension to temporal reference, which will be of special interest to us, are the ways in which a newly described eventuality can be linked to eventualities and times introduced earlier in the discourse. To establish such links between new events and states and those introduced in earlier clauses or sentences is one of the important functions of the tenses (and of other temporal sentence constituents as well). However, it is a function that is closely connected with the ‘rhetorical’ structure of discourse: the temporal relations between the events described by successive clauses or sentences correlate with the rhetorical relations between the clauses or sentences that describe them. The connections between temporal and rhetorical relations add another level of complexity to the semantics of tense and aspect, in which world knowledge plays a key role (Asher and Lascarides, Logics of Conversation).

(1) lists some of factors that contribute to the temporal location of the eventuality described by a clause, in relation to the utterance time and to other events and times mentioned in the discourse.

(1) a. the tense morphology of the verb;
   b. the aspectual properties of the lexical verb (Aktionsart);
   c. aspect operators, such as the English progressive, aspectual verbs such as start, finish, continue, used to, the perfect, generic operators like used to and possibly others;
   d. various kinds of temporal adverbials;
   e. rhetorical relations between clauses and sentences.

The often subtle effects of tense and other sentence elements relevant to temporal location often manifest themselves in the way the described eventuality is temporally related to events or times mentioned earlier in the discourse. The examples below provide some illustrations of this.

(2) a. John proved the theorem in twenty lines. Mary had proved it in ten lines.
   b. John proved the theorem in twenty lines. Mary proved it in ten lines.

(3) a. Fred went to Rosie for dinner. He came home in a state of euphoria.
   b. Fred went to Rosie for dinner. He put on clean trousers and his nicest shirt.
c. Fred went to Rosie for dinner. He bought flowers on the way. (Webber)

(4) When Alan opened his eyes he saw his wife who was standing by his bedside.
   (i) She smiled
   (ii) She was smiling.

(5) A man entered the White Hart. He was wearing a back jacket. Bill served him a beer. The man paid. He drank the beer. It was exceptionally good. (Kamp & Reyle, 1993)

(6) Bill arrived at noon. He had got up at six thirty, had cooked himself a full breakfast, and had washed up after finishing it. He had left the house in time to catch the 7.54 train at the central station.

(7) a. Henry arrived on Wednesday. He left again on Sunday.
   b. Henry arrived on Wednesday. He would leave again on Sunday.
   c. Henry arrived on Wednesday. He will leave again on Sunday.

Another source of complications are the temporal relations between the eventualities mentioned in indirect discourse clauses and the tenses of the matrix verbs under which these clauses are embedded. Illustrative examples are (8) – (11).

(8) a. Mary said she ate an apple.
   b. Mary said that she felt sick.
   c. Fred and Mary told us of the horrible scene they had watched when coming out of the train station. Mary said she felt sick.

(9) Fred told me that Mary is expecting.

(10) a. It was predicted once that civilisation would come to an end through a world-wide epidemic (in the year 3000/in the year 2000).
    b. It was predicted once that civilisation will come to an end through a worldwide epidemic (in the year 3000/# in the year 2000).

(11) Mary told me last week that she was going to file for a divorce in a couple of weeks but that she would tell Fred only then that she had (filed for a divorce).

The discourse-anaphoric phenomena attested in many of these examples are nowadays widely seen as involving presupposition. (This is true ont only for the temporal anaphora found with the tenses and other temporal sentence elements, but also for anaphoric pronouns. An adequate treatment of the discourse-related properties of tenses and other temporal expressions should therefore be postponed until we come to deal with presupposition in general. But there is much about the interpretation of temporal information that can and should be dealt with before we get to presupposition, and that is what we proceed to now.

In particular, accounting for the semantics of tense within the general framework we are pursuing is one reason for turning from the top-down approach to logical form construction to a bottom-up approach. (Proposals to this effect go back to the late eighties; see for instance
(Asher,??), (Zeevat,1989). But the reasons for preferring a bottom-up approach vary, and as far as I can tell, the present reason for switching isn’t quite the same as what motivated those authors.)

Here are some of the basic assumptions that motivate the treatment of tense and aspect by means of a bottom-up construction algorithm.

1. Verbs have referential arguments. These are always eventualities (events, states).
2. The eventuality that is introduced by the main verb of a clause is temporally located by its tense, by temporal adverbs in the clause (if present), and also by ‘anaphoric’ linking to the antecedent discourse.
3. An important factor is aspect (viewpoint aspect, (Smith,1990)): events and states relate differently to temporal adverbs and temporal element from the preceding discourse.
4. We assume that in the syntactic structure of a finite clause the information provided by tense is located at the ‘head’ T of the so-called ‘TP-projection of the verb (TP = ’Tense Phrase’). (The subject DP is assumed to be the ‘Specifier’ of TP.)
5. Aspectual information of the kind provided by operators like the English Progressive and the Perfect is available at levels between VP and TP, with Perfect at a higher level than Progressive.

1. -5. indicate the kind of syntactic structure from which we will construct semantic representations of tensed sentences.

From now on we will build DRSs ‘bottom-up’. That is, we start by inserting the semantic representations of the lexical items that appear at the leaves of the tree and work our way up from there, combining the representations of the daughter nodes of a given node into the representation of their mother. The combination rules correspond to the composition rules we find in the approaches to the syntax-semantics interface we find in the work of Montague and in the book of Heim-Kratzer (and also to the recursive clauses of the truth or satisfaction definition for formal systems like the λ-calculus or predicate logic).

We start with a very simple example, viz. the sentence (12). For this sentence we can make do with the syntactic representation in (13). (The Perfect and Aspect projections are arguably there, but they do not contribute anything to the semantics, waving the semantics of their sister nodes through, so to speak, to their mother nodes.)

(12) Frieda smiled.

(13) S
    Comp TP
    Ø DP T’
    Frieda T VP
    Past V
    smile
Before we can start with the construction of DRS for this or any other sentence, we first need to say something about the semantic representations of lexical items. This is a complicated matter, and for several reasons. For one thing, the kind of semantics that DRT attributes to various words which play some sort of ‘functional’ role is not of the sort that can be naturally represented in the form of a semantic representation. An example is the way in which the top-down algorithm treats determiners - every, many, some, a and so on, as shown in the examples we have gone through: their semantics is captured in one part by the construction operations they trigger and on the other by the verification conditions of the DRS-conditions that result from those operations.

On the other hand, for content words like nouns, verbs, adjectives and prepositions – all of them natural language predicates – a more conventional encoding of their lexical semantics seems more natural, in which the word is ‘translated’ into a predicate of our representation formalism. (Even here there are many problems which the usual translations offered in semantic treatments do not address, connected with the few remarks on lexical semantics in the introductory part of these notes.) We will (probably) only skim these difficulties in this seminar.

(N.B. To deal with the semantics of words like every in such a procedural way is certainly not beyond controversy. Most approaches, including Heim-Kratzer, assume that the semantics of such words can be given in the same format as that of content words like donkey or beat – as λ-terms (often of considerable complexity) whose abstraction operators will in most cases be ‘used up’ by instances of the operation of functional application when the semantics is computed for the sentences in which they occur. To some extent this difference is one of style of presentation. But not only. We will return to the point later on.)

The format for the lexical entries of content words we will adopt for the time being is essentially that of Kamp & Roßdeutscher (1994) (see also (Kamp and Reyle, forthc.)). For the verb smile the entry is given in (14).

(14) \[ \begin{array}{ll}
    \text{smile (verb)} & \text{nom} \\
    e & x \\
    \text{Sel. Restr:} & \text{human} \\
    \text{Sem. Repr:} & e: \text{smile}^e(x)
\end{array} \]

Comments:

1. The semantic representation in (14) is exemplary for the entries of lexical predicates in that it consists of (i) a store – a list of DRSs, listed to the left of ‘|’ – and (ii) a DRS. In all lexical entries for predicate words we will consider the store always contains just one DR, for the referential argument of the predicate.

2. The underlining of ‘\(x\)’ indicates that its status is not that of an argument but of an argument slot. When the lexical item is used in a sentence, then its argument slots must be
filled by ‘satellite phrases’. Thus, when for instance the verb *smile* is used in the active voice - the only option in this case, as *smile* is an intransitive verb -, ‘x’ is to be filled by the referential argument of the subject DP. Which phrases are responsible for filling which slots is a question for linking theory. We assume that it is one of the tasks of the syntactic parser that assigns sentences their syntactic structures (which serve as input to the construction of DRSs) to provide this information. (The syntactic parser has to discover this information in any case, for it has to check that the argument slots of the semantic representation of the predicate that it recovers from the lexicon are compatible in kind and number with the predicate’s argument phrases that it can make out within the predicate’s syntactic domain.) To represent the linking relations between argument slots and the phrases that fill them we may use of the familiar device of co-indexation. However, this information can be properly included in the structure only after the occurrence of the predicate word in the syntactic tree has been replaced by its semantic representation. So linking information will appear only after certain steps in the construction of the DRS have been taken. (It is convenient to assume that when a syntactic structure is converted into a DRS all such replacements are made first; from that point onwards DRS construction will the operate on a structure in which all linking information is explicit. But this way of proceeding is not essential, and we won’t always stick to it.)

3. It should be clear from what was said earlier about the distinction between referential and non-referential arguments that in general the semantic representation of a predicate word will come with one referential argument (the DR in its store) and zero or more non-referential argument slots. The semantic representation in (14) has just one slot, reflecting the fact that *smile* is an intransitive verb.

4. Entries for predicate words have one tier to specify the Selectional Restrictions they impose on their arguments. Almost all predicates have the property that they can be completed into meaningful predications only when combined with arguments that ‘fit’ their argument slots. Saying of the number 13 that it is green, or of the leg of my table that it is smiling isn’t just false, it doesn’t even make enough sense to be considered false. For the most part selectional restrictions seem to follow from the meaning of the predicate, i.e. from what it says about its arguments. But it has proved difficult to turn this intuition into an explicit and operative general principle – for one thing because it is so hard to state in non-question-begging terms -, and on the other hand information about selectional restriction can be vital for the purposes that semantic theory is pursuing. This has led to the decision to encode such information independently and directly as part of the lexical entry. (The predicates that are used to state selectional restrictions should ideally belong to a conceptual hierarchy – a network of one place predicates that makes the inclusion relations between them explicit. Such concept hierarchies play an important part in Computational Linguistics. Examples are the hierarchy of WordNet and those that are used in Web-oriented work on NL semantics, in particular OWL.

5. Often, as here, the DRS consists of just a single condition, and an empty universe. In such cases we will only present the condition, ignoring the box structure around it.

Now to the construction of the DRS for (12). Our first step is to replace the word *smile* by its lexical semantics and to insert the co-indexation of its slot x with the subject DP. The result is shown in (15).

(15) S
A comment is in order on what exactly is involved in transitions like that from (13) to (15). The lexical entries that will be used in DRS construction from now on always have two components. The first concerns the operations required for DRS construction that are triggered by occurrences of the lexical item in grammatically well-formed expressions. The second concerns the truth conditions of the parts of the resulting DRS for which the lexical item is responsible via the construction operations to which it has given rise. Exactly what this second condition comes to depends on what these operations and their products are like, but we will see how to make sense of this for the different types of lexical entries that will be introduced as we go along.

There is a very large category of lexical entries for which the first, construction-related component is always the same. These are the entries for normal predicate words: most verbs, nouns, adjectives, adverbs and presuppositions; the entry in (14) for the verb *smile* is one of them. For all such entries the construction components is their lexical insertion recipe, and this recipe is always the same:

1. choose a fresh discourse referent \( \alpha \) (one that hasn’t been used yet in the construction of the discourse representation that is in progress);
2. form a pair consisting of a store and a DRS \( K \) and insert \( \alpha \) as only element into the store;
3. Let \( K \) be the DRS that is obtained from the semantic representation in the entry by (a) replacing the referential argument from the entry everywhere by \( \alpha \), and (b) turning the non-referential arguments into corresponding argument slot symbols. (The way we do this here is by keeping the same letter symbols but provide them with underlining.)

The second component of the semantic contribution of a predicate word is given by the embedding conditions of the DRS that gets inserted. The entries for predicate words we will be using will for the most part sidestep the real problems here in that they simply ‘translate’ the predicate words of our natural language fragment into corresponding predicates of the representation language, in the way that (14) ‘translates’ the English verb *smile* into the predicate ‘smile’ of our DRS-language. In this we follow a long, quasi-inevitable (but nonetheless deplorable) tradition in formal semantics that can be traced back to Montague. The fundamental difficulty is that non-question begging characterizations of the meanings, application conditions or extensions of the predicates of natural languages transcends the means – and many linguists would argue: the task – of linguistic theory. Replacing *smile* by a condition involving the predicate ‘smile’ does nothing to clarify the meaning of *smile*, e.g.
in how it differs in meaning from grin, cry, laugh or kick. For an analysis of predicate meaning in that sense it is necessary to look elsewhere, and we won’t do that here.

Since the VP consists of the verb V only, this representation is passed unmodified to the VP node, as in (16). Note that the DR ‘e’ is now in the store of the VP representation. We express this by saying that it is the ‘referential argument of the semantic representation’ of this node. In general the referential arguments of predicate words will percolate up trough the word’s different syntactic projections. For instance, as we proceed with building the interpretation of (12), ‘e’ will also become the referential argument of the semantic representations of T’ and TP.

(16) 
\[
\begin{array}{c}
S \\
\text{Comp} & \text{TP} \\
\emptyset & \text{DP}_1 & \text{T’} \\
\text{Frieda} & \text{T} & \text{VP} \\
\text{Past} & < e \mid \text{e: smile’}(x_1) >
\end{array}
\]

The next step deals with the tense information under T. ‘Past’, contributed by the past tense of (12) locates the referential argument of its input structure as holding at the utterance time of the represented sentence or discourse. We represent the utterance time by means of the DR ‘n’. In a DRS for a sentence or discourse uttered at some particular time, ‘n’ will always be present. Strictly speaking it should be listed as one of the members of the universe of the DRS; but since it is present by default we won’t normally bother to display it as part of the universe, but only as a constituent of DRS conditions.

We represent the information contributed by T as follows: T introduces a location time t for the eventuality delivered by its sister node (here VP). This location time is represented as lying before the utterance time ‘n’ – this is because the tense is a past tense – and the eventuality e delivered by its sister node is encoded as temporally included within t – this inclusion relation reflects the fact that e is an event (and, by the same token, that the VP acts as a (+perf) predicate). t is entered into the store of the representation of T’.

(N.B. putting t into the store and then retrieving it later from there (as part of interpreting the sentence as a main clause; see below) is one option. Another option would be to place t right away into the universe of the DRS. I have been struggling with the question what is the (more) right decision here. We will come back to this.)

The result of these operations is as in (17).
The next operation deals with the subject DP *Frieda*. This is essentially the same operation as in the top-down algorithm. Insertion of the DR introduced by the DP is now guided by the co-indexation of the DP with the argument slot symbol ‘*x*’. (As mentioned before, this is not a very good way of handling proper names. A more adequate account of the interpretation of proper names will be given eventually.) The result of this operation is given in (18).

(18)  
\[
\begin{array}{c}
\text{f} \\
\text{Frieda(f)} \\
\text{S} \\
\text{Comp} \\
\emptyset \\
\end{array}
\]

The final operation is triggered by the complementizer ∅. We treat the information that Comp is empty as an indication that the represented cause is a main clause. In this case the discourse referents that are in the store are transferred to the universe of the DRS following it (which, as we have seen, has the effect of ‘existentially quantifying’ those elements). After this the store is abandoned. What we get is (19), which can be simplified to the representation in (20).

(19)  
\[
\begin{array}{c}
\text{f} \\
\text{Frieda(f)} \\
\text{S} \\
\text{t e} \\
\text{t < n e ⊆ t} \\
\text{e: smile’(f)} \\
\end{array}
\]

(20)  
\[
\begin{array}{c}
t e f \\
t < n e ⊆ t \\
\text{Frieda(f)} \\
\end{array}
\]
We now turn to the DRS construction of the more complicated sentence (21), which we assume has the syntactic structure given in (22).

(21) Frieda has been smiling.

(22) 
\[
\begin{array}{c}
\text{S} \\
\text{Comp} \hspace{1cm} \text{TP} \\
\varnothing \hspace{1cm} \text{DP}_1 \hspace{1cm} \text{T}' \\
Frieda \hspace{1cm} \text{T} \hspace{1cm} \text{PerfP} \\
\text{Pres} \hspace{1cm} \text{Perf} \hspace{1cm} \text{AspP} \\
\text{Asp} \hspace{1cm} \text{VP} \\
\text{+prog} \hspace{1cm} \text{V} \\
\text{smile}
\end{array}
\]

Again our first step is to replace the verb *smile* by its lexical semantics, followed by co-indexation of its slot \(x\) with the subject DP. Moreover, the semantic representation of V is passed up unaltered to VP. The result is in (23).

(23) 
\[
\begin{array}{c}
\text{S} \\
\text{Comp} \hspace{1cm} \text{TP} \\
\varnothing \hspace{1cm} \text{DP}_1 \hspace{1cm} \text{T}' \\
Frieda \hspace{1cm} \text{T} \hspace{1cm} \text{PerfP} \\
\text{Pres} \hspace{1cm} \text{Perf} \hspace{1cm} \text{AspP} \\
\text{Asp} \hspace{1cm} \text{VP} \\
\text{+prog} \hspace{1cm} \text{e: smile'}(x_1) >
\end{array}
\]

The feature ‘+prog’ specified by the Asp node indicates that the VP is ‘progressivized’. Morphologically this takes the form of turning ‘smile’ into ‘be smiling’, but the morphology doesn’t concern us here. As regards the semantics of the progressive we assume that +prog triggers the application to an operator PROG, which has the following properties:

(i) PROG is only defined for input structures whose referential argument is an event. This constraint is a kind of selection restriction. Such selection restrictions act as a kind of
presupposition. We therefore postpone detailed discussion of them until we turn to presuppositions as a general phenomenon. In the present case the restriction is evidently satisfied.

(ii) PROG turns its input representation into the representation of a state s. This state is represented as holding while an event of the kind specified by the input representation is ‘progressing’. The way in which this information about s should be represented is somewhat delicate. The reason is a phenomenon known as the Imperfective Paradox. The Imperfective Paradox does not arise for activity verbs like smile. For such verbs the state which results from the application of PROG could have been simply represented as temporally included in some event of the subject smiling. But this is not so for accomplishment VPs. Consider for instance the VP write a letter. When I say ‘John wrote a letter’, this will be understood as my speaking of an event e in which a letter was completed: at the end of e there was a letter and normally it will be a finished letter. But when I say ‘John was writing a letter’, then I do not imply that the letter he was writing was finished. He may have been interrupted while he was writing and have been unable to return to the letter to finish it. So the state described by the progressive ‘be writing a letter’ cannot be characterized as temporally included in an event described by ‘write a letter’, since there may be no such event.

The best we can do in such cases is to specify the state as related in some way to the property of being an event of the kind characterized by the description ‘write a letter’. This of course is no more than a first step in the right direction. What one would like is a representation of the progressive state that tells us how the state is connected with the event property. Attempts that have been made in that direction have shown that the task is quite difficult. We will make no such attempts here. (A well-known proposal to analyse the progressive in terms of possible worlds is Fred Landman: ‘The Progressive’, Natural Language Semantics 1,1, 2992, pp. 1 – 32.)

As noted, the state resulting when PROG is applied to the representation of an activity VP could be given as one contemporaneous with an activity of the given kind. However, we will use the general representation, according to which the state is some function of the event property, in these cases too.

We form a representation denoting the property of being an event e of the kind characterized by an input representation < e| K > as ‘^e.K’. So we get as representation for AspP – the mother node of Asp and VP, the one given in (24).

(24)  

\[ \begin{array}{c}
\text{Comp} & \text{TP} \\
\emptyset & \text{DP}_1 & T' \\
\text{Frieda} & T & \text{PerfP} \\
\text{Pres} & \text{Perf} & + \\
\text{AspP} \\
\end{array} \]

\[ < s \mid s: \text{PROG}(^e. e: \text{smile}(x_1)) > \]
The next step deals with the formation of the perfect, indicated by the feature ‘+’ that is contributed by the Perf node. For now we assume that the effect of forming the perfect is that of introducing a result state – represented here by the DR $s'$ - which is specified as ‘right-abutting’ the eventuality that acts as referential argument of the input structure. ($s$ ‘right abuts’ $s$ iff $s$’ starts when $s$ ends. We denote this relation as ‘$\supset\subset$’.)

We also assume until further notice that the operation triggered by the perfect transfers the referential argument ‘ev’ of the input structure from the store into the universe of the DRS to its right. Its role as referential argument of the representation is taken over by the result state introduced by the perfect operator. Application of the perfect operator to the semantic representation under AspP turns (24) into (25).

(25)  
\begin{align*}
&S \text{Comp} & \text{TP} \\
&\emptyset & \text{DP}_1 & T' \\
&Frieda & T & \text{PerfP} \\
&\text{Pres} & s \\
&s \supset\subset s' \\
<s' & | & s: \text{PROG}( & ^e. & e: \text{smile}(x_1) & ) >
\end{align*}

The next step deals with the tense information under T. This time the tense information is ‘Pres’, contributed by the present tense of (21). ‘Pres’ locates the referential argument of its input as holding at the utterance time of the represented sentence or discourse. (The ‘normal’ use of the present tense also comes with a constraint on the input: its referential argument should be a state. In English this is seen most clearly when the sister to T is an accomplishment phrase, e.g. ‘eats and apple’. ‘He eats an apple.’ Is not good English, arguably not even grammatical. The right thing to say is ‘He is eating an apple.’, where the progressive turns the accomplishment phrase into a stative phrase. Admittedly there are also uses of the English present tense in which the non-progressive forms of accomplishment and achievement phrases are acceptable, in particular the so-called ‘reportive’ use of the present tense. We will return to this point.) So as to achieve a certain uniformity with the treatment with other tenses (such as the past tense of (16)) we assume that ‘pres’ too introduces a location time t, but that it identifies t with the utterance time n (rather than placing it in the past or in the future of n).

The location of a state s via its location time t differs from that of locating an event in that the location time is understood as a time (or: one of the times) at which the state holds. This means that the temporal relation between location time and state is that the former is included within the latter: ‘$t \subseteq s$’. (This is just the converse of what we get when the eventuality that is being located is an event.)

With this, the implementation of ‘pres’ in (25) turns this structure into (26).
The remaining operations – dealing with the subject phrase *Frieda* and with the main clause Complementizer ∅ - are just as before and we only display the final result, after these two operations and simplification.

\[
(27) \quad t \quad s' \quad s' \quad \text{Frieda(f)}
\]

\[
\begin{align*}
&t = n \quad t \subseteq s' \quad s \supseteq s' \\
&s: \text{PROG}( \wedge e. \ e: \text{smile}(x_1) )
\end{align*}
\]

The next couple of examples we will look at are sentences in which temporal adverbs play a part in temporal location. But before can turn to the examples themselves, some remarks are in order about the range of temporal ‘locating’ adverbs that can be found in a language like English.

There are various ways in which the English temporal locating adverbials can be classified and I am not sure there is an optimal classification. Here we will proceed with an initial division into two main classes, the class of calendar-based adverbs and the remainder. The second class is not homogeneous and needs further subdivision.

Adverbs involving calendar-based terms are illustrated in (28). They come in two varieties, *absolute* calendar-based adverbs and *relative* (also: *context-dependent*) calendar-based adverbs. The phrases in (28.a) are examples of absolute calendar-based adverbs. They determine a particular portion of actual time (an instant or an interval) without the support of information from the context. There is only one calendar day fitting the description ‘fifth of October 1973’, only one month fitting the description ‘June of 1605’, only one summer fitting the description ‘summer of 1066’, only one moment fitting the description ‘10.05 p.m. January 1\textsuperscript{st}, 1905’, only one year fitting the description ‘527 b.c’. (I am assuming that when the indication ‘b c’ is absent, then there is a tacit agreement that one is talking about ‘a d’.)

\[
(28) \quad \text{a. on the fifth of October 1973, on Christmas day, 1966, in June of 1605 in the summer of 1066, at 10.05 p.m. January 1\textsuperscript{st}, 1905, in 527 b.c.}
\]

\[
\text{b. on the fifth of October, on the fifth, on Christmas day, in June, in the summer,}
\]
The phrases in (28.b) differ in that contextual information is needed to determine the indicated time. To interpret ‘on the fifth of October’ you need to know which year is being targeted, and likewise for ‘on Christmas day; to interpret ‘on the fifth’ you need to know the year and the month; to interpret ‘in June’ you need to know the year; to interpret ‘at 10.05 p.m.’ you need to know the year, the month and the day; and to interpret ‘on Wednesday’ you would need to know something like the year and the month, but that won’t even be enough: what you really need is some period of about a week - a period within which there is only one Wednesday - and then the indicated time will be the Wednesday within that period. (A standard strategy for interpreting a temporal adverb like on Wednesday is to zero in on a weekday which is not a Wednesday, and then to interpret on Wednesday as referring to the first Wednesday after that day of the last Wednesday before it.)

Note that the phrases in (28) all have the form of prepositional phrases – they all begin with one of the prepositions on, in or at. The ‘denotations’ talked about above were the denotations of the DPs governed by these prepositions. The locating adverbs as a whole take the form of PPs because it is their task to link the denotation of the governed DPs with the relevant element of the part of the clause to which they are attached. Details follow presently.

The prepositions of temporal locating adverbials need not be on, in or at, which express simultaneity of temporal inclusion. We also find (calendar-based) locating adverbs like those in (29), in which the prepositions express other relations between the time of the locating adverb and its locandum.

(29) between five and seven p.m. (on the thirteenth of October 1973), after five o’clock, before noon on June 16, during the afternoon of the fifteenth.

Some locating adverbs have the overt form of a single DP. Examples are today, yesterday, last week and so on, as we find them in sentences like (30).

(30) He came today/yesterday/last week.

We will treat such adverbs also as PPs, with a tacit preposition e whose semantics is (a suitable form of) co-temporality.

The formation of the (absolute or context-dependent) calendar terms that are the DPs of locating adverbs like those in (28) and (29) follows some of the general rules of DP formation in English, but also shows some idiosyncrasies that are specific to this particular subsystem of the grammar of English nominal expressions. We don’t go into the details of this system here. However, it is clear that the compositional syntax of such terms is a precondition for stating a compositional semantics for such terms and their constituents.

The semantics of such terms is evidently based on the calendar system: the system which we use to divide time up into years, months, days, hours, minutes, seconds (and when necessary, as in astronomy or microphysics, further units to the left and the right). This system does not only make it possible to pick out particular parts of the time axis by description, but it also imposes a metric. In fact, all the terms listed above (with a qualification for ‘month’) can be used as measure predicates for intervals of time (and some, e.g. ‘hour’ and ‘minute’, can only be used this way): a period of time qualifies as an hour, or a week etc., iff it has the right duration. Each of these predicates can be used to select a ‘unit of temporal measurement’ to
describe certain types of entities (those that have a certain duration, that is, periods of time, but also events and states) as having a duration of some given number of units of the kind defined by the predicate. Such descriptions often take the form of measure phrases, phrases consisting of a unit-denoting predicate preceded by a numerical term that denotes some positive real number. Some examples are given in (31).

(31) two hundred years, one week, an hour, five and a half minutes, 347.96 seconds

By themselves temporal measure phrases can’t serve as locating adverbs. But they are often part of locating adverbs, as in (32).

(32) five days before Christmas Day, 1875; 10 minutes after seven o’clock

The semantic function of such phrases suggests that it is best to see the measure phrases as modifiers of the prepositions before and after. Thus while before Christmas Day and some time after Christmas Day express the relation between the locandum and the referent of Christmas Day which holds when the locandum precedes the referent, five days before Christmas Day expresses the relation which holds when the locandum precedes the referent of Christmas Day by five days. (De facto this relation will hold of the locandum iff it occurred on the fifth day before Christmas Day (i.e. on the 20-th of December).

Note that on this analysis five days before Christmas Day gets a very different analysis than the fifth day before Christmas Day (and, by the same token, one day before Christmas gets a very different analysis from the day before Christmas). the fifth day before Christmas Day and the day before Christmas are regular definite descriptions which denote certain days. They can be used as temporal locating adverbs, but when they are so used they should be considered as PPs with tacit prepositions. In fact – and this point is crucial here – such phrases can also be used with the preposition on, as in ‘John came on the fifth/first day before Christmas’ and some speakers prefer to include the preposition in this context. For the phrase five days before Christmas Day, on the other hand, there is no alternation involving on. ‘John came on five days before Christmas’ is a grammatical, but it means something quite different, viz. that there were five days before Christmas’ on which John came. (The phrase one day before Christmas is ambiguous. It can be understood as an indefinite DP which speaks of some day preceding Christmas, but it can also be understood as a PP with the modified preposition one day before. On the first interpretation the referent isn’t fixed, on the second it is (viz. December 24).

So much for temporal measure phrases and their part in temporal locating phrases. One thing we have noted in passing is that calendar vocabulary can be used (in conjunction with prepositions like before, after, during and between) to form complex time-denoting DPs of familiar sorts (i.e. definite and indefinite descriptions, like the (first) day after Christmas, one of the last few days before Christmas and so forth which constitute a further extension of the repertoire of temporal locating adverbs. (These might be called calendar-based in the wider sense, in that the times they denote are computed from times that are denoted by calendar terms directly.)

Back to our basic characterization of temporal locating adverbs. Besides the calendar-based adverbs exemplified in (28) ad (29) there are also the indexical locating adverbs, some of which are given in (33).

(33) now, today, yesterday, tomorrow, last week, next year, five days ago
These are called ‘indexical’ because of their strong tendency to derive their denotations from the times at which they are uttered: now typically refers to the utterance time itself, today to the day containing the utterance time, yesterday to the day immediately preceding that day, last week to the week preceding the calendar week containing the utterance time, next year to the year immediately following the year containing the utterance time. five days ago is the odd one out in this list. The most plausible analysis seems one according to which ago is an indexical preposition, whose internal (non-referential) argument is always tacit and to be resolved via the utterance time. On this analysis, five days is a prepositional modifier, just as it is in (33) (on our analysis of those phrases) and ‘John came five days ago.’ is semantically equivalent to (the somewhat awkward, but arguably grammatical) ‘John came five days before now.’ - and this seems intuitively correct.

A third category of temporal locating adverbs, distinct from both the indexical ones of (33) and the calendar-based adverbs from (28) and (29), are elliptical expressions like those in (34).

(34) three days before, after four years, two hours earlier, five minutes later

These phrases are like the context-dependent calendar-based adverbs in that their denotations depend on context. But the principles via which their denotations are determined are different. The context-dependent calendar terms depend on context for a time t ‘at the next calendar level up’ and the denotation of the adverb’s DP is then determined as the unique instant or interval fitting the given description that is located within this time t. The phrases in (34) require from the context a time at the same calendar level (indicated by the lexical head of the measure phrase), the locandum is then asserted to stand to that time in the relation expressed by the modified preposition.

(N.B. This last assessment of the function of the phrases in (34) seems to apply straightforwardly only to the first two, with their prepositions before and after. But the modified comparatives two hours earlier and five minutes later play a role that is very similar to that of the modified prepositions of the first two examples in (34). There is no question but that comparative constructions have many intriguing and complicated syntactic properties that appear to be specific to them. But especially comparatives whose complements are DPs, such as ‘taller than Bill/his brother or ‘later than five o’clock’ show striking similarities with phrases like ‘above Bill/his bother’ or ‘after five o’clock’. All these serve as predicates of entities, of which they claim that they stand in a certain relation to some other entity (the non-referential argument of the preposition or the than-complement of the comparative). For present purposes no serious distortion is caused by treating earlier than and later than as temporal prepositions.)

I said about the indexical adverbs in (33) that they have a ‘strong tendency to derive their denotations form the utterance time’ (as indicated for the different examples in (33) in the lines following the quotation). This formulation is at variance with the classical analysis of indexicals (connected perhaps most of all with the name of David Kaplan, see in particular his “Demonstratives” in Almog, J., Perry, J. and Wettstein, H. (eds.) Themes from Kaplan, OUP, 1989). According to this classical account the adverbs in (33) always get their denotations from the utterance time in the manner indicated. But for these temporal expressions that claim turns out to be too strong. They can determine their denotations not only in relation to the utterance time of the sentence in which they occur, but also in relation to certain other times that are presented as the temporal perspective of some protagonist of the story that is being
told. Two examples for the word now are given in (35).

(35)  

a. Alan was sitting by the fire, trying to relax. The past week had been very stressful. But now all that was behind him and he could look forward with some pleasure to the days ahead of him.

b. He told me that he had got back quite depressed from his trip to outer Mongolia, with all its hopes and disappointments, but that he was now ready to make a fresh start.

In fact, perspectival shifts can be an important factor in the semantics of temporal reference and it is important to understand how they can do this. For now we only note that they can there is a role for them to play, leaving details till later.

Since the so-called indexical locating adverbs can derive their denotations also from other times than the utterance time, it may no longer seem quite clear what the difference is between them and the context-dependent adverbs in (34). But there is in fact a big and clear difference between them. The expressions in (34) are, you might say, ‘anti-indexical’: they can never derive their denotations from the utterance in the way that the expressions in (33) can (and usually do). To see this, compare the adverbs three days ago and three days before. The natural interpretation of (36.a) is that the speaker was ill three days before she utters the sentence. (36.b) cannot be understood that way. It implies that the context makes available some time other than the utterance time and that the speaker was ill three days before that time. (Moreover, in many contexts one would prefer ‘I had been ill’ to ‘I was ill’ in this second case. We will see later why this should be so)

(36)  

a. I was ill three days ago.

b. I was ill three days before.

In contexts like those provided in (35) it is possible to use either three days ago or three days before, see (37).

(37)  

a. Alan was sitting by the fire. Only three days ago he had been sick. But now he was feeling much better.

b. Alan was sitting by the fire. Only three days before he had been sick. But now he was feeling much better.

Even here there seems to be a subtle difference between (37.a) and (37.b). Later on we will have the tools to account for this difference.

The temporal locating adverbs we have considered so far were all analysed as prepositional phrases – even those in which no overt preposition is displayed. But is this a position that can be maintained in general? Possible exceptions, it might be thought, could be the adverbs in (38).

(38)  

soon, once, presently

These really look more like prototypical adverbs than any temporal adverbs we have considered so far. (Even the expressions in (33) aren’t typical adverbs, since they can naturally play the part of DPs, as for instance in the sentence ‘Today is the best day of my
life.’). We could treat these as regular adverbs, viz. as predicates of the referential argument of the sentence constituent to which the adverb is adjoined. For the sentence in (39) ‘John will come soon.’ this will come to the following: the event of John’s coming has the property of being ‘soon’.

(39) John will come soon.

But what does that amount to? Something like this: soon selects some time in the future of some contextually salient time t – in the case of (39) this is the utterance time – and one closer to t than might have been expected on the basis of the relevant contextual information. And it is at that time that the event of John’s coming is located. We can implement what this comes to by assuming that the referential argument t’ of soon is identified with the referential argument of the relevant projection of the verb (TP on the analysis we will adopt), assuming that this referential argument is a time t. Alternatively, if we assume that the referential argument of TP is the event e, the contribution made by soon will have to be analysed in the form of a temporal condition like ‘e ⊆ t’. In the latter case something in the syntactic structure will have to be responsible for the inclusion relation ⊆, and that is precisely the function of the tacit temporal prepositions that we have been assuming earlier. The question whether the adverbs in (38) should also be analysed as concealed PPs thus depends on what we take to be the referential argument of their adjunction sites.

So far the temporal locating adverbs we have considered were built exclusively from terms relating to times. But these are not the only ones. Temporal locating adverbs can also be based on descriptions of eventualities. To my knowledge these adverbs always involve temporal prepositions, at least in English. Some examples are given in (40).

(40) during the party, after the explosion, before his oral exam, at Sue’s wedding reception

These function in much the same way as PPs with the same prepositions but governing DPs which denote times (and not events). Since events determine intervals of time – the intervals of time during which they last, or go on – it is not surprising that the latter PPs can be formed and that they can be used for the same purposes as the former.

In addition to PPs like those in (40) there are also temporal subordinate clauses. These too locate the eventualities of the clauses to which they are subordinate in relation to the eventualities they describe themselves. The conjunctions governing these clauses usually have close etymological and semantic ties with the prepositions one finds in temporal adverbs like those in (40); and perhaps some of these actually are the same items, but for the fact that in the one case the locating eventuality is the denotation of a DP whereas in the other it is the event described by a clause. (41) gives a few examples.

(41) while they celebrated, after the tank exploded, before he had his oral exam, when Sue had her wedding reception, before my parents met

Temporal subordinate clauses pose a problem that is not found in any other of the temporal adverbs we have considered, viz. the interpretation of their own tenses, in relation to the tenses of the clauses to which they are subordinate and whose eventualities they locate. It is one of the paradoxes of the syntax-semantics interface for languages like English that in spite of the fact that the temporal subordinate clause serves the purpose of locating the main clause eventuality, it is nevertheless the tense of the main clause that guides the
interpretation of the subordinate clause (rather than the other way round). More about this later.

Besides the adverbs that serve to locate particular eventualities there are also those that have the effect of quantifying over eventualities. Some examples of these so-called quantifying temporal adverbs (or frequency adverbs, as they are also often called) are given in (42).

(42) always, sometimes, mostly, usually, often, seldom, rarely, never

These seem very different from the adverbs that we have been talking about so far – compare ‘John phoned rarely’ with ‘John phoned at nine’. But the difference is not as immense as might be thought at first pass. Frequency adverbs stand to the locating adverbs considered so far roughly as quantifying DPs like every linguist stand to non-quantifying DPs like this linguist or the linguist on our board or John. There are of course considerable differences between quantifying and non-quantifying DPs, but there are also similarities; and so it is for frequency adverbs and the locating adverbs discussed above.

There is however one feature of frequency adverbs that sets them apart from quantifying DPs: For a quantifying DP it is usually clear what sentence material goes into the restrictor (the material from the NP that complements the DPs quantifying determiner) and what goes into the nuclear scope (roughly: the predicate of which the DP occupies an argument position). But for frequency adverbs the question what goes into the restrictor and what into the nuclear scope cannot be answered in such simple terms. Presupposition and other aspects of information structure often play a decisive role here. A closer look at frequency adverbs will therefore be possible only once we have dealt with those aspects of information structure.

We continue with a few more examples of DRS construction for tensed sentences. The next two examples illustrate how temporal location can be supported by temporal adverbs.

(43) John wrote to Eisenhower on January 10-th 1953.

(44) S

Comp
∅

TP

PP

TP

DP

on

Jan. 10-th 1953

John

T

PerfP

Past

Perf

AspP

Asp

VP

default

V

PP

write

P

DP

to

Eisenhower
We begin by inserting the semantics for the verb *write* and co-indexing its argument slots with the corresponding DPs. We assume that the parser has identified the relevant version of *write* as a ‘2-place verb’ (a verb with 2 non-referential arguments, one for the subject and one for the *to*-object).

(44) S

Comp | TP
∅ | TP
TP | PP

DP₁ | T’
P | DP

John | T
PerfP
Past | Perf
AspP
Asp | VP
default | V
P | PP
< e | e: write’(x₁, z₂) >

(on) | Eisenhower.

Introducing a discourse referent *z* for the name *Eisenhower* and inserting it into the designated argument slot of the verb, passing the resulting representation up through the inert features ‘deault’ and –Perf gets us to the structure in (45).

(45) z

Eisenhower(z)

S

Comp | TP
∅ | TP
TP | PP

DP₁ | T’
P | DP

John | T
PerfP
past | < e | e: write’(x₁, z) >
In the next steps we deal with the past tense information under T and the subject DP John. As regards handling the tense information there are two options that were mentioned earlier. One (followed so far) is to place the discourse referent t for the location time introduced by tense into the store. The other is to insert it into the universe of the DRS. We show both version here, in (46.a) and (46.b).

(46) a.  
\[
\begin{array}{ccc}
& x & z \\
\text{John}(x) & \text{Eisenhower}(z) & \\
S & \\
\text{Comp} & \text{TP} & \\
\emptyset & \text{TP} & \text{PP} & \\
\langle t, e \mid e: \text{write'}(x_1, z) \rangle & \text{P} & \text{DP} & \\
\text{on} & \text{Jan. 10-th 1953} & \\
\end{array}
\]
\[t < n \quad e \subseteq t\]

(46) b.  
\[
\begin{array}{ccc}
& x & z \\
\text{John}(x) & \text{Eisenhower}(z) & \\
S & \\
\text{Comp} & \text{TP} & \\
\emptyset & \text{TP} & \text{PP} & \\
\langle e \mid e: \text{write'}(x_1, z) \rangle & \text{P} & \text{DP} & \\
\text{on} & \text{Jan. 10-th 1953} & \\
\end{array}
\]
\[t < n \quad e \subseteq t\]

The PP in (46.a,b) consists of the preposition on and the DP Jan. 10-th 1953. To analyze the DP into its constituents we would need the syntax and semantics of calendar-based expressions – a module of the grammar for which the need was pointed out above but which was left as a development site. Given that we can’t do much better at this point than leave Jan. 10-th 1953 unanalyzed, i.e. to treat it as if it were a proper name. This gives us as semantic representation for the PP on the one hand the discourse referent t’ for the DP together with the condition ‘Jan. 10-th 1953(t’)’ which states what time t’ stands for – these are placed in the universe and the condition set of the DRS we are constructing; as said before, this is a stop gap measure for treating proper names, that will be improved on later on.
– and a condition which comes from the preposition *on* and that is retained as the semantic representation of the PP. Assume that the semantics for *on* is given by a condition ‘*on*(u,v)’, in which u is the referential argument of the preposition and v its non-referential argument slot. (A lexical entry for the preposition *on* which provides this semantics is given in (47).) The non-referential argument slot of the predicate ‘*on*’ gets filled by the referential argument of the DP governed by the preposition, and the DR u is placed in the store of the representation. The results of these operations are shown in (48).

(47) \[ \begin{array}{ll}
\text{on (preposition)} & \text{(governed DP)} \\
\text{x} & \text{y} \\
\text{Sel. Restr:} & \text{time v eventuality} \\
\text{Sem. Repr:} & \text{on’(x,y)} \\
\end{array} \]

(48) \[ \begin{array}{llll}
\text{x} & \text{z} & \text{t’} \\
\text{John(x)} & \text{Eisenhower(z)} & \text{Jan. 10-th 1953(t’)} \\
\text{S} & \text{Comp TP} & \text{∅ TP PP} \\
\text{t} & < u | on’(u,t’) > \\
< e | e: write’(x_1, z) > \\
\text{t < n e ⊆ t} \\
\end{array} \]

The semantics of adjunction is ‘co-predication’, or ‘predicate modification’: the referential argument of the adjunct is unified with that of the adjunction site and the two DRSs are merged. The referential argument of the adjunct is u, the referential argument of the lexical head *on*. But what is the referential argument of the adjunction site? In (46.b) there is only one DR in the store, viz. e, so that is our only option in this case. Note that this choice is in keeping with the general principle that if the referential argument of a projection of a lexical head is the DR introduced by the head (or, if not, then it is a DR that has been introduced by an operation that binds the referential argument of the lexical head, as we saw in the case of the progressive). In (46.a) the store contains two DRs, e and t, and here we face the question which of the two should be treated as the referential argument of the representation. One possibility would be to say that the role of referential argument has passed from e to t at the point when t was introduced. (This, however, would, in the light of the general principles alluded to, suggest that e should have been transferred at that point from store o DRS universe.)

We do not want to decide this matter yet, but – provisionally – continue the construction with
(47), which itself came from (46.b). This leads to (49), which can then simplified to (50).

(49) \[ x \quad z \quad t' \]
    \[
    \begin{array}{c}
    \text{John}(x) \\
    \text{Eisenhower}(z) \\
    \text{Jan. 10-th 1953}(t')
    \end{array}
    \]

\[
S \\
t \\
e \\
t < n \quad e \subseteq t \\
on'(e, t') \\
e: \text{write}'(x, z)
\]

(50) \[ t \quad e \quad x \quad z \quad t' \]
    \[
    \begin{array}{c}
    t < n \\
e \subseteq t \\
\text{John}(x) \\
\text{Eisenhower}(z) \\
\text{Jan. 10-th 1953}(t') \\
on'(e, t') \\
e: \text{write}'(x, z)
    \end{array}
    \]

N.B. One loose end with our treatment of (43) is the attachment of the PP on January 10-th 1953. In our analysis it is treated as an adjunct to TP. But it isn’t obvious that this is imperative. As long as the PP is treated as an additional predicate of e, the same effects emerge when it is adjoined to some other projection of the verb. We will return to this question when we look more closely into the perfect.

Our next example is sentence (51). This sentence is much like (43), differing from it only in regard of its tense and the status of the temporal adverb, which is an indexical. The syntactic structure is given in (52). This time the Asp- and Perf-projections have been left out.

(51) Henry will arrive today.

(52) \[
S \\
\text{Comp} \\
\emptyset \\
\text{TP} \\
\text{PP} \\
\text{DP}_1 \\
T' \\
\text{P} \\
\emptyset \\
\text{VP} \\
\text{V} \\
\text{Fut} \\
\text{arrive}
\]

(53) shows the semantic representation of the lower TP (following the recipe of (46.b)).
This time we are in a position to provide a lexical entry for the temporal locating DP \textit{today}. It is given in (54). (This is our first deviation from our stop gap treatment of proper names.)

\begin{center}
\begin{tabular}{c}
(54) \textit{today} (proper name) \\
\end{tabular}
\end{center}

We semantically represent the empty preposition \(\emptyset\) in the same way we interpreted the preposition \textit{on} in (43). (We assume that this decision is a direct consequence of the parser, which must recognize \textit{today} as a DP that can be analyzed as a PP with empty preposition: Part of that recognition, we may assume, is that – semantically - it is this preposition that is remaining tacit. Here we make no attempt to spell this mechanism out formally.)

Lexical insertion of the semantics of the semantics of (54) for the occurrence of \textit{today} in (53) and of the semantics of (47) for the empty preposition is shown in (55).

\begin{center}
\begin{tabular}{c}
(55) \\
\end{tabular}
\end{center}
The result of combining the semantic representations of P and governed DP is shown in (56). Combining the PP representation with that of its adjunction site is shown in (57) and the final DRS in (58).

\[
\begin{align*}
(56) & & h \\
 & & \text{Henry}(h) \\
 & & S \\
 & & \text{Comp} \\
 & & \text{TP} \\
 & & \emptyset \text{TP} \quad \text{PP} \\
 & & t \quad \langle u, t' \mid n \subseteq t' \text{ day}(t') \rangle \\
 & & \langle e \mid n \subseteq t \rangle \\
 & & e : \text{arrive}'(h)
\end{align*}
\]

\[
\begin{align*}
(57) & & h \\
 & & \text{Henry}(h) \\
 & & S \\
 & & \text{Comp} \\
 & & \text{TP} \\
 & & \emptyset \text{TP} \\
 & & t \\
 & & \langle e, t' \mid n \subseteq t \rangle \\
 & & \langle e \mid n \subseteq t' \rangle \\
 & & \text{day}(t') \\
 & & \text{on}'(e, t') \\
 & & e : \text{arrive}'(h)
\end{align*}
\]

\[
\begin{align*}
(58) & & t \quad e \quad t' \quad h \\
 & & n \subseteq t \quad e \subseteq t \\
 & & n \subseteq t' \\
 & & \text{Henry}(h) \\
 & & \text{day}(t') \\
 & & \text{on}'(e, t') \\
 & & e : \text{arrive}'(h)
\end{align*}
\]

We now turn to a problem that has been with us all along, but which we have ignored – as it often is – while we were bracketing out the question of temporal interpretation. Consider the sentence we looked at before.
(59) John offended every linguist.

On our present analysis the verb contributes an event DR as its referential argument. But how many events are involved in a sentence like (59)? The answer would seem to be: that depends! (59) can be used in relation to a situation where John offended different linguists at different times – a whole lot of different events, which added up to him having offended all the linguists in question. But (59) could also described a single act which was offensive to every linguist. Our semantic representation algorithm should allow for both possibilities.

The ‘many events’ interpretation is the more problematic of the two. The reason has to do with the fact that we have been following the assumption that the information provided by tense is located high up in the syntactic tree (at T). This assumption is made by a large part of the syntactic community and seems quite deeply entrenched. We’d rather stay with this if possible.) Given this assumption, the event e introduced by the verb offend must remain available for predication until we get to T’. So, if the quantifier every linguist is to take scope over e – which means that e gets bound within its scope - it has to be in a position above the place where e gets its temporal location from T. The only way in which we can get it there is by raising it to such a position.

Since we have found the need for quantifier raising independently, this is no real concession. However, now that we make a distinction between TP and S, we have to decide to which of these two raised quantifiers are adjoined. Since quantifiers are typically not raised out of their clause, the natural option seems to be that they are raised to TP. The Complementizer then can be seen as the barrier that prevents them from rising higher.

Assuming this we get for (59) the syntactic structure in (60).

(60)  S
        Comp       TP
             ∅       DP₁       TP
             Det       NP       DP       T’
             every       N       John       T       VP
             linguist       Past       V       t₁
             offend

Lexical insertion for the verb allows us to establish the links between its argument slots and their occupants, the subject DP and (via its trace) the moved object DP:
Combining the V-representation with the trace has no effect. (In this architecture the trace is only there to mediate between the moved DP and its argument slot.) The contributions of T and of the subject DP are processed in the ways we have seen. (62) gives the semantic representation of the lower TP.

(62)
\[
\begin{align*}
\text{John(j)} \\
\text{S} \\
\text{Comp} \\
\emptyset & \text{DP}_1 & \text{TP} \\
\text{Det} & \text{NP} & \text{DP}_2 & \text{T'} \\
\text{every} & \text{N} & \text{John} & \text{T} & \text{VP} \\
\text{linguist} & \text{Past} & \text{V} & \text{t}_1 \\
< e | e: \text{offend}'(\chi_2,\chi_1) >
\end{align*}
\]

The representation of the N-node is: ‘\(< y | \text{linguist}'(y) >\)’ and this representation is passed up unaltered to NP. The quantificational effect of every is now to create a duplex condition in which its own sister (the NP representation) becomes the restrictor and the sister of its DP (here the representation of the lower TP) the nuclear scope. Discourse referents are bound by this operation – this is so for all operations that yield duplex conditions – according to the following principles:

(63) (direct and indirect binding through quantification)

i. (direct binding)

The referential argument of the sister to the quantifying element is directly bound. This takes the form of inserting it (a) under the quantifier symbol in the central component of the duplex condition, and (b) in the universe of the
restrictor DRS.

ii. (indirect binding)

Other discourse referents in the store of the restrictor representation may be
transferred to the universe of its DRS; and the same holds for discourse
referents in the store of the nuclear scope representation.

Those discourse referents in either store that are not transferred are collected in
a new store that is left attached to the DRS containing the duplex condition.

In the case at hand there is only one discourse referent that qualifies for indirect binding, viz.
e. We exercise its binding option since that is precisely what we need to get the ‘narrow scope
reading’ for e. The result is given in (64) and its simplification in (65)

(N. B. In this instance the new store for the duplex condition is empty. Normally, empty stores
are not shown. In this case the store has been shown for illustrative purposes.)

(64)

\[
\begin{array}{c}
\text{John(j)}
\end{array}
\]

The ‘single event’ interpretation can be obtained by (i) leaving the DP every linguist in situ
and (ii) not binding e as part of the formation of the duplex condition to which this DP gives
rise. The syntactic structure is now as in (66), with lexical insertion of the semantics of the
verb.

(65)

\[
\begin{array}{c}
\text{John(j)}
\end{array}
\]
Processing of the object DP now leads to a duplex condition right away. This time is left $e$ in its store. We get the structure in (67).

(67)

```
(66) S
    Comp          TP
    $\emptyset$  DP$_2$      T'
    John Tal        VP
    Past          V        DP
    $< e \mid e:\text{offend}('x_2', 'y_1') >$  Det  NP
    every  N

linguist
```

Processing of tense and the subject DP turn this into (68).

(68)

```
(68) x
    John(x)
    S
    Comp          TP
    $\emptyset$  t
    t < n  e \subseteq t
    $< e \mid y \forall >$
    linguist'(y)  y  e: offend'(x, y)
```
Existential binding of the remaining store element $e$ and simplification then lead to (69).

\[
\begin{align*}
\text{(69)} & \quad t \quad e \quad x \\
& \quad t < n \quad e \subseteq t \quad \text{John}(x) \\
& \quad y \quad \forall \\
& \quad \text{linguist}'(y) \quad y \quad e: \text{offend}'(x_2, y)
\end{align*}
\]

N. B. 1
A man entered the White Hart. He was wearing a back jacket. Bill served him a beer. The man paid. He drank the beer. It was exceptionally good.

Fred left on Wednesday. He arrived on Sunday.
Fred arrived on Wednesday. He left on Sunday.
Fred arrived on Wednesday. He had left on Sunday.
Fred arrived on Wednesday. He left again on Sunday.

Reasons why verbs should be construed as having eventualities as referential arguments:

1. The semantic relation between verbs and their nominalisations:

   a. The tank exploded on Sunday.
   b. The tank’s explosion occurred on Sunday.
   c. He insulted her on purpose.
   d. His insulting her was on purpose.
   e. The company went bankrupt as a result of years of gross mismanagement.
   f. The company going bankrupt was the result of years of gross mismanagement.
   g. The company’s bankruptcy was the result of years of gross mismanagement.

   *explosion, bankruptcy, etc. are count nouns which are true of events. The subject DPs of (14.b) and (16.c) denote events about which (14.b) and (16.c) make assertions. Similarly his insulting her and the company going bankrupt denote events about which claims are made in (15.b) and (16.b).

2. As noted earlier, the assumption that verbs have referential arguments removes an asymmetry between verbs on the one hand and other predicate words of natural language (nouns, adjectives, presuppositions) that would have to be accepted otherwise.

3. This assumption also allows us to make semantic sense of the syntactic principle that verbs are the lexical heads of their projections - TPs with T(ense) as functional head - just as nouns are the lexical heads of their functional projections, viz. DPs, in which the determiner is the functional head: In either case the lexical head introduces its referential argument as a variable that is bound by (according to the instructions given by) the functional head.

4. A further analogy: The “ontological” status of the referential argument of the lexical head constrains the choice of functional head and the semantics of the binding effected by the head. (Nominal domain: distinction between singular count nouns, plural count nouns and mass nouns; verbal domain: distinction between events and states.)
1. Tense Logic as a model for the semantic behavior of tenses in natural language.

Prioran Tense Logic (Arthur Prior, 1968)

Syntax:  
   i. Classical propositional logic or predicate logic.  
   ii. Two or more tense operators, e.g. P (Past, “it was the case that”) F (Future, it will be the case that”)

Examples of formulas:

\[ q, Pq, Fq, \neg Pq, \neg Fq, P(q \& Pr), q \& \neg Pq \& \neg Fq, P(q \& Pr) \lor P(r \& Pq), \neg F \rightarrow (q \rightarrow Fq) = G(q \rightarrow Fq), \text{using the abbreviation: } G\phi \equiv \neg F \neg \phi; \text{ also: } H\phi \equiv \neg P \neg \phi \text{ and } A\phi: H\phi \& \phi \& G\phi; \]

\[ PQ(c), H(Q(c) \rightarrow P \neg Q(c)), (\forall x)(Q(x) \rightarrow GQ(x)), (\forall x)(G(Q(x) \rightarrow F(\exists y)R(x,y))) ; \]

\[ PPq \rightarrow Pq, q \rightarrow GPq, (Pq \& Pr) \rightarrow (P(q \& r) \lor P(q \& Pr) \lor P(Pq \& r)), Pq \rightarrow PPq, (\exists y)PQ(y) \rightarrow P(\exists y)Q(y) \]

Semantics: Models of the form \( M = <T,M> \), where

   i. \( T = <T,<> \) is a time structure, consisting of a set of instants \( T \) and a strict linear ordering \(< \) of \( T \) (the “earlier-later” relation)

   ii. \( M \) is a function from \( T \) to extensional models (for propositional or predicate logic)

   (In particular, in the case of propositional tense logic \( M(t) \) is a valuation, which provides for each atomic sentence \( q \) a truth value of \( q \) at \( t \))

Translations from English into Tense Logic:

\[ \text{It is raining } \Rightarrow q; \]
\[ \text{It was raining } \Rightarrow Pq; \]
\[ \text{It has been raining } \Rightarrow \neg Pq; \]
\[ \text{Whenever it is raining, then it won’t be reading at some later time } \Rightarrow A(q \rightarrow F \neg q); \]
\[ \text{She loves him now, but she hasn’t always loved him and she won’t love him always either } \Rightarrow L(s,h) \& \neg H L(s,h) \& \neg G L(s,h); \]
\[ \text{Some things that exist now haven’t existed forever } \Rightarrow (\exists y)(E(y) \& \neg H E(y)) \]

\[ \text{Roger owns a car. He bought it from Fred. } \Rightarrow (\exists y)(C(y) \& O(p,y) \& P B(r,y,f)); \]
\[ \text{Roger had a car. He (had) bought it from Fred. } \Rightarrow P(\exists y)(C(y) \& O(p,y) \& P B(r,y,f)); \]

Question: What is wrong with Tense Logic as a model of tense and temporal reference in natural language?
Last week we considered a few examples of the top-down construction method for building DRSs. Our last example was the donkey sentence

(11) If a farmer owns a donkey, then he beats it.

In this case the procedure was based on the assumption that the conditional operator that connects *if*-clause and main clause has widest scope and is the first for the construction to deal with. It sets up a representation of the form “R1 ⇒ R2”, in which R1 and R2 are, to start with, the syntactic structures of *if*-clause and main clause, respectively. Applying the construction algorithm to these structures then yields the desired DRS. (In order to get at this DRS it is necessary to first convert R1 and then R2, for in this way one has the DRS K1 for the antecedent of the conditional that can serve as context for the interpretation of the consequent (R2), and is needed to give the right interpretation to the pronouns contained in it.)

**Principle**: the antecedent of a conditional can serve as interpretation context for its consequent.

The next example in line was the “donkey sentence”:

(12) Every farmer who owns a donkey beats it.

To construct the DRS for this sentence top down we first deal with the subject-VP combination. This leads, given that the subject is a universally quantifying DP, to a structure

(14) \[ x y \mid \text{farmer}'(x), \text{donkey}'(y), \text{own}'(x,y) \; \langle \forall x \rangle \; [R2]\]

where R2 is the syntactic structure of (12) except that the subject phrase has been replaced by x. Since the restrictor of a quantificational condition can serve as interpretation context for its nuclear scope, the pronoun *it* of (12) can be resolved as before and we get

(15) \[ x y \mid \text{farmer}'(x), \text{donkey}'(y), \text{own}'(x,y) \; \langle \forall x \rangle \; [u \mid u = y, \text{beat}'(x,u)]\]

**Principle**: the restrictor of a quantifier can serve as interpretation context for its nuclear scope.

Already in the eighties bottom up DRS-construction algorithms were proposed. (Asher, Zeevat).

Here we will illustrate one way of constructing DRSs bottom up which has been designed to deal also with presuppositions (in line with the work on presupposition of Van Der Sandt and Geurts).

First consider the bottom up construction for

(2.e) John offended every linguist.
The syntactic structure for (2.e) without quantifier movement, but with the semantic predicate for the verb inserted and its arguments linked to the DPs that fill it, is given in (16):

\[
S \\
\begin{array}{c}
\text{DP}_1 & \text{VP} \\
\text{John} & \text{V} & \text{DP}_2 \\
\text{offended}'(x_1, y_2) & \text{Det} & \text{NP} \\
\text{every} & \text{N} & \text{linguist}
\end{array}
\]

We start with the construction of a representation for the object DP. The representation of the head noun \textit{linguist} of the DP is

\[
< y_{\text{ref}} | < y | \text{linguist}'(y) > >
\]

The part to the left of the first | is a store in which we put discourse referents that still need to be bound. The part following the first | is a DRS (with universe consisting of just y). "ref" marks y as the referential argument of the represented expression. (It is this which tells the determiner \textit{every} that it is y that it should bind and inserted into the argument slot coindexed with the DP.)

Combining (17) with every sets up the quantificational structure (18)

\[
S \\
\begin{array}{c}
y & \forall \\
\text{linguist}'(y) & \text{DP}_1 & \text{VP} \\
\text{John} & \text{V} & \text{DP}_2 \\
\text{offended}'(x_1, y)
\end{array}
\]

The next steps concern (i) interpretation of the DP \textit{John} and (ii) combining that interpretation with that of the VP. (i) For the proper name \textit{John} we adopt the representation in (19).

\[
< x_{\text{ref}} | < x | \text{John}(x) > >
\]

The DRS within {} represents the referential presupposition triggered by the proper name.
The underlining of \( x \) in the universe of the presupposition DRS indicates that this is a referential presupposition which requires finding an antecedent for \( x \) in the context. The subscript “\( \text{pr.na.} \)” indicates that the presupposition is triggered by a proper name.

(ii) Combining (19) with the VP representation involves inserting the referential argument \( x \) of the subject DP into the coindexed argument slot of “offended’”. Moreover, the empty non-presuppositional DRS of (19) gets unified with the DRS resulting from the insertion. So we get as representation of the S-node of (18). (The representation of the VP in (18) is the DRS \(< | \text{offended’}(x_1,y) > \).)

The result of this is the DRS with empty universe and whose condition set only has t condition in (20)

\[
\begin{align*}
    & y \quad \forall \quad y & < \{ x \mid \text{John}(x) >_{\text{pr.na.}} \}, < | \text{offended’}(x,y) > > \\
    & \text{linguist’}(y)
\end{align*}
\]

Justification of the presupposition contributed by John (in the global context as is standard for proper names) turns (20) into (21)

\[
\begin{align*}
    & x \quad \forall \quad x & \text{John}(x) \\
    & y \quad \forall \quad y & \text{offended’}(x,y) \\
    & \text{linguist’}(y)
\end{align*}
\]

• Note that when we construct DRSs bottom up, we can no longer resolve pronouns with sentence-internal antecedents at the very point when they come up for interpretation. For their antecedents are always “higher up” and so no representing discourse referents have yet been introduced for them.

For instance consider again sentence (12)

\[
\begin{align*}
    & \text{Every farmer who owns a donkey beats it.}
\end{align*}
\]

If we construct the DRS for (12) bottom up, then we will first have to deal with the combination of the verb beats and its direct object DP it. The only way in which we can proceed is to assume that the pronoun (like proper names and, we will assume later, all definite noun phrases) a “referential” presupposition. In the case of a pronoun there are other resolution conditions on the presupposition than for e.g. proper names. In particular, pronouns may be resolved “anaphorically”, i.e. in the (global or local) discourse context.

So we assume that in particular, the it of (12) gets the representation in (22). (The
subscript is again a shorthand for the relevant constraints on justification of the presupposition. With pronoun presuppositions resolution to accessible discourse referents in the discourse context is a permissible form of resolution.)

\[<v_{\text{ref}} | <\{v | \neg \text{person}(v) \}^{\text{pron.}}, < | >> \]

**Exercise:** Give a bottom up construction of the EA reading for (3).

(3) Some philosopher offended every linguist.

Note that neither the top-down construction nor the bottom up construction for (3) gives the inverse scope (AE) reading for (3). To get this we must either allow the construction to change the argument insertion operations or else work from syntactic structures in which the quantifying DPs have been moved in the desired (inverse) order.

**Exercise.** Construct bottom up DRSs from the syntactic representations (5) and (6) for (3).

- Interesting in the present context are inverse linking sentences like (7) and (8).

(7) One apple in every basket is rotten.
(8) No student from a foreign country was admitted.

As it stands, the top down method yields, when applied to a syntactic structure in which the quantifiers have not been raised, the non-inversely linked interpretation (the one that is natural for (8) but bizarre for (7)).

To see this consider the variant (7’) of (7) in which we have replaced *one* by *every*.

(7’) Every apple in every basket is rotten.

This sentence is ambiguous in just the same way as (7), and here too the non-inversely linked reading is absurd. (It would require every apple to be in every basket.) (I will explain the reason for replacing *one* by *every* below.

Now let’s see what happens when we start the top down approach on a syntactic structure for (7’) in which the quantifying DPs have not been raised.

(9’)

```
S
  DP
    Det NP
      every N
  VP
    V
      is rotten
  PP
```
The first step of this algorithm deals with the subject DP and creates the duplex condition to capture the meaning of the determiner. This gives a structure like that in (10').

\[(10')\]

\[
\begin{array}{c}
\forall x \\
\text{NP}(x) \\
\end{array}
\]

\[
\begin{array}{c}
\text{VP} \\
\forall x \quad \text{V} \\
\end{array}
\]

\[
\begin{array}{c}
x \\
is \text{rotten} \\
\text{N} \\
\text{PP} \\
apple \\
in \\
\text{DP} \\
every \\
\text{NP} \\
\text{Det} \\
basket \\
\end{array}
\]

It is clear that if we continue the construction the quantifier *every basket* will eventually give rise to a duplex condition within in the restrictor box of the duplex condition in (9''), and thus that we get the non-inversely linked reading.

What about doing the construction bottom up? This time we have to build the representation of the complex subject DP of (9') before we combine it with the VP. Our first step in dealing with the DP concerns the embedded DP *every basket*. The question is: What does processing this phrase come to? What is the nuclear scope of this quantifying phrase? This is essentially the same question as the question t where this phrase should be raised, assuming that its scope should remain within the Larger DP. The most plausible answer would seem to be that the nuclear scope of *every basket* within the DP of (9') should include just the predication of which the phrase is an argument. This is the predication involving the preposition *in*. This choice corresponds to the option that H & K create by allowing for raising *every basket* to a position in which it is adjoined to PP.

What happens is seen more clearly if we replace the proposition *in* by (a constant in our representation formalism for) the binary relation in denotes, complete with the linking information according to which every basket is its non-referential argument. To do this we
need a representation for \textit{in}, which is on the one hand like the representation we adopted earlier for \textit{linguist} in that it explicitly introduces, in a similar manner, the referential argument position of \textit{in}, and on the other hand like \textit{offended} in that it links the non-referential argument of \textit{in} to the DP every \textit{basket} that fills that position. The representation I propose is that in (11’)

\[(11’) \quad \langle z_{\text{ref}} | \langle z | \text{in}'(z,w_2)\rangle\rangle\]

By the same token we might as well also make the linking explicit of the subject DP with the one argument position of \textit{is rotten} (which for simplicity’s sake we treat as a simple intransitive verb, with a semantics given by “is-rotten’(x)”). (12’) gives the representation of (9’) after insertion of (11’) for \textit{in} and “is-rotten’(x)” for \textit{is rotten}, and with the linking information that can now be made explicit.

\[(12’) \quad \]

\[
\begin{array}{ll}
\text{DP}_1 & \text{S} \\
\text{Det} & \text{VP} \\
\text{NP} & \text{is-rotten’(x_1)}”. \\
\end{array}
\]

\[
\begin{array}{ll}
\text{every} & \text{N} \\
\text{apple} & \text{PP} \\
\end{array}
\]

\[
\begin{array}{ll}
\langle z_{\text{ref}} | \langle z | \text{in}'(z,w_2)\rangle\rangle & \text{Det} \\
\text{NP} & \text{every} \\
\end{array}
\]

\[
\begin{array}{ll}
\text{basket} & \end{array}
\]

Giving \textit{every basket} as nuclear scope just the predication in which it is an argument means that we take its nuclear scope to be (11’). So assuming that \textit{basket} gets the same form of representation as \textit{linguist} in (2.e) – the direct analogue of (17), e.g. \langle w_{\text{ref}} | \langle w | \text{basket’(w)}\rangle\rangle - the described processing step involving \textit{every basket} leads from the DP of (12’) to the representation in (13’)

\[(13’) \quad \]

\[
\begin{array}{ll}
\text{DP}_1 & \\
\text{Det} & \text{NP} \\
\text{NP} & \text{every} \\
\end{array}
\]

\[
\begin{array}{ll}
\text{apple} & \text{PP} \\
\end{array}
\]

\[
\begin{array}{ll}
w & \forall \\
\end{array}
\]
In the next step the PP will combine with the lexical head apple in the sense of predicate conjunction (H & K’s P(redicate)M(odification)). We assume that the N apple gets the representation given in (14').

(14')  
\[
< x_{ref} | < x | apple'(x)> >
\]

Predicate conjunction binding of the referential argument of the modifier through identification with that of the head: the referential argument of the modifier is removed from its store and all other occurrences of it in the representation of the modifier are replaced by the referential argument of the head. In the case of (13') this operation leads to the structure in (15').

(15')  
\[
\begin{array}{ll}
\text{Det} & \text{NP} \\
\text{every} & x \\
< x_{ref} | & >
\end{array}
\]

\[
\begin{array}{l}
\text{apple}'(x) \\
\forall x < z | \text{in}'(z, w)> > \\
\text{basket } '(w)
\end{array}
\]

Again we have obtained the narrow scope reading for every basket.

Of course, what we might have done in the first construction step of the bottom-up construction procedure is to give every basket wide scope over the remainder of the structure. This would give the result we want. But the move seems utterly ad hoc, motivated solely by the urge to get to the interpretation we want. If the subject DP is not a scope island for the embedded DP, then there must be a good explanation for why that is so. That, in large part, was what motivated the quantifier raising principles in the first place. If we cannot come up with anything as good as that, then the best we can do is to buy into that analysis, and construct our DRSs from syntactic structures in which quantifier raising has taken place. But this puts the approach at a disadvantage vis-à-vis H & K as long as we have nothing to offer that can compare with the way in which syntactic and semantic principles interact in their approach.

On the other hand, DRT has something to say about many phenomena that the H & K approach (in the form in which it is known to me) does not seem to cover. So perhaps some kind of compromise of these two approaches is still something to strive for.
Plurals

1. Plural vs. singular pronouns.

Main claim:

The antecedents for anaphoric singular pronouns are present (“ready-made”) in the discourse context when constructed according to the principles of Ch.s 1 and 2. Notorious example to show this (Partee):

(23)  (i) √ One of the ten balls is not in the bag. It is under the sofa.
     (ii) # Nine of the ten balls are in the bag. It is under the sofa.

The antecedents for anaphoric plural pronouns often have to be “manufactured” from material that the discourse context makes available.

Examples:

(4.4)  (i) John took Mary to Acapulco. They had a lousy time.
       (ii) John took Mary to Acapulco. Fred and Suzie were already there. The next morning they set off on their sailing trip.

(4.5)  (i) √ Two of the ten balls are not in the bag. They are under the sofa.
       (ii) # Eight of the ten balls are in the bag. They are under the sofa.
       (iii) Freddie took one ball out of the bag. Andy took out another one. They are under the sofa.

(4.6) Susan has found every book/most books/ only few of the books that Bill needs. They are on his desk.

(24) Susan has found only few of the books Bill needs. He is disappointed, for he badly needs all of them.

(25) You don’t see hedgehogs in winter. They hibernate.

Empirical generalization:

Summation and Abstraction are permissible operations for creating antecedents for plural pronouns. Subtraction is not.

This suggests:

ii. The rules that govern the interpretation of plural pronouns are like rules of logic, but they do not exhaust these: antecedent construction for plural pronouns is not like ordinary logical deduction.

ii. These rules govern the behavior of a particular type of expression and thus must be considered as part of the grammar of the language.

iii. The scope of these rules extends beyond the limits of the single sentence.
Remark about the representation of generalized quantifiers (pp. 316, 317)

2. Distributional and collective interpretations of sentences with plural DPs.

(4.27) (i) The men carried the piano upstairs.
(ii) The lawyers hired a new secretary.
(vi) Martin connected the computers.
(vii) The newspaper tycoon left his children a huge fortune.

(4.28) Both the professors and the lawyers decided to get private secretaries.
But there was a difference. The lawyers hired a secretary they liked. The professors hired a secretary they could afford.

(4.31) (i) The lawyers hired a secretary.
(ii) Few lawyers hired a secretary.
(iii) The villagers built a town hall.
(iv) Many villagers built a town hall.

(4.36) (i) √ The crowd gathered in the square.
(ii) √ The men gathered in the square.
(i) # The man gathered in the square.

(4.37) (i) √ Many men gathered in the square.
(ii) √ Few men gathered in the square.

(4.38) The lawyers hired a new secretary they liked.
(4.40) Few lawyers hired a new secretary they liked.

3. Dependent Bare Plurals

(4.50) Most of my friends own cars.

(4.51) Most students bought books that would keep them fully occupied during the next two weeks.

(4.51) Most students bought a book that would keep them fully occupied during the next two weeks.

(4.52) Most students bought several books that would keep them fully occupied during the next two weeks.

4. “They as individual variable”

(4.67) Fred admires Susan. They are writing a paper on plurals.
(25) Fred admires Susan. They are writing papers on plurals.

(4.87) Few lawyers hired a new secretary they liked. They had discussed the applicants beforehand.
5. Dependent bare plurals (again) and dependent plural pronouns

(4.89) (i) The women bought cars which had automatic transmissions.
(ii) The women bought a car which had automatic transmissions.
(iii) The women bought cars which they liked.
(iv) The women bought a car which they liked.

(4.96) German civil defense workers spotted those planes.

(4.97) The boys gave the girls nickels/gave nickels to the girls.

(4.98) (i) Weak men tend to drive strong cars.
(ii) Strong cars tend to be driven by weak men.

(4.116) Every director gave a present to a child from the orphanage.
They /Some/Two (of them)/None of them opened them right away.

6. The distributivity and collectivity properties of nouns and intransitive and transitive verbs.

(4.161) Three lawyers hired five cleaners.

7. Singular and Plural denotations: individuals and sets vs. atomic and non-atomic individuals.

Three options:

(i) Singular DPs denote individuals; (referential) plural DPs denote sets
(with ≥ 2 members) (Winter)

(ii) Both singular and referential plural DPs denote sets. Singular DPs denote
singleton sets, plural DPs sets of cardinality ≥ 2. (Scha)

(iii) Both singular and referential plural DPs denote “individuals”. Singular DPs
denote atomic individuals, plural DPs sets non-atomic individuals. (Link)

• Further twists to this: groups (Landman); covers (Schwarzschild)

• Arguments for a “same type” treatment of singulars and plurals:

(d) The behavior of the (and other definite determiners in English and other
languages).

(e) The similarities between plural DPs and (singular) mass DPs.
(f) The complicated relations between grammatical number and atomicity structure.

Compare for instance:

i.  water, air, magma, butter, cheese
ii. rubbish, sand, sugar
iii. furniture, foliage
iv. drags, odds and ends, remnants
v. parts
vi. dogs, chairs

Further possible topics within the general area of plurals:

- Reciprocals (Heim et al), (Dalrymple et al.)
- Distributive and collective reading of verbs with one or more non-distributive plural DP arguments. (Scha, Landman)
- Polyadic quantifiers (Quantifiers that (seem to) bind more than one variable at once) (Keenan, Peters and Westerstahl); same, different, together.
In particular: Landman (Groups I) and Schwarzschild (Types of Plural Individuals)

I. Landman

1. Mereology vs. Set Theory.

According to Link (1983) the semantics of singular and plural count nouns and mass nouns is better modeled by “Mereology” than by Set Theory.

Def. A mereological structure is an upper semi-lattice \(<U, \leq>\), i.e. a weak partial ordering (reflexive, anti-symmetric and transitive) which is closed under sums

\(<U, \leq>\) is closed under sums: for every \(V \subseteq U\) there is an element \(s \in U\) such that

(i) for all \(v \in V, v \leq s\);

(ii) if \(w \in U\) is such that for all \(v \in V, v \leq w\), then \(s \leq w\).

(So \(s\) is the “least upper bound” of \(V\). \(s\) is denoted as \(\Sigma V\))

Difference between the denotations of count nouns and mass nouns (very roughly):

Denotations of count nouns are atomic mereological structures; denotations of count nouns are atomless mereological structures.

Def. Let \(<U, \leq>\) be a mereological structure.

(i) \(u \in U\) is an atom of \(<U, \leq>\) iff for no \(v \in U\), such that \(v \neq u\), then \(v \leq u\).

(ii) \(<U, \leq>\) is atomic iff for all \(v \in U\) \(v\) is the sum of all atoms \(u\) such that \(u \leq v\).

(iii) \(<U, \leq>\) is atomless iff \(<U, \leq>\) has no atoms.

(iv) Suppose \(<U, \leq>\) is atomic.

(a) \(<U, \leq>\) is complete iff for any set \(V\) of atoms \(\Sigma V\) exists.

(b) \(<U, \leq>\) is free iff for any two sets \(V, W\) of atoms, if \(V \neq W\), then \(\Sigma V \neq \Sigma W\).

N.B. Every free atomic mereological structure \(<U, \leq>\) is isomorphic to a set structure \(<\mathcal{P}(U') \setminus \emptyset, \subseteq>\), were \(\mathcal{P}(U')\) is the powerset of some set \(U'\) and \(\subseteq\) is the set-theoretic inclusion relation on \(\mathcal{P}(U')\).

Claim: Let \(N\) be any count noun, \(<U, \leq>\) the denotation of \(N\). The extension of the singular form of \(N\), \(N^\text{sg}\), is the set \(N^\text{at}\) of atoms of \(<U, \leq>\). The extension of the plural form of \(N\), \(N^\text{pl}\), consists of the non-atomic elements of \(<U, \leq>\), also called sums or pluralities.

(The extension of \(N^\text{pl}\) is often denoted as \(N^+\). \(N^* =_df N^+ \cup N^+\).)

Def. The language of plurality, \(LP\), is a formal language for describing mereological structure. \(LP\) is a language of first order predicate with some extra features:
an abstraction operator $\sigma$, which when applied to a formula $\phi$ and an individual variable $x$, forms a term $\sigma x. \phi$, in which $x$ is bound by $\sigma$;
(“$+X$” is short for “$\sigma x. x \in X$”)

(ii) two predicate modifiers $*$ and $D$, operating on 1-place predicates
(i.e if $P$ is a 1-place predicate, then so are $*P$ and $DP$).

Moreover, LP has two special predicates, $AT$ (1-place) and $\subseteq$ (2-place) as well as a 2-place operation constant $+$. Models for LP: atomic, complete mereological structures $M = <A, +, \subseteq, AT>$

Interpretation of $\sigma x. \phi$, $*P$ and $DP$:

$$[[\sigma x. \phi(x)]] = \text{the least upper bound of the d in M which satisfy } \phi(x);$$
$$[[*P]] = \{y \in A: (\exists X \subseteq [[P]]) y = +X\}$$
$$[[DP]] = \{y \in A: (\forall z)(z \subseteq y \& AT(z) \rightarrow P(z))\}$$

N.B. If $[[P]]$ is a set of atoms, then $[[*P]] = [[DP]]$.

2. Reasons (Link, Landman and others) why mereological structure by itself is not enough and needs to be enriched with groups:

(L21) The talking Heads gave a concert in Holland.
(L22) David, Chris, Jerry and Tina gave a concert in Holland.
(L26) Groenendijk and Stokhof presented a paper at the conference.
(L27) The cards below seven and the cards seven and up have been separated.
(L31) The cards below seven were separated from the cards seven and up.
(L32) The men and the women who were married still had to sleep in different dorms.
(L33) The Leitches and the Latches the each other.

3. Link’s way of introducing “groups” into LP:

Add to LP two 1-place operators $\uparrow$ and $\downarrow$. $\uparrow$ forms groups out of pluralities and $\downarrow$ turns a group into the plurality of its members.

One way to model this extended LP is set-theoretical:

(i) atoms are singleton sets;
(ii) non-atoms are sets of more than one element;
(iii) $\sigma$ is used to form sets out of formulas (defining conditions);
(iv) $\uparrow$ forms the singleton of the argument set $x$ to which it is applied: $\uparrow x = \{x\};$
(v) $\downarrow$ turns any singleton set $\{x\}$ into $x$: $\downarrow\{x\} = x$.

• This particular model of extended LP structure is not sufficient, since it does not make room for more than one group with the same members.
4. Landman’s simplification.

Landman proposes that on the other hand the system can be simplified as follows:

(i) The extensions of all predicates (verbs as well as nouns) consist solely of atoms.
(ii) collective readings are always group readings; when a predicate applies to a plurality it always distributes
(iii) * now takes over the role of $D$, which can be discarded; the new clause for *:

$$[[*P]] = \{y \in A: (\forall z)(z \subseteq y \& AT(z) \rightarrow P(z))\}$$

• Involvement. Landman argues that (L44.a) does not entail (L44.b) (even though David, Chris, Jerry and Tina are the members of The Talking Heads):

(L44) a. The Talking Heads gave a concert in Holland
b. David, Chris, Jerry and Tina gave a concert in Holland.

The reason is that (L44.b) seems to imply that all four were present at the concert. (L44.a) does not seem to carry this entailment.

The only way that the difference between (L44.a) and (L44.b) can be accounted for now that the system has been simplified in this way is by insisting that “The Talking Heads” and “David, Chris, Jerry and Tina” denote different groups.

Landman(?): Conjunctive DPs as in (L44.b) and also phrases like four boys, many boys, a group of four boys, as in

(1) Four boys/Many boys/A group of four boys built a boat together.

strongly suggest involvement of all their members in the collective predication expressed by the verb.

Questions: How do we account for this tencency? How plausible is a purely pragmatic account of the relevant differences?

• Application of the new system:

(L64) The cards below seven and the cards from seven up form a deck (together).

$$F((\sigma x. x < 7) + (\sigma x. x \geq 7))$$

(L66) The cards below seven and the cards from seven up are shuffled.

One reading: *SH($\sigma x. x < 7$) + $\sigma x. x \geq 7$)

(L27) The cards below seven and the cards from seven up are separated.

$$S(\sigma x. x < 7) + \sigma x. x \geq 7$$)
The boys and the girls had to sleep in different dorms, met n the morning at breakfast, and were then wearing their blue overalls.

To be dealt with using type shifting, here using the operations LIFT and LOWER.

Let B&G be the term “$\uparrow (\uparrow (\sigma x.*B(x)) + \uparrow (\sigma x.*G(x)))$”. And let “$\downarrow^2 (a + b)$” be short for “$\downarrow (a) + \downarrow (b)$”. Then (L71) translates into:

$$\text{S}(B&G) \land M(\uparrow (\downarrow^2 (\downarrow (B&G)))) \land *W((\downarrow^2 (\downarrow (B&G))))$$

II. Schwarzschild.

• Main thrust of the paper:

There are two approaches to the semantics of plurals, the “sums approach” and the “groups approach”.

There appears to be strong evidence in favor of the group approach.

However, when the evidence is considered more carefully, this is no longer quite so clear.

• A general methodological problem:

How do we tell whether two plural terms t and t’ are coreferential or not?

Prima facie test for non-coreferentiality: Find a (linguistic) predicate P so that the combination of t with P is a true sentence in a given situation and the combination of t’ with P a false sentence. But this is not fool-proof:

(S1)  a. [George and Mike] [are running with Dan and Lloyd, respectively].
      b. [Mike and George] [are running with Dan and Lloyd, respectively].

Suppose (1.a) is true and (1.b) is false. Does that show that “George and Mike” and “Mike and George” are non-coreferential?

• A second methodological issue. Schwarzschild excludes “distributive” readings of conjunctive NPs. What he means is this:

When it is used to conjoin NPs and is ambiguous between:

(i) its general polymorphic use as a (shifted) sentence conjunction, and
(ii) a “sum” operator, which forms the sum, or perhaps the group consisting of, the denotation of the conjuncts.

On the first reading, (1.a) is to be analyzed as (1.b):

(1)  a. The Titans and the Martians are strong.
     b. The Titans are strong and the Martians are strong.
Schwarzschild excludes this use of and. Note however that in many cases “distributive” interpretations (in this sense) of conjoined NPs lead to the same truth conditions as “Non-distributive” readings

N.B. That and allows for the “sum” interpretation when conjoining NPs is a remarkable fact. The possibility is found only marginally with other grammatical categories, and it is not found at all with, for instance, or. For instance (2.a) only has an analysis on which it reduces to (2.b).

(1) a. The Titans or the Martians are strong.
   b. The Titans are strong or the Martians are strong.

• Arguments in favor of groups:

(S5) a. The cows and the pigs were separated.
   b. The young animals and the old animals were separated.

(S8) a. [[Blücher and Wellington] and Napoleon] fought against each other near Waterloo.
   b. [Blücher and [Wellington and Napoleon]] fought against each other near Waterloo.

(S9) a. The pigs from the two communities hated each other.
   b. The pigs from the two parties hated each other.

(S11) a. The animals filled the barn to capacity.
   b. The cows and the pigs filled the barn to capacity.
   c. The young animals and the old animals filled the barn to capacity.

(S12) Upward Closure Phenomenon

If a predicate of English is true of a group G of first order, it has a homonym that is true of all higher order groups that are formed using all the members of G (are “related” to G).

(S13) If \( \alpha \) is a one-place predicate of English that translates as \( \alpha' \), then it also translates as \( \text{LIFT}(\alpha') \), where

\[
||\text{LIFT}(P)|| = \{ Y \in D : x \in \text{IN} : x \in * Y \in ||P|| \}
\]

(\( * \) is the transitive closure of \( \in \))

(S16) Mereological Generalization

If a predicate of English is true of a group G of any order, it has a homonym that is true of that first order group G’ which is composed of the individuals
used to generate G.

(S17) If \( \alpha \) is a one-place predicate of English that translates as \( \alpha' \), then it also translates as \( \text{LOWER}(\alpha') \), where

\[
||\text{LOWER}(P)|| = \{ Y \subseteq \text{IN} : (\exists K)(K \in ||P|| \& \{ x \in \text{IN} : x \in^* K \} = Y) \}
\]

(\( \in^* \) is the transitive closure of \( \in \) )

N.B. Always \( \text{LOWER}(\text{LIFT}(\alpha')) = \alpha' \), but in general not \( \text{LIFT}(\text{LOWER}(\alpha')) = \alpha' \).

Question: Do the principles (S12) and (S16) lead to an inconsistency?

Schwarzschild: This is not as obvious as it might seem at first sight. Consider (S19.a-f):

(S19) a. The young animals and the old animals are just the cows and the pigs.
    b. The young animals and the old animals were separated.
    c. The animals were separated.
    d. The animals were separated by age.
    e. The cows and the pigs were separated by age.
    f. The cows and the pigs were separated.

So, doesn’t this show that (S19.a,b) entail (S19.f) after all?

Question: Could it be that the interpretation for (S19.f) on which it is entailed by (S19.a,b) can be obtained only when the intermediate sentences make the interpretation available? If that is so, what does that tell us about entailment within natural language?

More examples to show how hard it is to be sure that certain interpretations are not possible:

(S26) Despite their current membership in a common market, only 45 years ago, Germany and England and France and Italy were fighting each other in one of the worst wars in history.

(S8’) Blücher and Napoleon and Wellington (listed in alphabetical order) fought against each other near Waterloo.

- What enables the interpreter of a sentence that requires making a partition of the denotation of a plural DP to make the intended partition?

(S28) In this neighborhood the upper class children and the lower class children did not hate each other, but the adults do.

(S29) The various children couldn’t get along with each other nor could the men and women.

- Doing without groups.

(S31) a. The cows and the pigs were involved in a debate. The former were in favor of rebelling but the latter were not.
b. The young animals and the old animals were involved in a debate. The former were in favor of rebelling but the latter were not.

(S34) The prisoners on the two sides of the room could see each other.

(S37) Farmer Smith ad Farmer Jones said that although their cows could stay together the pigs had to be separated.

Question: Is the resolution of the partition problem that such sentences pose the same as the resolution problem for pronouns?

Schwarzschild: Not quite, it seems. Decisive in the case of partitioning are properties that are made salient in the discourse. (e.g. the property of belonging to Smith and the property of belonging to Jones)

Question: What is the role by the by-phrases of sentences like (3)?

(3) The animals were separated by age.

Why does (4) seem so very bad (and not just redundant)?

(4) The old pigs and the young pigs were separated by age.

Another general question that Schwarzschild’s discussion raises:

What in meaning and interpretation has to do with denotation and what with representational form?
Some reasons why mereological structure is to be preferred over set-theoretical structure.

Reason 1: We want to be able to analyze *hate each other* in (1) and *were separated* in (2) as relations between two groups, rather than applying to a single plurality.

(1) The Montagues and the Capulets hate each other.
(2) The cows and the pigs were separated.

Reason 2: The name “The Talking Heads” of the pop group behaves differently from the plurality denoting NP “David, Chris, Jerry and Tina” that enumerates its members

(3) a. The Talking Heads has four members.
   b. ?? David, Chris, Jerry and Tina has/have four members.

Reason 3:

(4) (= L6) Who made a mess of the living room?
   Intuitively: Answer could specify a single individual or

Fourth reason: Number-neutral uses of plural descriptions like *the books* in

(5) The books the students bought would be enough to keep them busy for the next two weeks.
Temporal relations between sentences in discourse.

(12) A man entered the White Hart. He was wearing a back jacket. Bill served him a beer. The man paid. He drank the beer. It was exceptionally good.

(13)  
  a. Fred left on Wednesday. He arrived on Sunday.  
  b. Fred arrived on Wednesday. He left on Sunday.  
  c. Fred arrived on Wednesday. He had left on Sunday.  
  d. Fred arrived on Wednesday. He left (again) on Sunday.

To interpret a sequence of sentences as a coherent piece of discourse requires us to perceive the successive sentences to be connected by certain rhetorical relations, such as ‘narrative continuation’, ‘causal explanation’, ‘elaboration’ and so on. Each such relation carries certain implications for the temporal relations between the eventualities described in the sentences – that must hold
Presupposition.

I. A very fast run through the history of theorizing about presupposition.

A. Logicians and Philosophers.

• Frege (1892):

The sense of the sentence “After Schleswig-Holstein was separated from Denmark, Prussia and Austria quarreled” can also be rendered in the form “After the separation of Schleswig-Holstein from Denmark, Prussia and Austria quarreled”. In this version it is surely sufficiently clear that the sense is not to be taken as having as a part the thought that Schleswig-Holstein was once separated from Denmark, but that this is the necessary presupposition in order for the expression “after the separation of Schleswig-Holstein from Denmark” to have a reference at all.’

According to Frege definite descriptions (among them mathematical descriptions like the smallest prime, the largest prime, the largest prime pair and so on) come with a presupposition that their descriptive content has a unique satisfier. For Frege, who saw failure of reference of a descriptive term in a sentence as entailing a failure of the sentence to determine a truth value, definite descriptions whose unique satisfaction presuppositions are not satisfied constituted a threat to logic.

• Russell (1905) (The "Theory of Descriptions"):

There is no need to assume that definite descriptions carry presuppositions. Their "presuppositions" are part of the propositional content of the sentences containing them.

• Strawson (1950, 1964):

Russell's treatment of definite descriptions is unnatural for various reasons. If we attend more closely to the way they work in natural language, we see that definite descriptions really ought to be treated as expressions that trigger presuppositions (and that these presuppositions can fail).

• One spin-off from the Strawson line:

Attempts to develop partial- and multi-valued logics for languages with presuppositions. For many years this was a true industry that kept many logicians off the unemployment lists.

• Stalnaker (Presupposition and Assertion in Context, around 1970):

By using a sentence that comes with a presupposition p the speaker indicates that he takes p to be true in the background context or common ground.

B. The Linguistic Turn.
Late sixties (Langendoen & Savin (1971), Kiparski & Kiparski (1970)):

Linguists begin to realize that presupposition is not something peculiar to definite descriptions, but a much more general phenomenon; all sorts of expressions and constructions in natural languages other than definite descriptions are presupposition triggers.

Karttunen (1973, 1974):

The Projection Problem for Presuppositions: Presuppositions triggered by words or constructions in embedded clauses sometimes manifest themselves as presuppositions of the sentence as a whole and sometimes not.
The problem: How do we account for when they do and when they don’t.


Van Der Sandt (1992) (also: Geurts, Zeevat): Presupposition as a form of anaphora; the unification of presuppositional and anaphoric phenomena. This account makes an apparently crucial use of DRT.

II. Presupposition tests.

How do we distinguish between those parts p of the information conveyed by a sentence that are presuppositional and those that are non-presuppositional?

The two main tests for presuppositionhood are:

(i) The negation test: p is a presupposition of S if it is also part of the information conveyed by the negation of S.

(a) *The King of France came to the exhibition.*
(b) *The King of France didn’t come to the exhibition.*

Both (a) and (b) carry the implication that there is a King of France.

(ii) The question test: p is a presupposition of a yes-no question Q (and therewith also of other moods corresponding to Q, in particular of the corresponding declarative sentence) iff knowledge that p is false makes it inappropriate to answer Q with a straight (“yes” or “no”).

A: *And did the King of France come to the exhibition?*
B: (a) Yes (*); (b) No (?); What do you mean?. There isn’t any King of France (√).

III. Some examples of presupposition triggers.

(1) Definite noun phrases - not only definite descriptions, but also proper names,
demonstratives and pronouns. These all come with referential presuppositions, to the effect that the phrase properly denotes in accordance with the reference rules associated with their type (i.e. whether they are proper names, pronouns, descriptions, etc.)

(2) Factive verbs.

(a) emotive: regret, be happy, be sorry, ..
(b) non-emotive: know, realize, discover,..

(a) John regrets/doesn't regret that he went to the concert.
Presupposes that John went to the concert.
(b) She has/hasn’t discovered that he is having an affair.
Presupposes that he is having an affair.

(3) Change of state verbs: arrive, leave, die, kill, marry, .. (“prestate presuppositions”)

Mary arrived in Paris last Monday at 10.30.
Presupposes: Mary was not in Paris for some period leading up to 10.30 last Monday.

(4) Aspectual verbs: stop, start, begin, continue, carry on, remain,..

Last week John stopped smoking.
Presupposes: John smoked for some period of time leading up to last week.

(5) Tenses:

Come with presuppositions linking the described eventualities to reference times and in some cases to temporal perspective times

(6) Additive particles: too, also, as well, even,..

Nixon is guilty too.
Presupposes: Someone other than Nixon is guilty.

She gave him a kiss too.
Presupposes either: (i) She gave him something else,
or: (ii) She gave someone else a kiss too.
(7) again

Mary closed the window again.

Presupposes either:
(i) Mary closed the window before. (repetitive reading)
or:
(ii) The window was previously closed. (restitutive reading)

I will/won't go to Disneyland ever again.

Presupposes either that I have been to Disneyland in the past or that I am there right now or that I will go to Disneyland at some time before the one targeted in the sentence (as in: I’ll come with you to Disneyland tomorrow. But I won’t go to Disneyland ever again.)

Another famous example from the literature (Kripke): compare (i) and (ii):

(i) If we have pizza on Mary's birthday, we won't have pizza on John's birthday.

(ii) If we have pizza on Mary's birthday, we won't have pizza again on John's birthday.

(8) Clefts

Presuppose that the relative clause of the construction has at least one instance.

It was/wasn't Fred who solved the problem.

Presupposition: Someone solved the problem.

(9) "Positive" Quantifiers (everyone, all, most, many, five, at least five, more than five, ..)

Presuppose that the domain of quantification is non-empty.

(Not) every American monarch was at the reception.

Presupposes that there are some American monarchs.

(10) Wh-questions

Presuppose that the predication they express of the wh-element has instances.

Who has been in the kitchen?

Presupposition: Someone has been in the kitchen.

(Question: Is this really a presupposition?)
(11) Argument selection restrictions of predicate words.

Two examples:

(i) the verb murder. Any use of murder presupposes that both its subject and its direct object are persons.

(ii) the verb prevent. Uses of prevent presuppose that the subject is an agent and the direct object an eventuality.

(12) Focus.

Focused constituents of a sentence – marked by focal stress, the default method for marking focus in a language with highly rigid word order such as English, or in some other way, e.g. through position as in Hungarian, or by explicit focus articles as in certain South-East Asian languages – divides the sentence into two parts: (i) the focused constituent and (ii) the remainder, or background, or focus frame; semantically the background/focus frame can be seen as a lambda-abstract over a variable that replaces the focused constituent when it is extracted from the sentence.

It has been suggested that focus creates a presupposition to the effect that there is something satisfying the focus frame. For instance, the focus on Fred in (a) creates the focus frame in b, and the presupposition given in (c) $\lambda y. y$ solved the problem

(a) **FRED** solved the problem.
(b) $\lambda y. y$ solved the problem
(c) $(\exists y) y$ solved the problem

On this view the sentence in (a) has the same presupposition as the cleft sentence

(d) *It was Fred who solved the problem.*

But the two presuppositions do not seem to behave in quite the same way. For instance, (e) seems fine, while (f) seems odd.

(e) If **FRED** didn’t solve the problem, then nobody did.
(f) If it wasn’t Fred who solved the problem, then nobody did.

The explanation suggested for this difference is that the cleft-presupposition in the antecedent of (f) is robust and thus percolates up to the context of the conditional. (It “projects”.) In the context of that presupposition the consequent of the conditional is odd, since it contradicts this presupposition. In contrast, the presupposition of the antecedent in (e) is less robust and can be overruled by the pressure to get a coherent interpretation for the consequent. This is one example of presuppositions that are subject to different justification regimes, even while their propositional content is identical.

IV. The Projection Problem
A naïve idea of presuppositions in complex sentences:

No matter where in a sentence a presupposition gets generated, it always becomes a presupposition of the sentence as a whole, which should be satisfied in the ‘global’ context in which the sentence is uttered.

But this isn’t so. There are countless examples to show this. Among them are the following (Karttunen, 1973).

(13)  

<table>
<thead>
<tr>
<th>Case</th>
<th>Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>If John has children, then his children are bald.</td>
</tr>
<tr>
<td>b.</td>
<td>If John is bald, then his children are bald.</td>
</tr>
<tr>
<td>c.</td>
<td>If John’s children are bald, then he has children.</td>
</tr>
<tr>
<td>d.</td>
<td>If John has sons, then at least some of his children are bald</td>
</tr>
<tr>
<td>e.</td>
<td>If at least some of his children are bald, then John has sons.</td>
</tr>
<tr>
<td>f.</td>
<td># If John’s children are bald, then he is bald.</td>
</tr>
<tr>
<td>g.</td>
<td>John has children and, moreover, his children are bald.</td>
</tr>
<tr>
<td>h.</td>
<td># John’s children are bald and, moreover, his children are bald.</td>
</tr>
<tr>
<td>i.</td>
<td>Few people who know John’s children, know him.</td>
</tr>
<tr>
<td>j.</td>
<td>Few people who know John, know his children.</td>
</tr>
<tr>
<td>k.</td>
<td>Few people who know that John has children, know his children/them personally.</td>
</tr>
<tr>
<td>l.</td>
<td>Few farmers who have children beat them.</td>
</tr>
<tr>
<td>m.</td>
<td>Few farmers who own a donkey beat it.</td>
</tr>
<tr>
<td>n.</td>
<td>If John comes today, then he will come again tomorrow.</td>
</tr>
<tr>
<td>o.</td>
<td>If John comes again today, then he will come tomorrow too.</td>
</tr>
<tr>
<td>p.</td>
<td>If John keeps his promise, then he will come again tomorrow.</td>
</tr>
<tr>
<td>q.</td>
<td>If John keeps his promise, then he will come tomorrow.</td>
</tr>
</tbody>
</table>

General conclusion: Not all presuppositions project to the level of the whole (complex) sentence within which they are generated. Some are justified by the ‘local context’ that is created by some other part of the sentence. Examples of local contexts for sentence parts:

(i) The first conjunct of a conjunction is a local context for (the presuppositions of) the second conjunct.

(ii) The antecedent of a conditional is a local context for (the presuppositions of) its consequent

(iii) The restrictor of a quantifier is a local context for (the presuppositions of) its nuclear scope.

Note that these instances of the ‘local context’ relation are also instances of the ‘accessibility’ relation of DRT. In fact, for all we know, the two relations are one and the same. (The DRT treatment of presupposition phenomena is based on this assumption.)

(For the presuppositions generated in grammatically and logically simple sentences there are no local contexts. These presuppositions must always be satisfied in the
global content.

- When a presupposition is neither satisfied by the global context nor by some local context, then often it can still be ‘accommodated’:

  (14) a. John’s children are bald.
  b. Annabel has turned up again.

  Accommodation in the case of (14.a): Apparently (the speaker assumes that) John has children.

  Accommodation in the case of (14.b): Apparently (the speaker assumes that) (i) Annabel has come on one or more previous occasions (‘repetitive’ use of again), or (ii) that Annabel was here before, but then had been gone for some time.

  Accommodation ‘of’ a given presupposition can be thought of as an adjustment that the recipient of the utterance makes to his understanding of the context, so that the presupposition will hold in the revised (accommodated) context. The motivation for it is something like this: ‘if the speaker is using a sentence that generates this presupposition, then she must be assuming a context in which this presupposition is satisfied; for otherwise she would not have expressed herself in this way’. (Beaver, 1994, 2001) Indeed, in those cases where it is clear that the speaker is talking about the real world and where the recipient knows that the presupposition cannot hold in the global context, because it contradicts a real fact of which he is aware, then accommodation is not really possible – or only as a conversational ploy of playing along with the speaker to see where that will lead.

  It is a point of debate whether accommodation is possible only at the global level (i.e. as accommodation of the global context) or also at local levels. In the cases we will assume here accommodation is possible only at the global level. (Beaver, 1997).

  The nature and forms of accommodation: In the presupposition literature there is both talk of ‘accommodation of a presupposition’ and of ‘accommodation of the context’. Use of the phrase ‘accommodation of a presupposition’ is often associated with the view that when a presupposition is accommodated, it is added to the context ‘whole sale’ (i.e. the presupposition is assumed to express a proposition and that proposition is added to the context).

  The phrase ‘accommodation of the context’ is typically used by those who are not committed to this last assumption: If a presupposition is not satisfied in the context as it is given (or as the recipient takes it to be), then the context will, if possible, be adjusted in some plausible way which ensures that the presupposition will be satisfied. But this need not take the form of adding the presupposed proposition just as it is. It will often suffice to accommodate some information that entails the presupposition in conjunction with contextual information that is already available. Sometimes the accommodation will in fact be stronger than what is strictly needed for the satisfaction of the presupposition, because it makes more sense for the accommodator (i.e. the recipient) to assume that this is what the speaker must be taking for granted. And of course the actual bit of information that is added may also be logically weaker than the presupposed proposition because it is only in conjunction with the contextual information that is available already that it has to entail the presupposed proposition.
Moreover, it quite often happens that ‘justification’ of a presupposition takes the form of combining information from the global and some local context, or of using information of some local context in combination with information that is ‘accommodated’ at the global level.

More complicated cases of the latter kind were (I believe) first brought to the attention of a wider audience in a (for many years unpublished) lecture by Kripke. (A version of this lecture recently appeared in Linguistic Inquiry 20??) and even more recently in Kripke’s collected essays.

A variant of one of Kripke’s examples (though not in the version of the paper that has now appeared) is the following.

(15) a. We are not going to have pizza on Billie’s birthday, if we are going to have pizza on Mary’s birthday.

b. We are not going to have pizza again on Billie’s birthday if we are going to have pizza on Mary’s birthday.

Observation: (15.b) carries the implication that Billie’s birthday will be after Mary’s birthday. (15.a) does not carry this implication (or only very weakly, and easily overridden).

Explanation: The presupposition triggered by ‘again’ in the consequent of the conditional in (15.b) is to the effect that there was an earlier event of the subject eating pizza. We can see this presupposition as justified if we assume the global context to contain the information that Billie’s birthday is after Mary’s (or: if we accommodate this information at the global level, accommodate the global context by adding this information to it).

In a case like (15.b) the accommodation seems forced upon us, as it were. It almost seems like (15,b) entails that Billie’s birthday is after Mary’s. But if that is true at all, it is an entailment that holds only be virtue of there being no other contextual information that justifies the again presupposition. Consider for instance (16), in which the first sentence provides such additional information. Here the ‘entailment’ disappears.

(16) We already just had pizza on Freddie’s birthday last week. (So) we are not going to have pizza again on Billie’s birthday, if we are going to (also) have pizza on Mary’s birthday.

Here is another type of example in which several different presuppositions connive to produce the effect of what looks like a real entailment. (Kamp 2001)

(17) I gave the workers a generous tip. One thanked me. But the other one left without saying a word.

‘Entailment’: the number of workers referred to in the first sentence was 2.
Question: How can we explain how ‘entailments’ like this one come about?

- A further range of complications arises when presuppositions are generated within non-veridical contexts. Telling cases are presuppositions connected with counterfactuals.

(13) Counterfactuals.

Counterfactual conditionals like (18.a) presuppose both the falsity of their antecedent and of their consequent.

‘Even’-counterfactuals like that in (18b) presuppose the falsity of its antecedent but the truth of its consequent.

(18) a. If John had left on time, then he would have been here on time.
b. Even if John had left on time, he wouldn’t have been here on time.

Counterfactuals provide an illustration of an aspect of presupposition that we have not yet touched on, although it also plays a role in the presuppositionality of factive verbs such as regret or know. This is that in some cases the local context that is provided by one part of a complex sentence for the presuppositions generated by some other part cannot be treated as an expansion of, or addition to, the global context. In the present case the local context is that provided by the antecedent of the counterfactual for the presuppositions of its consequent. The antecedent of a counterfactual sets up a context of its own, which can be characterized in first approximation as a set of possible worlds in which the antecedent holds together with what can be salvaged from the global context when it is revised in the light of the antecedent. (Recall that the antecedent is presupposed to be false in the global context. So not all of the information from the global context can be retained in building a coherent new context in which the antecedent is true.)

(For those familiar with semantic analyses of counterfactuals such as those of Stalnaker, Lewis or Kratzer – analyses of the truth conditions for conditionals according to which “If it had been the case that A, then it would have been the case that B” is true in a world w iff b is true in all the nearest A-worlds (i.e. all those worlds which verify A while retaining as much of what is true in w as possible). Justification of a presupposition generated in the consequent of a counterfactual therefore tends to involve contexts that cannot be determined on the basis of purely linguistic information even when the global context is given.)

There are many other intensional constructions besides counterfactuals which create non-veridical local contexts for presuppositions. For all of these presupposition justification involves this additional problem of assessing an alternative to the global context of the utterance. This problem is absent from those constructions that have traditionally served as the primary illustrations of the Projection Problem: presuppositions generated by the second conjunct of a conjunction, in the consequent of an indicative conditional or in the nuclear scope of a quantifier. For the latter it is plausible to maintain the following principle:

A further complication with counterfactuals arises for presuppositions that are generated by constituents of their antecedents or consequents. Consider for instance
the sentences in (19).

(19) a. If John’s children had been bald, he would have had others.  
    b. If John had had children, then his children would have been bald.  
    c. If John had been bald, then his children would have been bald.

In (19.a) the presupposition that John has children that is generated in the conditional’s antecedent can only be justified within the global context in which the conditional is uttered. That is, John must have children in the real world. And this piece of information then has to be carried over to the new ‘counterfactual’ local context for the consequent, in which the antecedent must hold as well. So the presupposition ends up holding in both the old global and the new local context.

The presupposition generated in the consequent of (19.b) is justified by the local context provided by the antecedent (as for non-counterfactual conditionals).

It would seem that the presupposition in the consequent of (19.c) should hold in the global context of the conditional (i.e. in the actual world). But this is because the antecedent doesn’t entail the presupposition (nor contradicts it). If the information from the local context doesn’t entail the presupposition then this information must come from the global context; that is, it must belong to that part of the global context that is carried over to the new context induced by the antecedent.

We see something similar with presuppositions generated within the propositional attitude contexts created by factive verbs such as regret. The presupposition in (20) that John has children must hold both in the real world (global context) and in the belief world of John.

(20) John regrets that his children are bald.

The basic set of principles that emerge from this discussion are the following two, bundled in the following statement:

(PJA) (Justification and accommodation of presuppositions)

(i) Justification is always in the local context*.
(ii) Accommodation is restricted to the global context.

(*) Here by “local context” I mean the “expanded” local context, which consists of the information specified in the local context itself together with all information available in parts of the sentence representation that are accessible from it (all those that lie on the ‘Accessibility path’ going from the local context ‘upwards) as well as the global context. (It is part of the logical architecture of DRT that all this information percolates down into the local context representation.)

In the case of counterfactual conditionals something like (PJA) still obtains, but the global context is now the global context after a revision of it induced by the conditional’s antecedent. (This affects (i) as well as (ii), since the global context enters also into the characterization of the expanded local context.)

For other intensional constructions similar modifications of (PJA) are required.
Two further important points that are to be noted:

1. Many sentences generate not just one but several presuppositions, and sometimes a whole battery of them. Example:

   (21) John regrets/doesn't regret that he went to the concert.

   Presupposes: (i) There is some individual called "John" that the speaker is talking about.

   (ii) There was a unique concert (satisfying some further conditions, to be supplied by the context.)

   (iii) The entity referred to by "John" is an "agent", capable of propositional attitudes. (selectional restriction of regret)

   (iv) The complement of regret – the proposition that John went to the concert – is (a) true and (b) a fact of which John is aware.

2. Presuppositions differ considerably with regard to the effects of their failure.

   In some cases of presupposition failure (for instance, reference failure of referring singular terms) it often seems that the sentence doesn’t express a proposition at all; in others (e.g. failure of a presupposition triggered by again, too or emotive factives like regret) a proposition is clearly expressed, but its wording is not adequate to the context in which the utterance is made.

   Moreover, in the case of (e.g. again, too) absence of a particle with the given kind of presuppositional semantics they represent in contexts where the presupposition is clearly satisfied can also cause infelicity:

   Last week John came to the meeting. Yesterday he came \(\emptyset\) /again (\(\checkmark\)) /too (\(\checkmark\)).

   Different types of presuppositions also vary significantly with regard to their “accommodation potential” (Beaver and Zeevat, 2009): how easy or hard is it to accommodate the presupposition? Is this possible only in certain contexts, or only ‘under duress’?

V. The history of presupposition after Karttunen (1974).

Gazdar (1976, 1978) develops a formal theory of presupposition, conversational implicature and conventional implicature.

This is the first formal development of a dynamical, incremental and procedural perspective of how meaning is determined by form.

It also was the first theory to take seriously the distinction between the identification
of presuppositions (as parts of a provisional logical form of the processed sentence; Gazdar refers to these as ‘ppresuppositions’, an abbreviation for ‘potential presuppositions’) and their ultimate justification.

Unsatisfactory from the point of view is that the theory treats all cases where presuppositions do not project in the same way, failing to distinguish between the cancellation of a presupposition and its satisfaction in a local context. Cancellation, on the basis of information-theoretic conflicts (inconsistency, redundancy) with non-presuppositional content and already established implicatures is the only mechanism used to account for non-projection. This leads to false projection predictions in a number of cases.

• Karttunen and Peters (1979). This is a two-dimensional theory of meaning, in which non-presuppositional pairs of propositional contents and their presuppositions are computed compositionally. The account is implemented within Montague Grammar.

This theory accounts explicitly for the possibility of local satisfaction of presuppositions (and therewith for the non-projection that results from this).

A difficulty is that all presuppositions are lumped together, so that it is difficult to see what happens when one presupposition generated within a certain part of a complex sentence is satisfied in the local context provided by some other part of the sentence whereas another presupposition that is also generated in the first part is not satisfied locally.

In general the theory has nothing directly to say about presupposition accommodation nor does not provide a helpful basis for the discussion of accommodation phenomena.

• Heim (1983). This terse and pithy paper is widely (and rightly) seen as a milestone in the development of the dynamic perspective on meaning. Though the thoughts that went into this paper were clearly closely connected with the File Change Semantics that Heim developed around the same time, the paper does not make use of the particular ways in which FCS was developed in Heim’s dissertation Heim (1982).

Heim’s definition of presupposition and assertion (for a comparatively small, but nevertheless expressively powerful language fragment, which is not fully spelled out, but closed under the familiar logical operations \(\neg\), \&, \(\lor\), \(\rightarrow\), \(\exists\), \(\forall\), explicitly accounts for the systematic ways in which the evaluation of a sentence in this given context modifies that context, as well as for presupposition satisfaction in local contexts.

But like Karttunen and Peters (1979) it too lumps different presuppositions together into their ‘logical sums’. And as it stands it too has nothing to say about accommodation.

• Van Der Sandt (1992). Van Der Sandt’s is one of the first systematic treatments of presuppositions within DRT and the one that is most widely known and most often cited.

Van Der Sandt’s approach has several advantages from the perspective of detailed modeling/description of presupposition phenomena:
It is possible to account for presupposition generation and presupposition justification at subsentential levels. (For instance – a case that arises quite often in practice – a predicate Q can presuppose some other predicate P; this means that any predication Q(x) (where x may be a variable, or discourse referent, that is bound higher up) presumes P(x), i.e. that x satisfies P.)

It is this possibility of treating presuppositions at subsentential levels that makes it possible to treat presupposition and anaphora as instances of the same general phenomenon. (That presupposition and anaphora are two sides of the same coin is one of the central claims of this paper.)

Presuppositions generated by different presupposition triggers are not amalgamated into a single ‘sum presupposition’.

Presupposition accommodation can be dealt with explicitly and systematically. Van Der Sandt specifies an explicit accommodation algorithm as part of his general algorithm for presupposition justification. This is arguably the most problematic aspect of his proposal. The difficulties were noted early on by Beaver. (See Beaver (2001), also for references to Beaver’s earlier work on this.)

Van Der Sandt’s approach creates the possibility for developing explicit procedures for the construction of semantic representations for the presuppositions due to different presupposition triggers. It is these representations which then identify the presuppositions that need justification (within the global or some local context).

While the general framework that Van Der Sandt develops in this paper offers the possibility for making the construction of presupposition representations explicit, he himself does not exploit this possibility. (In the examples he discusses the representations are presented as given, rather than constructed by application of explicit syntax-semantics interface rules.)

But in fact, the construction of explicit representations of presuppositions (and the precise identification of their content) can be a quite tricky business. The reason is two-fold.

First, presupposition triggers are often single words, such as too, again, still, stop, manage, regret, and the presuppositions that are generated by particular occurrences of presuppositions are the result of how these occurrences interact with other material in the sentences that contain these occurrences. The sentence material from which the representation of the presupposition must be constructed is often referred to as the ‘scope’ of the given trigger occurrence.

The material in the scope of a presupposition trigger often does double duty: it furnishes the basis for constructing the representation of the presupposition, but it also contributes to the non-presuppositional part of the representation of the sentence. However, the contributions that it makes to these two representations must be ‘constructed in the same way’. That is, whenever representation construction allows for two or more alternatives, the same alternative must be
chosen in the construction of the presupposition representation that is also chosen in the construction of the non-presuppositional representation. (For instance if the material that forms the scope of a given trigger contains two quantifying phrases with an indeterminate quantifier scope relation, then this relation must be resolved in the same way in the presupposition and in the contribution to the representation of the non-presuppositional content.)

Second, the scope of a presupposition trigger often contains further triggers. These give rise to ‘presuppositions within presuppositions’. This not only complicates the construction of presupposition representations, it also presents problems of ‘parallel resolution of options’ mentioned in the last paragraph: if a presupposition is triggered within the scope of some presupposition trigger, then it will emerge both a subsidiary presupposition of the presupposition generated by that trigger and as a presupposition of the non-presuppositional representation. It is a general requirement that these two presuppositions be resolved in the same way (just as the quantifier scope issue mentioned in the last paragraph).

For instance, when the scope of a given trigger contains a third person pronoun – in Van Der Sandt’s theory third person pronouns are also treated as presupposition triggers – then the subsidiary presupposition generated by the pronoun and the presupposition of the non-presuppositional content that it contributes must be resolved to the same antecedent. Thus in (21) the second he is ambiguous between John and Bill.

(21) John regrets that he told Bill that he had made a mistake

This ambiguity must be resolved in the same way in the representation of the non-presuppositional content of (21) and in the representation of the factive presupposition of regrets. It won’t do if in actual fact John told Bill that he, John had made a mistake but that the content of his regret was that John told Bill that Bill had made a mistake.

The construction of presupposition representations – ‘presupposition computation’ in the terminology of Kamp (2001) – is no less important, and in general no less challenging, than presupposition justification, the aspect of presupposition theory that most discussions exclusively focus on.

In our use of presupposition theory, presupposition computation will play a central part.

Van Der Sandt and Geurts (at that time his student) were led by their ideas about how presupposition should be treated within DRT to the DRT architecture that was first displayed in joint work (Van Der Sandt and Geurts (1991) and which has become a new standard ever since. This is a two-level architecture, in which one first computes ‘preliminary’ sentence representations from syntactic structures of those representations – these are either DRSs or more complex representations built from constituent DRSs – and then, at the second level, the resolution of the presuppositions in the preliminary representation in their respective local contexts.
We will be making use of this two level architecture from now on.

- One of the old disputes about presupposition is whether it is a phenomenon in its own right or whether it should be seen and treated as a form of implicature. A prominent advocate of this second line of thought in recent years has been Schlenker. (See Schlenker (?)).

A central goal of this approach is to eliminate what is seen as the arbitrariness of those approaches (including the one we will be pursuing here) which are content to specify the presupposition triggering behavior of words as a separate part of their lexical entries. Rather, it is assumed, the presuppositional properties of such words can be derived from their non-presuppositional meaning using general pragmatic principles.

If such a reduction were possible, then it should of course be adopted. I am not convinced however that such a reduction is really possible. In what we will be doing in this class I will not assume that this is always possible and that the presupposition behavior of lexical presuppositions is specified explicitly in their lexical entries.

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VI. Computation and Justification of certain Presuppositions

1. An example with \textit{again}.

(1) It rained yesterday. It rained again today.

DRS construction for the first sentence leads to (2). This DRS will serve as context for justification of the presupposition the preliminary representation for the second sentence. (The processing of weather verbs like rain will be made explicit when we deal with the second sentence.

(2)

\[
\begin{align*}
& t_1 & e_1 & t'_1 \\
& t_1 < n & e_1 \subseteq t_1 & t' \\
& e_1 \subseteq t'_1 & day(t') \\
& & n \subseteq t' \\
& & day(t'_1) \\
& & t'_1 \supseteq t' \\
& e_1 : \text{rain}'
\end{align*}
\]

We assume for the second sentence of (1) the syntactic structure in (3).

(3)

\[
\begin{array}{ccccccc}
S & \text{Comp} & \text{TP} \\
\emptyset & \text{TP} & \text{PP} \\
\text{DP} & \text{T'} & \text{P} & \text{DP} \\
\text{it} & \text{T} & \text{VP} & \emptyset & \text{today} \\
\text{past} & \text{VP} & \text{Adv} \\
\text{V} & \text{again} \\
\text{rain}
\end{array}
\]

We assume that the verb \textit{rain} is a 1-place predicate, which has a referential argument but no non-referential slots. So the semantic representation from its lexical entry is simply the condition ‘e: rain’. We assume that the parser is capable of recognizing that such verbs require dummy subjects, and that this subject must always be the word \textit{it}. The effect of this recognition is that the subject DP remains without index also after insertion of the semantics for the verb, and the construction algorithm will interpret this by simply ignoring the subject when its turn comes, passing the semantic representation of T’ unaltered to TP. The result of
As we have seen in earlier examples the semantics of the intransitive verb rain is passed up as is to the VP node, where it is combined with the semantics of again. The effect of again is to add to the semantic representation of its sister node a presupposition to the effect that the referential argument of the sister is preceded by an eventuality of the same ‘kind’. (The referential argument of the sister node must be an eventuality; if again is adjoined to a node which does not provide an eventuality as referential argument, the structure cannot be interpreted.) In the present instance the requirement is fulfilled, since the referential argument of the sister node is the event discourse referent e₂. The presupposition that e₂ is preceded by an ‘eventuality of the same kind’ can be made precise as follows: firstly this eventuality must be of the same aspectual sort as e₂, i.e. it must also be an event; and secondly, it must satisfy the same predicates that the DRS of the sister node specifies for e₂. For the present case this amounts to no more than that the new eventuality – let us use the DR ‘e₂’: rain’ – satisfies the condition ‘e₂’: rain’. So in this case the presupposition amounts to there being an event e₂ satisfying this condition preceding e₂. We can represent this presupposition in the form of a DRS, as in (5).

(5) $e_2'$

$e_2'$: rain'

$e_2' < e_2$

We left-adjoin this presupposition to the DRS of the sister node. We place the presupposition within curly brackets in order to do justice to the circumstance – of which we will see numerous instances presently – that more often than not a sentence will give rise to several presuppositions all of which are left-adjoined to the DRS which forms the non-presuppositional part of the representation. In the present, comparatively simple case the presupposition set is a singleton set.

With this the semantic representation of the upper VP node in (4) is as shown in (6)
The past tense now does its usual work of locating the referential argument \( e_2 \) of its sister and, as said nothing happens in this case in the transition from T’ to TP. So we get as representation for the lower TP node the structure shown in (7).

(7)

\[
\begin{array}{c}
S \\
\text{Comp} & \text{TP} \\
\emptyset & \text{TP} & \text{PP} \\
\text{DP} & \text{T'} & \text{P} & \text{DP} \\
\text{it} & \text{T} & \text{VP} & \emptyset & \text{today} \\
\text{past} & < e_2 | <\{ \} , e_2 \colon \text{rain'} > > & e_2' \colon \text{rain'} & e_2' < e_2 \\
\end{array}
\]

Location by the PP \textit{today} also proceeds in the already familiar way. After this the operation associated with the main clause Complementizer \( \emptyset \) transfers the DR \( e_2 \) to the universe of the non-presuppositional DRS to the right of its store. This gives us the representation of the S node in (8). (We have once again applied our current stop gap recipe for proper names by moving the information provided by the ‘proper name’ \textit{today} to the top of the DRS of which the decorated syntactic tree is one of the DRS conditions.)

(8)

\[
\begin{array}{c}
t'_2 \\
day(t'_2) & n \subseteq t'_2 \\
\end{array}
\]
There is one further purely structural operation that can and should be performed on the representation in (8): The non-presuppositional DRS of the S node representation should, as before, be merged with the main DRS. But the case presented by (8) differs from those we have encountered so far in that the non-presuppositional DRS under S is preceded by a presupposition set. This presupposition set is now promoted to a position in which it is left-adjoined to the main DRS (of which the non-presuppositional DRS under S has become an integral part through merge). The result – the preliminary representation of the second sentence of (1) - is shown in (9).

To turn this preliminary DRS into a presupposition-free DRS its presuppositions must be justified in the context. In the present case our context consists of the DRS in (2) for the first sentence of our ‘discourse’ (1). This DRS verifies the presupposition of (9) in the following sense: it entails that there was an event of the right kind, viz. the raining event $e_1$, which is guaranteed to have preceded the event $e_2$ of the non-presuppositional part of (9) since $e_1$ took place yesterday, whereas $e_2$ is supposed to have taken place today. Since the presupposition of (9) is verified by the context DRS (2), it can be considered as taken care of and eliminated from the representation in (9) of which it has so far been a constituent. This turns (9) into a normal DRS, which can now be merged with the context DRS (2) to give us a DRS for the 2-sentence discourse (1).

2. *again* and negation.

Consider the two sentence pairs in (10).

(10) a. It didn’t rain yesterday. It didn’t rain again today.
    b. It rained yesterday. (But) it didn’t rain again today.
These sentences raise an issue that we have not touched upon since we started to address the problems of tense and aspect and switched from the top-down algorithm of From Discourse To Logic to the bottom-up algorithm that we are in the process of developing now. This is negation, and in particular its interaction with tense and aspect.

Negation is affected with all sorts of puzzles. Here we will look only at a few of those, mostly questions that have to do with the aspectual properties of negated phrases.

A notorious example that points at important features of both negation and tense is due to Partee (1973):

(11) I didn’t turn off the stove!

The scenario is that of a couple who have just closed up the house, and are a few miles from home, on their way to the place where they will spend their holiday. Partee’s aim with this example was to show that the past tense is often understood in a kind of anaphoric way, much like a pronoun: in (11) the past tense refers to some time that is salient in the given context, viz. that when the couple left their house. We will turn to this side of (11) a little while. But (11) can also be used to illustrate another point, which has to do with its negation. Suppose that t is the salient time that the speaker is ‘referring to’ through her use of the past tense in (11). What is it that she says happened at that time, or was the case? One natural gloss is this: What happened at t - or better perhaps: what was the case at t - was the absence of an event of her turning off the stove. We can think of this – that which, according to what the speaker says, characterizes t – as a ‘negative state’, which consists in there being no turning-off-the-stove event while it lasts.

This is how we will analyze the effect of negation in finitely tensed clauses here. On this analysis the effect of negation is comparable to that of, say, PROG: in both cases the result of the operation is a state that is characterized in terms of an eventuality property that is provided by the sister node. (A difference between the negation operator NEG and the operator PROG is that NEG is also applicable to input whose referential argument a state (i.e. has the feature ‘-perf’).

Connected with the semantic effects of negation is the question of where it is to be located in the syntactic structures from which we compute our logical forms. Because of the aspect modifying effect of negation (and in particular its similarity with PROG) we assume (at least for now) that negation is situated in the Asp node.

This leads to the following syntactic structure for the first sentence of (10.a).

(12)  

\[
\begin{array}{cccc}
S & \text{Comp} & TP & \emptyset \\
& TP & PP & \\
& DP & T' & P & DP \\
& it & T & AspP & \emptyset & \text{yesterday}
\end{array}
\]
Insertion of the lexical semantics of \textit{rain} gives (13).

(13) \[
S
\]

\begin{array}{cccc}
\text{Comp} & \text{TP} & \text{PP} \\
\emptyset & \text{TP} & \text{PP} \\
\text{DP} & \text{T} & \text{P} & \text{DP} \\
\text{it} & \text{T} & \text{AspP} & \emptyset \\
past & \text{Asp} & \text{VP} \\
neg & \text{V} \\
< e_1 | e_1: \text{rain'} > \\
\end{array}

The feature ‘neg’ contributes the operator NEG, which turns its argument (the semantic representation of the VP node) into a term denoting an eventuality property, which then becomes its operandum. We can denote the resulting predication as ‘NEG(\(^{e_1} e_1: \text{rain'}\)’), just as we did for the operator PROG. But in this case we can do better, using the negation construct of DRT. One way to express this is by way of a meaning postulate. Meaning postulates can be thought of as among the axioms of what may be called ‘the lexical theory’: a formal theory of lexical meaning that axiomatizes aspects of lexical meaning that, for one reason or another, we cannot or do not want to encode in the lexical entries themselves. The meaning postulate in question can be cast in the form shown in (14.a). In fact, left hand side and right hand side of (14.a) are equivalent, so we also get the converse implication, as in (14.b).

(14) \[
a. \quad s \quad \Rightarrow \quad \text{ev} \\
s: \text{NEG}(^{\text{ev}} K(\text{ev})) \quad \neg \quad K(\text{ev}) \\
\text{ev} \subseteq s \\
b. \quad s \quad \Rightarrow \quad s: \text{NEG}(^{\text{ev}} K(\text{ev})) \\
\text{ev} \\
\neg \quad K(\text{ev}) \\
\text{ev} \subseteq s
\]
Using the right hand side of (14.a) we can represent the AspP representation in (13) as in (15).

\[ \begin{align*}
\text{S} & \quad \text{Comp} \\
\emptyset & \quad \text{TP} \\
\text{TP} & \quad \text{PP} \\
\text{DP} & \quad \text{T'} \quad \text{P} \quad \text{DP} \\
it & \quad \text{T} \quad \text{AspP} \quad \emptyset \quad \text{yesterday} \\
\text{past} & \quad e_1 \quad \langle s_1 | \quad \neg e_1 : \text{rain'} > \\
& \quad e_1 \subseteq s_1
\end{align*} \]

The next operation locates \( s_1 \) in the past of \( n \), combining with the subject DP again does nothing. This gives us the representation at the lower TP:

\[ \begin{align*}
\text{S} & \quad \text{Comp} \\
\emptyset & \quad \text{TP} \\
\text{TP} & \quad \text{PP} \\
\text{P} & \quad \text{DP} \\
t_1 & \quad \emptyset \quad \text{yesterday} \\
t_1 < n \quad t_1 \subseteq s_1 \quad e_1 \subseteq s_1 \\
\text{past} & \quad e_1 \quad \langle s_1 | \quad \neg e_1 : \text{rain'} > \\
& \quad e_1 \subseteq s_1
\end{align*} \]

The remaining operation is that of locating by means of the adverb \textit{yesterday}. Adverbial location of states is often ambiguous between an interpretation on which the state holds throughout the adverb time, and one according to which the state only holds throughout some implicit subinterval of the adverb time that has to be recovered from the context or accommodated. In the present instance the first interpretation entails that it did not rain at all yesterday, while the second entail only that it did not rain during some unspecified part of yesterday. When there is no context for the interpreter to rely on – and that is often the case with discourse-initial sentences – then the first interpretation strategy is often preferred; so this is the option we adopt in this case.

With this decision we get as the final representation of the first sentence of (10.a) the one in (17).

\[ \begin{align*}
t_1 & \quad s_1 \quad t'_1 \\
t_1 < n \quad t_1 \subseteq s_1 \quad t'_1 \subseteq s_1 \quad t''_1
\end{align*} \]
We now turn to the second sentence of (10.a). The syntactic structure for this sentence presents us with a difficulty with which sentences with adverbs will confront us again and again: where in the structure are the different adverbs attached? I have only limited understanding of the syntactic constraints on adverbs placement. I will proceed as if there are few such constraints – I will adhere only to the principle that adverb phrases must be adjuncts to maximal projections, although I am not absolutely certain that even this principle should be regarded as binding – and so will assume that adverb attachment is subject to a great deal of ambiguity or underspecification; and I will assume that these ambiguities are resolved in such a way that the intended interpretations can be computed from the syntactic structures we will adopt.

The sentence which appears as the second sentence in (10.a) and (10.b) is a case in point. Intuitively, *again* has the negation in its scope in the second sentence of (10.a) but not in the second sentence of (10.b). (Only on these assumptions is it possible to see the *again*-presuppositions of these sentences as satisfied by the contexts that are provided by their predecessors.) We will deal with this ambiguity just as it suits us, assuming a different syntactic input structure for the second sentence of (10.a) from the one we will be assuming for the second sentence of (10.b). For the second sentence of (10.a), where the negation should be in the scope of *again*, we assume that again is adjoined to AspP. The syntactic structure is given in (18).

\[
\begin{align*}
\text{day}(t''_1) & \quad n \subseteq t''_1 \\
\text{day}(t'_1) & \quad t'_1 \supseteq t''_1 \\
\neg & \quad e_1 \\
\neg & \quad e_1 : \text{rain'} \\
\neg & \quad e_1 \subseteq s_1
\end{align*}
\]

\[
(18)
\begin{align*}
\text{S} & \\
\text{Comp} & \\
\emptyset & \text{TP} \\
\emptyset & \text{TP} \\
\text{PP} & \\
\text{DP} & \text{T'} & \text{AspP} & \emptyset & \text{DP} \\
\text{it} & \text{T} & \text{past} & \text{AspP} & \text{AdvP} \\
& & \text{neg} & \text{VP} & \text{V} \\
& & \text{rain}
\end{align*}
\]

The lower AspP node in (18) gets the same semantic representation as the AspP node of (12):

\[
(19)
\begin{align*}
\text{S} & \\
\text{Comp} & \\
\emptyset & \text{TP} \\
\emptyset & \text{TP} \\
\text{PP} & \\
\text{DP} & \text{T'} & \text{AspP} & \emptyset & \text{DP} \\
\text{it} & \text{T} & \text{past} & \text{AspP} & \text{AdvP} \\
& & \text{neg} & \text{VP} & \text{V} \\
& & \text{rain}
\end{align*}
\]
The principle according to which the semantics of *again* is applied to the semantics of its sister is the same as it was in the representation construction for the second sentence of (1): from the sister representation we construct the representation of a presupposition by (i) introducing a fresh copy for the referential argument, substituting this for the referential argument throughout the sister representation and adding it to the universe of the DRS resulting from the substitution or substitutions. This time the referential argument is a state, so the fresh discourse referent must be a state DR as well. Using the symbol ‘s’ for this purpose we get the following semantics for the upper AspP node of (20).

(20)

```
S
Comp
∅
TP
DP
it
T
P
PP
DP
T'
P
AspP
∅
today
past
T
AdvP

again

e2
< s2 | ¬ >
e2 : rain’
e2 ⊆ s2
```

Temporal location by tense and by the adverb can be assumed to proceed as in the case of the first sentence. This leads to the upper TP node representation in (21).

(21)

```
t'_2
```
day(t'\textsubscript{2})
\begin{align*}
n \subseteq t'\textsubscript{2}
\end{align*}

S

Comp

TP
\begin{align*}
\emptyset & \quad t_2 \\
\quad & \\
\quad & t_2 < n \quad t_2 \subseteq s_2 \\
\quad & t'_2 \subseteq s_2 \\
\quad & \\
\quad & < s_2 | <\{ \neg e_2 : \text{rain}', \}, \neg e_2 : \text{rain}' > \\
\quad & e_2 \subseteq s' \\
\quad & e_2 \subseteq s_2 \\
\quad & \\
\quad & s' < s_2
\end{align*}

N.B. it might be thought that there something isn’t quite right with the way (21) deals with the temporal relation between s\textsubscript{2} and today: Suppose (10.a) were uttered in the middle of the day (in the early afternoon, say). In that case the past tense of the second sentence would seem to suggest that the speaker is only talking about that part of today that is behind her, and not about the part that is still to come. In other words, the second sentence has nothing to say about the rest of the day; it makes no claims about there being no rain after the time at which it is uttered. So, stating the temporal relation between s\textsubscript{2} and today the way that is done in (21), according to which the no-rain-state includes all of today does no seem right.

My personal reaction to this objection is that the second sentence of (10.a) just isn’t a good sentence to be used at any time than when the day is for all practical purposes over and one use the past tense to talk about all of it. If this intuition is correct, it actually provides support for the analysis in (21). Because the interpretation of the temporal relation is as (21) has it, the past tense sentence is appropriate only when said at the end of a day; for only then is there no conflict between the temporal relation between the referent of today and the state the sentence describes and the principle that by using the past tense at any time t one can only say something about times that lie in the past of t.

The operation associated with the main clause Complementizer ∅ transfers the DR s\textsubscript{2} to the universe of the non-presuppositional DRS to the right of its store. This gives us the representation of the S node. Merging and promotion of the presupposition set then leads to the preliminary DRS in (22).

(22)
\begin{align*}
s' & \quad t_2 & \quad s_2 & \quad t'_2 \\
\quad & e_2 & t_2 < n & t_2 \subseteq s_2 & \quad \text{day}(t'_2) \\
\quad & e_2 : \text{rain}', \} & \neg e_2 : \text{rain}' & > \\
\quad & e_2 \subseteq s' & e_2 \subseteq s_2 & \\
\quad & e_2 & t'_2 \subseteq s_2 & 
\end{align*}
Once again the presupposition of this representation is justified by the context DRS (17), which asserts the existence of a state of no rain which obtained yesterday and so can be assumed to precede any such state that held today. And note that if we had interpreted again in the second sentence as contributing the presupposition that there was an earlier raining event, then that presupposition would not have been justified by the first sentence of (10.a). Thus our interpretation of the second sentence is guided by the consideration that only the interpretation we have chosen leads to a presupposition that the context verifies.

For (10.b) the situation is just the reverse. Here the first sentence entails that there was an earlier raining event, not that there was an earlier period of no rain. We repeat the DRS for the first sentence of (10.b), which we first displayed under (2) as DRS for the first sentence of (1) (which is identical with the first sentence of (10.b)).

\[(24) \quad t_1 < n \quad e_1 \subseteq t_1 \quad t' \quad e_1 : \text{rain}' \quad \text{day}(t') \quad n \subseteq t' \quad \text{day}(t_1) \quad t_1 \supseteq t' \quad e_1 \subseteq t_1\]

To obtain a coherent discourse interpretation for (10.b), then, requires that we interpret again as having narrow scope vis-à-vis the negation. And that in turn requires that the syntactic structure we use as starting point for the interpretation of the second sentence is one like that in (25).

\[(25) \quad S \quad \text{Comp} \quad TP \quad \emptyset \quad \text{TP} \quad PP \quad \text{DP} \quad \text{T'} \quad P \quad \text{DP} \quad \text{it} \quad T \quad \text{AspP} \quad \emptyset \quad \text{today} \quad \text{past} \quad \text{Asp} \quad \text{VP} \quad \text{neg} \quad \text{VP} \quad \text{Adv} \quad V \quad \text{again} \quad \text{rain}\]

In (25) again operates on the semantic representation ‘\(< e_2 | e_2 : \text{rain’} >’ of VP. The result is like the one we obtained when computing the preliminary representation for the second sentence of (1). This time the result is the representation of the upper VP node, see (26).
The effect of the negation is once again that of binding the referential argument of its sister and to replace it by a state to the effect that an event of the kind described by the sister representation does not take place in the course of its duration. But in the present case there is a further wrinkle. The presupposition of the input representation requires that the presupposed event $e_2'$ precede the referential argument $e_2$ of the representation. This role is now taken over by the state $s_2$. This means in particular that the relation between presupposed and non-presupposed information in the representation is now to be mediated by the new referential argument (and not by the old one, which is now bound inside the argument of NEG and thus no longer available for this purpose). This means that in the precedence condition '$e_2' < e_2'$, $e_2$ must be replaced by $s_2$.

With this we obtain as AspP representation the one shown in (27).

$$(27)\quad \text{S}$$

\[
\begin{array}{cccccc}
\text{Comp} & \text{TP} & \emptyset & \text{TP} & \text{PP} \\
\end{array}
\]

\[
\begin{array}{cccc}
\text{DP} & \text{T} & \text{AspP} & \emptyset & \text{today} \\
t & \text{past} & \neg & < e_2' \text{ rain'} >> & e_2 < e_2 \\
\end{array}
\]
Observation 1. The replacement of $e_2$ by $s_2$ is an instance of the more general principle that when an operation triggered by Asp binds the referential argument $\alpha$ of the sister node representation and replaces it by a new referential argument $\beta$, then references to $\alpha$ in presuppositions must be replaced by references to $\beta$. Consider for instance the progressive sentence ‘Mary is writing a novel again.’ One way to construe this sentence is as saying that what is going on is another novel-writing activity, while presupposing that there have been such activities before. (This is the sort of thing one might say, somewhat deprecatingly, of a person who keeps starting over and over again on new novels, but without ever finishing any one of them.) On the account of interpretation presented here this interpretation requires that again have the progressive operator within its scope. But the account also allows for another interpretation, which assumes that the progressive operator is not in the scope of *again*, and leads to a preliminary representation according to which the present novel writing activity is supposed to have been preceded by one or more completed novel writings. Unfortunately it is not easy to make a convincing case that there is such an ambiguity in the present case, since any complete novel writing episode entails activities of being engaged in writing a novel. With negation the situation is, as we have just seen, quite different. Here whether again is within the scope of the negation or conversely, makes a crucial difference.

Observation 2. The transition from the semantic representation of (16) to that of (17) is our formal implementation of the principle that negation is “transparent” for presupposition, or is a ‘hole’ in the terminology of (Karttunen, 1973): the presuppositions of $S$ are also presuppositions of not-$S$. This, as we have seen, is the basis for one of the best established presupposition tests: If some proposition $p$ that is entailed by a declarative sentence $S$ is preserved when we form the negation of $S$, then that is an indication that $p$ is a presupposition, rather than an integral part of the assertoric content of $S$. Whether a certain operation involved in DRS construction is a ‘hole’ for presuppositions is something that has to be made explicit in the description of what the operation does when its input representation involves presuppositions as well as a non-presuppositional DRS. According to what has been said about aspectual operators in Observation 1 all such operators are ‘holes’ for presuppositions.

Applying the DRS-construction operations that remain in (27) in the by now familiar ways we arrive at the preliminary representation in (28).

\[
\begin{align*}
\text{(28)} & \quad e_2', \quad t_2, \quad s_2, \quad t_2' \\
& < \{ e_2': \text{rain'}, e_2 < s_2 \}, \quad t_2 < n \quad t_2 \subseteq s_2 \quad \text{day}(t_2') \quad n \subseteq t_2' \quad t_2' \subseteq s_2 \\
& \quad \neg \quad e_2 \quad e_2': \text{rain'} \quad e_2 \subseteq s_2
\end{align*}
\]
It is clear that the context DRS (24) gives us all that is required to satisfy the presupposition of (28). The event \(e_1\) with the properties that (24) attributes to it satisfies the presupposition provided we make sure that the state \(s_2\) whose existence is asserted in (28) does not extend beyond today in the direction of the past, and there is nothing that prevents us from imposing this further constraint on it.

It is time to reflect somewhat more closely on the lexical entry of the presupposition trigger *again*. As we have seen in the examples above, the crucial part of the lexical specification of *again* concerns the operations for which the word is responsible in the course of DRS construction. There is no need in this case for a specification of lexical semantics of the kind that is found in our entries for lexical predicates, since all the DRS conditions that owe their introduction to *again* are provided by its sister node representation, except for conditions like \(e_2 < s_2\), which say that the presupposed eventuality must precede the asserted one. The lexical semantics of the relation \(<\) is part of the general logical structure of the models in terms of which DRSs are evaluated as true or false, so there is no need for the entry of again to specify it. And the semantics of the conditions that stem from the sister node is specified via the entries for the lexical items that are enter into the sister node representation.

In the case of presupposition triggers, however, there may be a need for lexical specification pertaining to yet another level of the interpretation process. As shown by the presupposition examples considered so far, presuppositions must be justified in context. That process can be complicated, for one thing because it often involves accommodation. From what is known and understood about presupposition at the present time, the constraints that govern presupposition justification and especially the constraints on possible accommodation, vary between presupposition triggers. Also, presuppositions generated by different triggers vary with regard to the ease or difficulty with which they can be cancelled. If it turns out that these variations cannot be accounted for by general principles, then the question how the presuppositions triggered by a particular trigger may be justified or cancelled, will have to be specified by the entry of that trigger.

We will not try to address this last aspect of lexical specification here. Until further notice we will proceed on the assumption that the canons of presupposition justification which were implied by what we have been saying about presupposition justification in the examples we have looked apply universally to all presuppositions. This is one reason why the lexical specification below is to be regarded as preliminary. But there are other reasons as well. One is that the specification will not deal with the distinction between the repetitive and the restitutive use of *again* – it is solely concerned with its repetitive interpretation. (For a widely discussed account of the repetitive-restitutive ambiguity and of the restrictions on restitutive interpretations see (Von Stechow, 1995).) But this may not be all; the proposal below may need adjustment for other reasons as well.

This is what we can extract from the examples of again-presupposition construction we have looked at so far. In general the representation of the sister node to an occurrence of *again* will be of the form in (29.a), where \(\alpha_0, \alpha_1, \ldots, \alpha_n\) are discourse referents - with \(\alpha_0\) the referential argument of the representation as a whole and \(\alpha_1, \ldots, \alpha_n\) possible additional discourse referents - and \(K_{pr,1}, \ldots, K_{pr,m}\) and \(K\) are ‘DRSs’. (The ‘DRSs’ are DRSs in an extended sense in that their conditions may contain presuppositions in turn; but this is a complication that is irrelevant to the present discussion. For now just think of the ‘DRSs’ as DRSs of the familiar sort, where conditions are either atomic or complex conditions of the kinds discussed in From
Discourse To Logic or later versions of DRT, such as Kamp et al., *Discourse Representation Theory, an Updated Survey.*

(29) (lexical entry for *again*)

a. \(<\alpha_0; \alpha_1, \ldots, \alpha_n | \{K_{pr,1}, \ldots, K_{pr,m}\}, K >>\) (input)

b. \(<\alpha_0; \alpha_1, \ldots, \alpha_n | \{K_{pr,1}, \ldots, K_{pr,m}, K'\}, K >>\) (output)

*again* transforms the representation in (29.a) into that of (29.b). A precondition of this transformation is that \(\alpha_0\) should be a discourse referent for an eventuality. Assuming that this precondition is satisfied, (29.b) is obtained by (i) choosing a fresh eventuality discourse referent \(\alpha'_0\); (ii) constructing \(K'\) by (a) replacing \(\alpha_0\) everywhere in \(K\) by \(\alpha'_0\), (b) adding \(\alpha'_0\) to the universe of the new DRS and (c) adding the condition ‘ \(\alpha'_0 < \alpha_0\) ’ to its condition set; (iii) adding \(K'\) to the presupposition set of the input representation.

This, then, is our first proposal for the ‘lexical entry’ for *again*: it operates on semantic representations like that in (29.a), on the assumption that \(\alpha_0\) is an eventuality DR. Its effect is to add a DRS, constructed in the way described from the non-presuppositional DRS \(K\), to the presupposition set of the input representation, and that is it.

How does this entry compare with the lexical entries of predicate words? As noted earlier about such entries, they too should be read as instructions for the DRS construction operations that are triggered by occurrences of the lexical item that are part of larger syntactic structures. But all that the entry specifies is the semantic representation that forms the core of what is inserted for an occurrence of the item. This core varies from predicate word to predicate word, but all else – choosing a fresh discourse referent of the right sort for the referential argument of the predicate, putting it into a store and putting it into the referential argument lot of the semantic representation of the predicate, turning all non-referential arguments (assuming there are any) into argument slot symbols co-indexed with the argument phrases that are syntactically linked to them - is the same and therefore doesn’t have to be spelled out anew in each individual entry. The above entry for *again* differs from this pattern in two ways: (i) there is no need in this case for the specification of a semantic core; (ii) in other respects the construction operations are (as far as we know at this point) specific to *again* and therefore have to be spelled out as part of its lexical entry.

We continue with two more examples involving again, both mentioned in the informal introduction to this section on presupposition under (7). The first is Kripke’s example. A slight variation of the sentence with *again*, for which we are going to construct the DRS, is given under (30.a). (30.b) provides a further variant, in which the sentence in (30.a) is preceded by an introductory sentence.

(30) a. We won't have pizza again on John's birthday, if we are going to have pizza on Mary's birthday.

b. We have just had pizza on Billy's birthday. So we won't have pizza again on John's birthday, if we are going to have pizza on Mary's birthday.

We assume that (30.a) has the syntactic structure in (31).

(31) a. (over-all structure)
S
  Comp  TP
  Ø  TP  S
    Comp  TP
    if

b. (main clause TP)

  TP
  PP
  DP  T'  P  DP
  we  T  AspP  on  John's birthday
  fut  Asp  VP
  neg  VP  Adv
  V  again

  have pizza

c. (if-clause TP)

  TP
  PP
  DP  T'  P  DP
  we  T  AspP  on  Mary's birthday
  fut  Asp  VP
  default  V

  have pizza

N.B. We have simplified the syntactic structure in several places so as to not get sidetracked into discussions of issues that we have not yet dealt with, but which are orthogonal to our present interest:
We treat *have pizza* as an unanalyzed intransitive verb.

We treat *John’s birthday* and *Mary’s birthday* as proper names (of certain times).

We treat the subject DPs *we* as proper names.

We treat the locution *be going to* as a form of the future tense.

Both the semantic representation of the middle TP of the main clause and that of the upper TP of the *if*-clause TP are constructed according to principles we have already seen in action. The representation of the *if*-clause TP is given in (32.a) and that of the main clause TP in (32.b).

\[
\begin{align*}
(32) & \quad a. \quad t'_2 \quad w_2 \\
& \quad \text{Mary’s birthday’}(t'_2) \quad \text{we’}(w_2) \\
& \quad S \\
& \quad \text{Comp} \quad \text{TP} \\
& \quad \text{if} \quad t_2 \\
& \quad < e_2 \mid n < t_2 \quad e_2 \subseteq t_2 \quad e_2 \subseteq t'_2 \quad > \\
& \quad e_2: \text{have p.’}(w_2) \\
& \quad b. \quad t'_1 \quad w_1 \\
& \quad \text{John’s birthday’}(t'_1) \quad \text{we’}(w_1) \\
& \quad S \\
& \quad \text{Comp} \quad \text{TP} \\
& \quad \emptyset \\
& \quad e_1’ \quad t_1 \\
& \quad < s_1 \mid < \{ e_1’: \text{have p.’}(w_1) \}, \ n < t_1 \quad t_1 \subseteq s_1 \quad > \} \\
& \quad e_1’ < s_1 \quad \text{t’}_1 \subseteq s_1 \\
& \quad e_1 \quad \neg e_1: \text{have p.’}(w_1) \\
& \quad e_1 \subseteq s_1
\end{align*}
\]

As in the top-down algorithm we combine the *if*-clause with the main clause by forming a
conditional DRS condition for which the \textit{if}-clause representation provides the antecedent and the main clause representation the consequent. The details of this operation are now somewhat different, however. Because of our provisional treatment of proper names, which has led to the discourse referents for the DPs \textit{we}, \textit{John’s birthday} and \textit{Mary’s birthday} and their reference-determining conditions in the main DRSs for \textit{if}-clause and main clause we are not yet in a position to give a definitive formulation of these details. But there is some part of will become our final specification for the lexical entry of the conjunction \textit{if} that we can say already.

It is this: Given the way in which we have set up the syntactic structure of (30.a), the combination involves two separate operations: (i) transferring discourse referents in the stores to the universes of the non-presuppositional DRSs following them; (ii) forming the conditional condition in which (a transformation of) the representation of the \textit{if}-clause TP becomes the antecedent and (a transformation of) the semantic representation of the main clause TP its consequent. But which discourse referents should be transferred? There appears to be no conclusive rule to determine that. A discourse referent may be transferred at this point, in which case it gets the kind of local scope that we have seen to be typical for narrow scope indefinites. But it may also be kept in store, in which it gets wide scope over the conditional as a whole. We will see later that some discourse referents have to be retained in store at this point.

In general this means that the stores of \textit{if}-clause TP and main clause TP need not become empty at this point. In that case we merge them into a single store and place this store in front of the main DRS, which has the new conditional condition as one of the members of its condition set.

In the present instance it is natural to allow the two DRSs that are still in their respective stores to be bound at this point, by transferring them to the universes of the non-presuppositional DRSs to the right of their stores. Both the state DR $s_1$ and the event DR $e_2$ constitute new information. We do justice to this intuition by transferring the DRSs to the relevant DRS-universes.

There is a further problem that the representations in (32.a) and (32.b) present us with, which is generated by our present stopgap treatment of proper names. This treatment places the discourse referents introduced by the ‘proper names’ – in the present instance: by the DPs that we have decided to treat as such - in the universe of a DRS of which the partially converted syntactic structure is one of the DRS conditions and places the reference determining conditions for those discourse referents in the condition set of that DRS. Combining the representations of \textit{if}-cause and main clause requires that we merge their two main DRSs into a single DRS, with a universe consisting of the discourse referents $t’_1$, $w_1$, $t’_2$ and $w_2$ and a condition set containing the conditions ‘John’s birth day’($t’_1$)’, ‘we’($w_1$)’, ‘Mary’s birthday’($t’_2$)’ and ‘we’($w_2$)’. The conditional DRS condition which combines the two TP representations is also entered as a condition into this condition set. Note well that the special handling of the proper name representations that is needed as part of combining (32.a) with (32.b) is an artifact of our provisional treatment of proper names. This complication will disappear when proper names, like other definite noun phrases, will be analyzed as presupposition triggers (viz. as expressions which come with the presupposition that their referent can be identified independently of the given use that is being made of them).

After these motivations we are ready at last to present the preliminary DRS for (30.a).
How can we justify the presupposition adjoined to the consequent in (33)? The material in the antecedent seems to be just what is needed for this. But it can be used to justify the presupposition only when we can show that it precedes the state $s_1$ and that depends on the temporal relation between the location times $t'_2$ and $t'_1$: the precedence relation between $e_1'$ and $s_1$ will be guaranteed to be satisfied only when $t'_2$ precedes $t'_1$, i.e. if Mary’s birthday comes before John’s. So this is the information that an interpreter who is confronted with (30.a) without the benefit of further context will feel he needs to accommodate. ‘The speaker’ - so we can reconstruct the interpreter’s strategy – ‘would not have used the word again, knowing full well as a competent speaker that it will generate the presupposition represented in (33), without a justification for it. But all I, the interpreter, have been given is the material in the sentence itself. The only part of that material that could be used to justify the presupposition is that in the antecedent of the conditional. So presumably that is what justifies the presupposition. But it can serve as justification only if Mary’s birthday comes before John’s. So the speaker could have used the sentence legitimately only if she had good reason to assume this to be so.’ Since there is a general tendency for interpreters to assume that speakers use their language responsibly, our interpreter will infer that the speaker is right about this and thus that Mary’s birthday does precede John’s birthday.

The right place for the accommodated information is the condition set of the main DRS in (33). After all, what the interpreter accommodates is a bit of categorical information: Mary’s birthday comes before John’s birthday, period. (Clearly the accommodated information shouldn’t go into the antecedent of the conditional – the interpreter doesn’t reconstruct what the speaker is saying as ‘We won’t have pizza again on John's birthday, if we are going to have pizza on Mary's birthday and Mary’s birthday is before John’s birthday.’, which is the reading that would get. Nor should the accommodated information go into the consequent DRS, which would lead to the truly absurd paraphrase: ‘We won't have pizza again on John’s
birthday and Mary’s birthday is going to be before John’s birthday, if we are going to have pizza on Mary’s birthday.’) (34) repeats (33), but with the accommodated condition added. (For easy recognition the condition is given in boldface.)

(34)\[ t’_2 < t’_1 \]

\[ n < t_2 \Rightarrow \{ e_1’ : \text{have p.’}(w_1) \} \quad , \quad n < t_1 \quad t_1 \subseteq s_1 \]

That it is the interpreter wanting to use the antecedent in (33) to justify the presupposition in the consequent which leads to his conclusion that Mary’s birthday comes before John’s birthday is confirmed by the variant in (30.b). Here the first sentence establishes the occurrence of an event of pizza eating by the subject ‘we’. With that the need to use the antecedent of the second sentence for the justification of the presupposition in its consequent is obviated: again is justified simply because an event of pizza eating by the subject at any time in the future of now would be a repetition of the past event mentioned in the first sentence. This accounts for why interpreters of (30.b) tend not to conclude that Mary’s birthday must come before John’s.

These arguments about the justification of the again-presupposition in (30.a) and (30.b) are based on the assumption that the antecedent of a conditional can serve to justify presuppositions generated within the consequent. What entitles us to this assumption? The answer to this question goes back to the seminal paper on presupposition that Karttunen published in 1974: Presuppositions can be justified not only by the ‘global’ context in which the sentence is uttered within some part of which they are triggered, but also by ‘local’ contexts, which are established by other parts of the sentence itself. This is how (Karttunen, 1974) accounts for many intriguing projection facts and provides the first systematic and conceptually plausible solution to the Projection Problem. Roughly ten years later Heim, in (Heim, 1983), recast Karttunen’s account in a more formal setting of Dynamic Semantics, relying on the work of Stalnaker and, especially, on her own proposal for a Dynamic Semantics in (Heim, 1982). Yet another small decade later Van Der Sandt and Geurts established a direct connection with DRT, observing that the local contexts which can be used to justify presuppositions generated in some particular part of a logically complex sentence are the very same as those which, according to DRT, can provide antecedents for anaphoric pronouns occurring in that part: the contexts suitable for the justification of presuppositions are precisely those which, in DRT terms are accessible from the positions of the triggers of those presuppositions. Indeed, Van Der Sandt and Geurts concluded that anaphora and
presupposition (as it had been understood up to then) were really just two sides of the same coin, a conclusion that is transparent of Van Der Sandt’s now famous 1992 paper: ‘Presupposition Projection as Anaphora Resolution.’ On this view pronouns are presupposition triggers too, which give rise a special kind of ‘reference presupposition’ – a requirement imposed on the context in which the pronoun is used to the effect that it must provide an antecedent for the pronoun. (See (Van Der Sandt and Geurts, 1991), (Van Der Sandt,1992).)

Nowadays it is widely held that it isn’t just pronouns that give rise to reference presuppositions, but that this is a general property of all definite noun phrases, which include besides pronouns also proper names, definite descriptions and demonstratives. This is the line we will adopt here. This will lead among other things to the revised treatment of proper names which has already been alluded to more than once.

The unification of presupposition and anaphora that Van Der Sandt and Geurts argued for has been remarkably fruitful. (For one thing, it explains why it is the same notion of non-global context – that of an accessible context in DRT-technical terms – that is operative in either.) But there are nevertheless important differences. One is that the local contexts used in presupposition justification often do not operate on their own, but in conjunction with other contexts: it is the combined information from those different contexts that provides a justification without remainder. An instance of this has already been on display when we told our story of how the again-presupposition gets justified in (30.a): The interpreter of (30.a), we argued, is induced to accommodate the condition ‘t’₂ < t’₁’ at the level of the main DRS, also called the global context level. Once this condition is in place, as in (34), it can be combined with the information in the local context that is provided by the antecedent of the conditional condition to yield a seamless justification of the presupposition. This justification can be obtained only by pooling information from the local context with information of the global context.

This need to combine information from different context levels plays no part in the resolution of anaphoric pronouns. An anaphoric pronoun needs a discourse referent from the context in which it is interpreted to serve as its antecedent. The pronoun can be resolved only if a suitable antecedent can be found in some accessible context; and if that is the case, then only that context which provides the antecedent is involved in the pronoun’s resolution.

There is also another respect in which pronouns differ from most other presupposition triggers: they do not allow for accommodation, or only marginally so. First, when pronouns occur in texts, and so can be resolved only in the discourse context (the context that is made available by the antecedent discourse and/or accessible part of the same sentence), it is impossible (or marginal at best) to accommodate an antecedent for it even if the context entails that an entity of the right sort exists. Classical illustrations of this fact are attempts at donkey sentences and donkey discourses like those in (35).

(35) a. ?? Bill is a car owner. But he hardly ever drives it.
    b. √ Bill owns a car. But he hardly ever drives it.
    c. ?? If John is a horse owner, he keeps it/them in some distant place.
    d. √ If John owns a horse, he keeps it in some distant place.
    e. √ If John owns horses, he keeps them in some distant place.

(35.b,d,e) are the familiar examples of pronouns that find a suitable antecedent discourse referent in an accessible discourse context (given by the preceding sentence or by the if-clause
of the conditional). This is not so in (35.a,c), in spite of the fact that the corresponding contexts entail that there is a car that Bill owns or one or more horses that are owned by John. Apparently existence is not enough; the discourse or clause must give rise to the explicit introduction of a discourse referent representing a car or a horse or several horses. A second, but clearly related difference between pronouns and other presupposition triggers arises in situation where justification is not necessarily text-driven. When you say to me something like (36.a) and up to this moment I knew nothing about your wife’s former husband – neither that he is staying with you now nor that he has done so in the past - a perfectly natural reaction on my part will be to not only take the assertoric content of what you say to be true – your wife’s former husband is staying with you right now- but also to accommodate the presupposition that has done on one or more previous occasions. And I am likely to feel that I am not missing anything substantial of what you are saying to me. If on the other hand you are saying (36.b) to me, and I do not know whom you are referring to by he, then am at a loss what to do with your utterance. Just accommodating that there is someone that you are referring to and that you know who you are referring, and even that you are probably assuming that it must be clear to me in the given context who you are referring to, isn’t quite good enough. I feel that there is something I am missing until the reference of the pronoun has been clarified.

(36) a. My wife’s former husband is staying with us again.
    b. He is staying with us.

In spite of these clear differences between the behavior of pronouns on the one hand and presupposition triggers like again on the other, there is some real benefit to be got from treating them as different species of the same genus, i.e. by seeing both as involving presuppositional mechanisms. But we do this we have to keep firmly in mind that presuppositions come in different varieties.
VI    Definite Noun Phrases as Triggers of Reference Determining Presuppositions.

Historically speaking, singular definite descriptions are the prototypical presupposition triggers. It was about the presuppositions that seem to accompany the use of such noun phrases that Frege, to whom the notion is usually traced back, was worried. On such a view the king of France generates the presupposition that there is a unique king of France, the smallest prime number that there is a unique prime number that is smaller than all other prime numbers, the largest prime number that there is a unique prime number that is larger than all other prime numbers, and so on. Notoriously the principal opponent of this view in those early days (the first few decades of the 20-th century) was Russell, and it should be noted that even for someone who believes that natural languages do have all sorts of presupposition triggers (such as, say, again) and that these require the kind of treatment presented in subsection V, it remains possible to deny that definite descriptions are among them. But as a matter of fact I do not know of anybody who holds and has seriously defended such a combination of views. In any case, we will take it for granted that definite descriptions are among the presupposition triggers of English. (Probably we would want to say that this is so for all languages that have a definite article, but possibly that isn’t saying very much, for perhaps that is just what it is for a determiner to count as a definite article.)

Assuming that definite descriptions are presuppositional is one thing. Saying exactly what those presuppositions are, and how they come about and which constituents of definite descriptions are responsible for them is another. These questions have taken on a new life and interest because of extensive work – much of it of a cross-linguistic nature – on the internal structure of the noun phrase. In the light of this work some of the answers now look quite different from what they did even twenty or ten years ago.

Our views of the semantics and pragmatics of definite descriptions and other definite noun phrases has been influenced also by work in computational linguistics, especially that on ‘noun phrase resolution’, a branch of NLP which tries to develop algorithms that determine which noun phrases occurring in a text ‘corefer’ with each other and which do not. This work is interesting partly because it proves to be so surprisingly difficult, and largely for reasons that would not readily occur to a theoretical linguist (of the sort that would be engaged in the kind of work that we are engaged in as part of this seminar).

This however does not settle exactly how the presuppositions of definite descriptions come about – i.e which constituent or constituents of phrases that have the form of a definite description are responsible for their presuppositions or for which parts of them. The answer to that question has shifted over the years, largely because our understanding of internal DP structure, and of the internal structure of singular and plural definite descriptions in particular, has been undergoing substantial change.

Another reason why views on the nature of how definite descriptions refer, and more specifically on what their reference presuppositions are exactly like and how they can be resolved, is an increased awareness of the variety of ways in which descriptions can be used on the one hand and on the other how they often compete, when they are used in a particular way with other DPs that can be used for much the same purpose. The most often mentioned, and perhaps also most extensively documented competition of this sort is that between definite descriptions and third person pronouns in texts. When in writing we want to refer back to something that has already been mentioned we often hesitate between using a pronoun and using some definite description in its stead. The choice can be decided by various factors: we may prefer a description because a pronoun would be ambiguous, or because the
antecedent is too far back for a pronoun to be readily interpretable as referring back to it, even though there are no later competing antecedents. But whatever the precise reasons, the choice typically is that between two referring expressions both of which have anaphoric potential, but which differ in that one has more descriptive content than the other. If the anaphoric link is clear without the additional descriptive content that distinguishes the definite description envisaged by the writer from the pronoun, then that descriptive content will just be redundant and the pronoun preferred. If the pronoun cannot do an optimal job in the given situation, then the choice will fall on a description whose content unambiguously conveys the writer’s referential intention.

However, we find such competitions not only between definite descriptions and pronouns. Simple and complex demonstratives can be competitors as well, for either definite descriptions or pronouns; and sometimes there is a competition between all three expression types. But what holds for one of these phrase types seems to hold for all: they come with a referential constraint on the context: the context should be such that it enables the interpreter to identify the intended referent of the phrase. These constraints vary from one such noun phrase type to the next and they may also vary with the kind of use that is made of a given type. But they are all constraints to the effect that the context must provide what is needed to determine the referent (according to those rules that govern the given use of the given expression type). And all of these different constraints are shown to be presuppositional by the standard presupposition tests.

The class of definite noun phrases includes two further subcategories, the category of proper names and that consisting of the first and second person pronouns. Arguably these two types come with reference determining presuppositions as well. But their reference presuppositions are nevertheless quite different. Proper names follow a regime very much of their own, the nature of which came into focus primarily through the position expounded in Kripke’s “Naming and Necessity”. The ‘reference presuppositions’ of first and second person pronouns are very different yet again. At least that is so for the singular first and second person pronouns. The reference condition for the English first person pronoun I (and its morphological variants, me, my and mine) is that it refers to the utterer. Since what we are concerned with are utterances of words, this condition can hardly fail to be fulfilled; for what could be an utterance without an utterer?

(Arguably there are marginal cases in which it may be unclear who the referent of I is, or indeed whether there is a referent at all. For instance, suppose that some store sells posters with the inscription “Anyone who has come across --- (name of cat or dog on collar to be filled in) please contact me at --- (slot for e-mail address and/or telephone number)”. If I put up such a poster somewhere for a lark, filling in your telephone number and some fictitious name of a dog, does the ‘I’ on the poster refer to me, to you, or to no one in particular?

If there is anything that can be learned from such marginal and contrived examples, it is that the principles (a) that it is always possible to determine whether an utterance has been performed; and (b) that every utterance has a uniquely determined utterer; are valid only up to a point and that, as with almost any principle relating to some human practice, we can come up with scenarios on which they have no purchase. One could argue that this shows that even such principles come with a certain kind of presupposition, to the effect that the context of use ought to be one to which they can be applied. That even the seemingly more robust such presuppositions can fail in unusual or outlandish situations should not be a surprise to anyone. It is a decision for the theorist whether to take such situation into account and formulate his theory in a way that diffuses such situations as potential counterexamples. If the situations are
outlandish enough, then such an effort can easily become counterproductive, sacrificing transparency to a thicket of epicycles and qualifications.

Here we will stick to the assumption that it is possible to identify when an utterance has taken place what it is an utterance of and that every utterance fixes in a unique and unambiguous way the identity of its utterer or utterers. (An utterance may have a group of agents for its joint or collective utterers. When this is so, and the utterance contains occurrences of the first pronoun, these will be instances of we and its morphological variants, rather than of I and its variants. I add for the record that plural first and second person pronouns present some intriguing problems of their own. We will turn to some of these later on.)

The case of the second person pronoun you is a little different from that of I. First, English you has the special (and cross-linguistically perhaps not all that common) property that it can be either singular or plural. For now let us focus on its use as a singular pronoun. The reference rule for (singular) you is that it refers to the addressee of the utterance. But not every utterance has an addressee, e.g. when enters a thought into her diary. So the use of you comes with the presupposition that the utterance in which it occurs must be one that has an addressee. What that amounts to isn’t all that easy to say in sufficiently precise and general terms. Addressing someone is obviously an intentional notion. That an utterance is addressed to someone, and whom it is addressed to is a matter of the utterer’s intentions. Usually these intentions will be transparent to the recipients of the utterance. But that need not be so, and the cases where it isn’t need not be outlandish in the way of constructed counterexamples to the reference rule for I. For utterances without an occurrence of you it may be quite often unclear whether they are addressed to anyone or not, but since they don’t contain you that won’t in general be an impediment to interpreting them. Utterances which do involve you are coherent only if the speaker is addressing someone, since by using you the speaker makes public that she has such an intention. But that does not settle who the addressee is. There are endless jokes that trade on this possibility. (An arch subcategory are jokes involving cross-eyed speakers.) In such cases the reference presupposition that comes with you is falsely resolved, by one or more recipients of the utterance, leading to misunderstandings that are sometimes thought to be amusing. However, cases where the presupposition fails, in the sense that there is no addressee in spite of the fact that the utterance contains you as a constituent, are as outlandish as those that show the application limits of the reference rule for the first person pronouns: the speaker must think that she is addressing someone, but is under an illusion that there is someone she is addressing.

So I conclude that outright failure of both the reference determining presuppositions associated with the first and second pronoun singular is an exotic rarity, which we do well to ignore.

If that is what we do, then the question may be raised whether we are really with reference determining presuppositions we are dealing in relation to these words. What is a presupposition that can never fail? I think this is just a matter of terminology. I and you come, like all other definite noun phrases, with rules for the identification of their referents, and these rules are presuppositional in that they require the context to be such that they can be successfully applied. As it happens, some of these rules are such that situations in which the context prevents their successful application cannot arise (or only marginally so, but we have decided to ignore the marginal cases). But that is no compelling reason for withholding the predicate ‘presupposition’ from them. As far as their reference conditions are concerned, I and you, you might say, are just luckier than other definite noun phrases. They never (or hardly ever) fail to determine a referent, whereas other types of definite noun phrases can, and often
do.
To sum up the discussion above, we distinguish five main types of English definite noun phrases:

(i) **Definite descriptions**

(ii) **Demonstratives** - simple (*this, that, these, those*) and complex (*this book, that man, this paper you were talking about yesterday*)

(iii) **Proper names**

(iv) **3-d person pronouns**

(v) **1-st and 2-d person pronouns**

We will now have a closer look at each of these categories.

(i) **Definite descriptions**

- Definite descriptions generally come with a uniqueness requirement: their descriptive content must have a unique satisfier.

- In general the explicit descriptive content (given by the overt material in the sister node to Det) must be enriched with an implicit restriction predicate C that has to be recovered from context.

- Both the recovery requirement on C and the unique satisfaction requirement have the status of presuppositions.

- The unique satisfaction presupposition can be resolved either *anaphorically* or *non-anaphorically*.

  In cases of non-anaphoric resolution the presupposition is resolved in relation to the real world that the discourse talks about (independently of how it is being talked about).

  In cases of anaphoric resolution the presupposition is resolved within the discourse referent. Here the domain within which the (enriched) descriptive content must find a unique satisfier is the discourse domain, given by the discourse referents introduced so far.

- In the preliminary representation of a definite description the discourse referent that represents the referent of the DP is put in store until the time when the presupposition is resolved. (This also applies to the reference presuppositions of all other definite DPs.)
The uniqueness presupposition of singular definite descriptions is the result of interaction between (a) the determiner the and (b) the number feature ‘sing’.

*the* signals *maximality*: the referent of the DP is the totality of the satisfiers of the (enriched) descriptive content. (or the ‘sum’ of the satisfiers when we assume a mereological ontology (Link, 1983)

‘sing’ signals that the referent is a single individual (or an ‘atomic’ individual in the sense of mereological ontology)

If the totality of the satisfiers is a single individual, then that means that there is exactly one satisfier.

We assume that the number feature enters into the syntactic representation at a projection somewhere between NP and TP. For instance, for the DP *the student* we assume the structure in (1).

(1)  
\[
\text{DP} \\
\text{Det} \quad \text{NumP} \\
\text{the} \\
\text{Num} \quad \text{NP} \\
\text{sing} \quad \text{N} \\
\text{student}
\]

The representation of this DP is given in (2) and its construction in (3.a-c)

(2)  
\[
\text{DP} \quad \Rightarrow \quad \langle \xi \rangle < \{ \text{C} \}, \quad \xi = \Sigma x'. \quad \text{student}'(x'), \quad \text{atomic}(\xi)
\]
(3)  a.  N  \Rightarrow  \langle \xi | < \{ \}, \text{ student'}(\xi) \rangle
\begin{array}{c}
C(\xi)
\end{array}

b.  NP  \Rightarrow  \langle \xi | < \{ \}, \text{ student'}(\xi) \rangle
\begin{array}{c}
C(\xi)
\end{array}

c.  NumP  \Rightarrow  \langle \xi: \text{ atomic}(\xi) | < \{ \}, \text{ student'}(\xi) \rangle
\begin{array}{c}
C(\xi)
\end{array}

* With this representation for *the student* we get as preliminary representation for the sentence in (4) the one given in (6). (5) gives the syntactic structure we assume for (4), (7.a-c) give the representations of the VP, TP and S node.

(4)  The student laughed.

(5)  \begin{array}{c}
\langle x | < \{ \}, \Sigma x' \}, \text{ student'}(x') \rangle
\begin{array}{c}
t \leq t
\text{ e: laugh(x)}
\end{array}
\end{array}

(6)  \begin{array}{c}
S
\end{array}
\begin{array}{c}
\text{ Comp}
\end{array}
\begin{array}{c}
\text{ TP}
\end{array}
\begin{array}{c}
\varnothing
\end{array}
\begin{array}{c}
\text{ DP}_1
\end{array}
\begin{array}{c}
\text{ T'}
\end{array}
\begin{array}{c}
\text{ Det}_1
\end{array}
\begin{array}{c}
\text{ NumP}
\end{array}
\begin{array}{c}
\text{ T}
\end{array}
\begin{array}{c}
\text{ VP}
\end{array}
\begin{array}{c}
The
\end{array}
\begin{array}{c}
\text{ Num}
\end{array}
\begin{array}{c}
\text{ NP}
\end{array}
\begin{array}{c}
past
\end{array}
\begin{array}{c}
V
\end{array}
\begin{array}{c}
sing
\end{array}
\begin{array}{c}
N
\end{array}
\begin{array}{c}
laugh
\end{array}
\begin{array}{c}
\text{ student}
\end{array}
\begin{array}{c}
< e | e: \text{ laugh'(x)} >
\end{array}

(7)  a.  VP  \Rightarrow  \langle e | e: \text{ laugh(x)} \rangle
b. \[ T' \Rightarrow <e|t < n \Rightarrow e \subseteq t > \]
\[ e: \text{laugh}(x_1) \]

c. 
\[ \xi \]
\[ \text{TP} \Rightarrow <e, \xi|\{\xi = \Sigma x'.}, t > \]
\[ \text{student}'(x') \quad t < n \Rightarrow e \subseteq t \]
\[ \text{C}(x') \quad e: \text{laugh}(\xi) \]
\[ \text{atomic}(\xi) \]

d. 
\[ \xi \]
\[ \text{S} \Rightarrow <\xi|\{\xi = \Sigma x'.}, t > \]
\[ \text{student}'(x') \quad t < n \Rightarrow e \subseteq t \]
\[ \text{C}(x') \quad e: \text{laugh}(\xi) \]
\[ \text{atomic}(\xi) \]

- Without more information about the context the presupposition of (5) might have to be resolved either anaphorically or non-anaphorically. But with more context the choice between these two options may be clear.

(8) A student and two professors walked by. The student was crying.
(iii) **Proper names**

- Proper names are our principal tools for securing communication about absent referents in verbal communication.

- How this works something like this:
  
  - Language users are equipped with large mental libraries of entity representations. Many of these representations are ‘labeled’ with a proper name (and sometimes with more than one) for the represented referent.
  
  - Moreover, speakers know this about one another: A speaker may know that the person or persons she is addressing has/have a representation for the entity she wants to say something about, and that that representation will bear some name N as label.
  
  - By using N as argument phrase in what she says about the referent she enables her audience to associate the content of her words with the N-labeled entity representation they have, thus providing them with new information of the referent.

- For the most part this works well. Speakers tend to be good at judging whether their addressees have N-labeled entity representations for the referents they want to talk about (just as they themselves do on the occasions when they use N to say something about the referent).

- We will call this use of names its *standard case*:

  In standard cases of the use of a name N the speaker uses the name N to refer to an entity x, (for which, inevitably, she has an N-labeled representation), the audience has an N-labeled entity representation for x and associates the information the speaker expresses about x with its N-labeled entity representation for x.

  More precisely: The utterance S that the speaker makes, and which contains N, can be interpreted as a predication, in which some (simple or complex) predicate P is applied to the represented entity. The audience ‘associates the information expressed by S with its N-labeled entity representation r of x’ by predicating P of r.

- Sometimes things do not work out quite this way. The audience may fail to have an N-labeled representation of x; or the audience may have an N-labeled representation, but for some entity different from x; or it may have several N-labeled representations. And in the last case it may be that none of them are representations of x; or it may be that one of them is a representation of X, but that the audience ‘misidentifies the referent’ by applying P to an N-labeled representation for some other entity than x.

- The case where the interpreter of the utterance doesn’t have an N-labeled representation has played a central role in the philosophical literature about names since the seminal work of Kripke’s “Naming and Necessity” (1971). In such cases the interpreter will, it is claimed, typically accommodate’ the name in creating an N-labeled representation for whatever the speaker is referring to by using N.
In this way the interpreter slots himself into a practice of communication about the referent $x$ through the use of $N$. He may interpret subsequent uses of $N$ by this and other speakers as also about $x$ (the referent represented by his newly formed $N$-labeled entity representation). And he can now also use $N$ himself to refer to $x$ and make statements about $x$, ask questions about $x$ and so on. In this way he can come to learn much about $x$ and become a fully integrated member of the community as regards the use of $N$ as a name for $x$.

Kripke has argued forcefully that this is how names spread through the community and are passed on from generation to generation. And that with the spread and the passing on access to (and information about) their referents also spread and are passed – as part of the same package deal so to speak.

Kripke is surely right about this. But nevertheless the cases of this kind, where the interpreter doesn’t have an $N$-labeled entity that he can use to make sense of an utterance containing $N$, are special (as well as comparatively rare).

In our terminology they are not among the standard cases of the use of a proper name.

All cases of name use so far discussed are what we will call referential uses. Every referential use of a name $N$ by a speaker $S$ involves some $N$-labeled entity representation of $S$. And the import of using $N$ in this way is that the recipient should associate the received information with a matching $N$-labeled representation of his own.

The standard cases are those where this succeeds. In the other cases we have mentioned, it goes wrong in some way or other.

All ordinary uses of names can be understood as coming with an instruction to the audience to identify the referent (and to do so in terms that are independent of what the speaker predicates of the referent that she uses the name to refer to).

In other words, each ordinary use of a proper name comes with a reference presupposition. In this respect proper names are like other definite noun phrases.

We have described informally what the reference presupposition that is part of the ordinary use of names comes to, but we have done so in a setting of verbal communication that goes well beyond the formal framework for doing formal semantics in which we are working.

In the framework in which we are working the form-meaning relation is explicated in terms of a general mechanism for assigning semantic representations to discourses and texts, while abstracting of the separate roles that producer (speaker, writer) and recipient (hearer, reader) play in this process.

In this framework we cannot capture the way in which the interpreter is meant to resolve the reference presupposition that comes with an ordinary use of a name: it has no means for talking about the entity representations in the minds of individual speakers and so it cannot express in such terms what successful interpretation of a name comes to.
Therefore we can only gesture in the direction of a lifelike account of the reference presuppositions that accompany the ordinary uses of proper names by including in the representation of an utterance containing an ordinary use of a name N a presupposition that contains the referential argument for (and introduced by) the given occurrence of N. We will hint at the story that needs to be told – but can be told only in a much richer framework than we are using - about how the interpreter is meant to resolve the presupposition by using the subscript ‘pr. na.’.

Furthermore we assume that the contents of the presupposition consist of (i) the discourse referent \( \alpha \) that is chosen as the referential argument of the given occurrence of the name; and (ii) the condition ‘named(‘N’,\( \alpha \))’, which says that \( \alpha \) stands for an entity that goes by the name N. Often we will abbreviate this condition as ‘N(\( \alpha \))’.

The stipulations above entail that when a name N is used as a DP, then the semantic representation of that DP is as in (9). An instance is given in (10).

\[
\begin{align*}
(9) & \quad \alpha \\
& \quad < \alpha | \{ \}, \quad >> \\
& \quad \text{named(‘N’,}\alpha) \\
& \quad \text{pr. na.}
\end{align*}
\]

\[
\begin{align*}
(10) & \quad x \\
& \quad < x | \{ \}, \quad >> \\
& \quad \text{named(‘John’,}x) \\
& \quad \text{pr. na.}
\end{align*}
\]

As we noted, within our formal framework there is little that can be said about the resolution or accommodation of the reference presuppositions of proper names. The only thing that we can say is that both their resolution and their accommodation happen at the global level. For accommodation this means that the referential argument ends up in the universe of the main DRS and the condition ‘named(‘N’,\( \alpha \))’ (or ‘N(\( \alpha \))’) in the condition set of the main DRS.

In the light of our informal story of proper name resolution this means that an antecedent \( \beta \) for the referential argument must be available at the global level, together with the information that this antecedent represents a referent that bears the name ‘N’, viz. with the condition ‘named(‘N’, \( \beta \))’. Identification of \( \alpha \) with \( \beta \) renders ‘named(‘N’,\( \beta \))’ equivalent to ‘named(‘N’, \( \alpha \))’. So in this case too we may assume that \( \alpha \) is a member of the universe of the main DRS and ‘named(‘N’, \( \alpha \))’ a member of its condition set. So, at the level of formal description that is available to us resolution and accommodation come to the same thing. We will assume that this is always the result of dealing with the reference presupposition of a proper name. This means that in the end – i.e. after presupposition resolution – the result is the same as that of the original treatment of proper names: the referential argument of the name ends up in the main universe and the accompanying name condition in the main condition set.

This means that for a sentence like (11) we get the preliminary representation in (12)
and the final representation in (13).

(11) John loves Mary.

(12) \[ \begin{array}{ccccccc}
\langle x, y | < \{ & \text{name}(\text{John},x) & , & \text{name}(\text{Mary},y) & \rangle > \\
\text{pr. na.} & \text{pr. na.}
\end{array} \]

(13) \[ \begin{array}{ccccccc}
\langle x, y | < \{ & \text{name}(\text{John},x) & , & \text{name}(\text{Mary},y) & \rangle > \\
\text{pr. na.} & \text{pr. na.}
\end{array} \]

For good measure the different steps in which the preliminary representation in (12) is constructed are given in (14).

(14) a. \[ V \Rightarrow < s | \text{love}(x_1,y_2) > \]

b. \[ DP_2 \Rightarrow < y | < \{ \text{name}(\text{Mary},y) \rangle > > \]

c. \[ VP \Rightarrow < s, y | < \{ \text{name}(\text{Mary},y) \rangle > > \]

\[ \text{pr. na.} \]

d. \[ T' \Rightarrow < s, y | < \{ \text{name}(\text{Mary},y) \rangle > > \]

\[ \text{pr. na.} \]

e. \[ TP \Rightarrow < s, x, y | < \{ \text{name}(\text{John},x) \rangle > > \]

\[ \text{pr. na.} \]

f. \[ (= (12) ) \]

\[ \text{S} \Rightarrow < x, y | < \{ \text{name}(\text{John},x) \rangle > > \]

\[ \text{pr. na.} \]
Not all uses of proper names are ordinary uses in our sense. ‘Non-ordinary’ uses are those where the name is quoted, or used in some quasi-quotational way, as in:

*a man named Jones, I baptize this ship ‘Vanguard of Hope’, she goes by the name of Tipples, we will call this use ‘the Ordinary Use’, and so on.

Non-ordinary uses do not give rise to the reference presupposition of the ordinary use. To see the difference compare the following things that Bill could say to Anna when she comes home:

(15)  

a. A man named Jones called while you were away.
b. Jones called while you were away.

Non-ordinary uses like that in (15.a) are ordinary indefinites which can be represented like other indefinites. Thus the preliminary representation of “A man called” is as in (16):

(16)  

\[
\begin{align*}
& t \quad e \quad x \\
& t < n \quad e \subseteq t \quad \text{named('Jones',x)} \\
& e: \text{call(x)}
\end{align*}
\]

(iv) **third person pronouns**

- 3-d person pronouns (henceforth simply ‘pronouns’) have two uses:

  (a) deictic
  
  (b) anaphoric

  Deictic uses of pronouns (also called ‘demonstrative uses’) refer to entities accessible in the shared environment in face-to-face communication. The classical examples from the literature are those of an assault victim in front of a police line-up, uttering (17) while pointing at one of the people in the line-up:

(17)  

It was him.

(Here the deictically used pronoun is *him*. *it* is a kind of dummy pronoun, much like the *it* of cleft sentences.)

Anaphoric uses of pronouns are those in which the pronoun ‘refers back’ to something introduced earlier into the discourse. Typically the introduction involved the use of some other noun phrase. That is not always so, but for anaphoric singular pronouns it is close to the norm and it is these cases that we focus on here.
• The division between deictic and anaphoric uses is not sharp. Consider the case of Mary who cries to John, who is in the other room:

(18) She got in.

What Mary means to say is that their daughter was admitted to Julliard. There is a range of situations in which (18) would be appropriate. She and John may have just been talking about their daughter’s chances to get into Julliard and (18) might be considered as something like a continuation of that discourse. In that case the use of *she* might qualify as anaphoric.

But - to mention just one other possible situation - there may have been no explicit mention of their daughter by either Mary or John for quite some time. But the question of her admission has been on both their minds for some time. Such a situation suggests that the use of *she* in (18) is more like a deictic use.

• When pronouns occur in texts that are written for wide or general consumption (so that the writer cannot rely on shared information between her and her readers based on earlier personal communication, pronouns are almost without exception anaphoric. Here we assume that they always are.

• Pronouns are among the definite noun phrases and thus should be treated as coming with reference presuppositions.

The reference presupposition for a singular anaphoric pronoun is to the effect that an anaphoric antecedent for the pronoun can be found in the text. For us this takes the form of a requirement that a discourse referent can be found for the pronoun within the representation (DRS) that has been established on the basis of the preceding part of the text (*global* resolution of the pronoun presupposition) or in an accessible part of the representation of the sentence in which the pronoun occurs (*local* resolution of the presupposition).

• Anaphorically used singular pronouns are thus anaphoric in two different senses:

(i) they must be resolved in the *discourse* context

(ii) the antecedent used to resolve them must be present in the discourse context in the form of an (accessible) discourse referent

Thus anaphoric pronouns are like anaphoric definite descriptions in the sense of (i) but not in the sense of (ii).

A famous illustration of this difference between pronouns and definite descriptions is the marble example of Partee.

(19) a. One of the ten marbles is not in the bag. It/The missing marble is under the sofa.

b. Nine of the ten marbles are in the bag. (?) It/ (√) The missing marble is under the sofa.
In (19a.) where the subject DP of the first sentence has led to the introduction of a discourse referent for the missing marble both it and the missing marble can be used to refer to it. In (19.b) only the description the missing marble is felicitous. Here the first sentence establishes a discourse context from which the existence of the missing marble can be inferred. But no discourse referent for it has been so far introduced, and apparently subtraction (of the set of nine marbles from the set of ten marbles) is not a legitimate way of creating an antecedent for the pronoun.

- This means that pronouns cannot be simply treated as definite descriptions with limited descriptive content. English pronouns do have some such content – as a rough approximation: *she* and its morphological variants (*her, hers*) can be used only to refer to female humans, he and its variant only to male humans and it only to non-humans.

But pronouns in other languages impose different kinds of restrictions on their antecedents, in particular matching of grammatical gender with their ‘grammatical antecedents’ (the noun phrases that were used to introduced to introduce the discourse referents that serve as antecedents in our reconstruction of anaphora resolution). Nevertheless, in all other respects pronouns in such languages seem to function like the pronouns of English.

- The presuppositions we assume for English singular anaphoric pronouns contain (i) a discourse referent, serving as the pronoun’s referential argument and (ii) conditions which constrain the range of its possible referents.

In addition, the presupposition comes with an annotation – the subscript ‘3aspr.’, which indicate that the presupposition was triggered by a third person anaphoric singular pronoun. As an example (20) gives the presupposition generated by the pronoun *she*.

\[
\begin{array}{c}
\alpha \\
\{ \text{hum(} \alpha \text{)}, \text{fem(} \alpha \text{)} \} \\
\text{3aspr}
\end{array}
\]

(The occurrence of the discourse referent \( \alpha \) in the universe of the presupposition DRS is often underlined (as shown here) to indicate that the presupposition is anaphoric in the sense that resolution requires a discourse referent with which the underlined discourse referent is to be identified.)

As with the presuppositions for proper names most of the ‘action’ is hidden away in this subscript. But the case of pronouns is different insofar as it is possible to describe the main constraints on the resolution of their presuppositions within the framework we are using.

- (21) gives an example of what preliminary representations involving pronoun presuppositions look like. (21.b) gives the DRS for the first sentence (after resolution of the proper name presupposition). (21.c) gives the preliminary representation of the
second sentence, and (21.d) the DRS for the two sentences after the pronoun presupposition has been resolved (to Mary).

(21) a. Mary called. She will arrive tomorrow.

b. \[ t_1 \ e_1 \ m \]
\[ t_1 < n \ e_1 \subseteq t_1 \ \text{Mary(m)} \]
\[ e_1: \text{call}'(m) \]

c. \[ u \ t_2 \ e_2 \ t_2' \]
\[ u < t_2 \ e_2 \subseteq t_2 \ \text{tomorrow}'(t_2') \]
\[ \text{hum(u)} \ n < t_2 \ e_2 \subseteq t_2 \ \text{tomorrow}'(t_2') \]
\[ \text{fem(u)} \]
\[ 3\text{aspr} \]
\[ e_2: \text{arrive}'(u) \]

d. \[ t_1 \ e_1 \ m \ t_2 \ e_2 \ t_2' \ u \]
\[ t_1 < n \ e_1 \subseteq t_1 \ \text{Mary(m)} \ n < t_2 \ e_2 \subseteq t_2 \ \text{tomorrow}'(t_2') \ u = m \]
\[ \text{hum(u)} \text{ fem(u)} \]
\[ e_1: \text{call}'(m) \ e_2: \text{arrive}'(u) \]

Constraints on pronoun resolution.

- The possible interpretations of anaphoric pronouns are constrained in various ways that are not captured by the presuppositional account we are developing here as part of our bottom-up construction algorithm.

The only constraint captured so far is that of the accessibility of antecedents of pronouns (in the sense of accessibility in DRT). This constraint is captured in essentially the same way as it was captured by the top-down algorithm. As before, accessibility is defined in terms of the hierarchical structure of DRSs. (This relation now has to defined on representations that involve stores and presupposition sets as well as non-presuppositional DRSs and DRS conditions, but once an operational definition of the new representation structures is in place, this is more or less automatic.)

The second ingredient in the way accessibility constraints are captured by the bottom-up algorithm is that presupposition representations are always adjoined to the (sub-) DRSs for the clauses within which the presuppositions are triggered. This means that the position of the representation of the presupposition triggered by the occurrence of a pronoun allows us to identify the accessible antecedent candidates in essentially the same way they are identified by the pronoun itself in the top-down algorithm.

- But there are various kinds of other constraints that are not captured. Some of these
weren’t captured either by the top-down algorithm as it was presented it. But there was one constraint that was captured, and that isn’t by our current bottom-up algorithm.

This constraint is ‘syntactic’ in that it can be stated as a configurational constraint on the syntactic relation between the pronoun and the DP whose referential argument is to serve as the pronoun’ antecedent. The syntactic constraint is that the pronoun my not C-command the antecedent DP. The case where this becomes a problem for the present approach is illustrated by sentences like that in (22.a).

(22)  
a. He chased a woman who loathed a man.  
b. A man chased a woman who loathed him.

It is plain that the subject he in (22.a) cannot be interpreted as anaphoric to the DP a man which it C-commands. For this reason, and for this reason only, is it impossible to assign (22.a) an interpretation that makes it equivalent to (22.b) (on the most natural interpretation of that sentence).

The syntactic structure of (22.a) is given in (23).
It is clear why there is no way of using a man as antecedent for he in (22.a) when we apply the top-down algorithm. This is because it is part of that algorithm that pronouns must be interpreted ‘on-line’: when a pronoun is reached in decomposing the syntactic structure of a sentence, an antecedent discourse referent must be found for it then and there. And, obviously, in the case of (23), where he is the first constituent that must be dealt with, the discourse referent for a man won’t be available yet; not discourse referent coming form any part of the sentence itself has become available yet, since interpreting he must be the first move.

The on-line requirement thus enables us to capture the configurational constraint that prevents us from interpreting he as anaphoric to a man because it reflects an aspect of the syntactic configuration of the input. But when we interpret pronouns by introducing presuppositions for them in the course of constructing the preliminary representation and then proceed to resolve those presuppositions only when the construction of the preliminary representation is complete, then the relevant information about the syntactic input structure may have been lost.

For the case at hand this is shown by the preliminary representation that the bottom-up algorithm produces for (23).
Note that (24) is indistinguishable from the one that we get for (22.b), where he can be resolved to a man. Evidently, in the process of representation construction we have lost information that we still need.

Question: What can we do to preserve it?

• Before we try to answer this question, let us first note that the constraint illustrated by (22.a) is not the only syntactic constraint on pronominal anaphora in English. Much more familiar in the syntactic literature is the constraint expressed by Condition B of Chomsky’s Binding Theory, a component of his grammar model known as ‘Government and Binding’. This constraint is illustrated by the sentences in (25).

    b. He admires *him/*himself.
    c. Mary compared John to *him/*himself.
    d. John was happy. He admired *him/*himself.
    e. John found a snake near *him/*himself.
    f. John talked to Mary about *him/*himself.

In all sentences in (25) where the pronoun him cannot be interpreted as anaphoric to a coindexed DP preceding it the intuitive reason is that the antecedent is ‘too near’. When the antecedent is as near as it is in these examples, then anaphoric coreference must be expressed by the reflexive pronoun himself. Reflexive and non-reflexive pronouns are almost in complementary distribution, but there are some examples, such as (25), that indicate the complementarity is not perfect. (Though it might be that the alternations we find in such cases indicate that we are dealing with two distinct underlying syntactic structures.)

The classical account of the constraint that is at work in (25) is Condition B, which in essence says that a pronoun (as opposed to an anaphor; in Chomsky’s terminology the anaphors of English are the reflexive pronouns and the reciprocals, each other and one another) and its antecedent cannot be arguments of the same predicate. [check]

• We now turn to the question how such constraints on pronoun presupposition resolution that appear to be syntactic in nature and origin can be made available to a bottom up algorithm of the kind we are developing.

Let us assume that the syntactic relations between pronouns and putative antecedents that bock an interpretation of the pronoun as anaphoric to the antecedent are known and that the syntactic parser that provides the construction algorithm with its inputs can list the prohibited antecedent-pronoun pairs as part of the input it delivers. Then the following is a way of making this information available to the resolution procedure that operates on preliminary DRSs:
1. Assume (as we have been doing already) that insertion of the semantics of all predicate words in the sentence occurs before any other construction steps are performed, and that every DP has an index which links it to the argument position of one of the semantic predicates thus introduced. We now annotate each DP occurrence \( \alpha \) in addition with the set of all indices of pronoun occurrences \( \beta \) to which \( \alpha \) is linked by a relation that prohibits \( \alpha \) from serving as anaphoric antecedent to \( \beta \). (Given the list of pairs delivered by the parser this set consists of all indices of \( \beta \)'s such that \((\alpha, \beta)\) appears in the list. For most \( \alpha \)'s this set will of course be empty.)

2. When a DP \( \alpha \) is interpreted, its index set is transferred to the discourse referent that serves as its referential argument.

3. When a pronoun is interpreted, its index is transferred to its referential argument (the underlined discourse referent of the reference presupposition that gets introduced at that point).

4. When, after completion of the preliminary representation, a pronoun presupposition gets resolved, all those discourse referents are ignored whose index sets contain the index of the pronoun.

- This algorithm deals with all the cases exemplified in (22) and (25) except for (25.d). Here the problem is that the method we have described allows that both he and him can be resolved to the subject John of the preceding sentence. We can guard against this by adding the index of the referential argument of a pronoun to the discourse referent to which it is resolved. If we assume that pronoun presuppositions are resolved in some order, then that will prevent unwanted resolutions in cases like (25.d): either him is first resolved to John, and that will then prevent resolving he to John, or one first resolves he to John, which then prevents a like resolution of him.

- The constraints on pronoun interpretation just considered also apply to definite descriptions. (26) gives a couple of examples.

(26) a. The man chased a woman who loathed a man.
   b. John\(_1\) admired *the man\(_1\).

A way of extending the method sketched above for capturing the constraints on pronoun interpretation to definite descriptions is to include their indices also in the index sets of those DPs to which they may not be interpreted as anaphoric. The discourse referents that have the index of a definite description in their index sets must then be excluded from the domain within which the definite description must find its unique satisfier. We omit the (non-trivial) details.

- The syntactic constraints on pronominal anaphora can be seen as another instance of the problems that beset notions of strict compositionality. The proposal we have proposed here simply amounts to carrying enough information about syntactic structure along for long enough while making the transition from syntactic form to an explicit semantic representation.

In this way some form of compositionality – in our case: building semantic
representations from syntactic structures bottom up, along the lines that have been emerging from the examples we have so far looked at – can be maintained in the presence of various kinds of obstacles. But at some point one can no longer avoid the question whether this way of saving a certain conception of compositionality isn’t a bit of a sham. A similar question must also be asked about manipulations of the syntactic input before semantic interpretation gets under way in earnest, for instance in the case of quantifier raising, and in relation to other operations that syntacticians have posited to obtain ‘LFs’ from surface structures.

What is clear is that – in some way, and in cooperation with the context - syntactic form must provide the interpreter with enough to go by in his effort to reconstruct the information that the utterance or text is meant to convey. And clearly the guidance provided by syntactic form must be systematic; otherwise languages couldn’t be acquired or used. But exactly how syntactic form guides interpretation and where the different clues are located in syntactic structure that guide different syntactic operations is another matter. Syntactic structure, it seems, is subject to its own laws and constraints. Sometimes these are in the way, it almost seems to a semanticist, of the most direct way of expressing the semantics of that speakers need their language to be able to express. In such cases languages have developed to devices where things don’t work according to the standards set by certain simple and streamlined conceptions of compositionality. That is where natural language semantics gets hard; but they are also points at which it gets interesting.

• In addition to these syntactic constraints on pronoun resolution there are also constraints that haven’t yet been mentioned and that are of a semantic or pragmatic nature. One is illustrated in (27).

(27) a. If a boy asks a girl out and she likes him, she will usually accept.
   b. ?? If she likes him and a boy asks a girl out, she will usually accept.

(26.b) can hardly be interpreted – if indeed it can be at all - in the way we naturally interpret (26.a). Given all that has been said about anaphora resolution as a species of presupposition resolution in some global or local context, this isn’t surprising. What (26) shows is that the first conjunct of a conjunction provides a local context for the resolution of presuppositions generated in the second conjunct, but not conversely. This is entirely consistent with what we have observed about discourse anaphora, and more generally with presupposition resolution in discourse: the previous part of the discourse can be used to resolve presuppositions occurring later on in the discourse.

So the constraint that is demonstrated in (27) is just of the kind that one would expect a DRT-based semantics to be in a good position to account for. So far, however, we have not developed adequate means for dealing with it. (There is a quite complicated and convoluted proposal in Section 5 of Ch. 1 of From Discourse to Logic. The book would have been better without that section.)

A better treatment can be obtained when we enrich the vocabulary of our DRS languages with an additional condition-forming operator. Like ⇒ and v this operator forms a complex DRS condition out of two DRSs. We use the symbol ‘;’ for this operator (as a tribute to the Dynamic Semantics of Groenendijk and Stokhof, although here ‘;’ works somewhat differently from the dynamic conjunction operator ;
Dynamic Semantics in their sense). Thus, when \( K \) and \( K' \) are DRSs, possibly with presupposition sets left-adjointed to them, then \( K;K' \) is a DRS condition.

For a DRS language that contains conditions of the form \( K;K' \) the definition of accessibility can be extended by stipulating that in \( K;K' \) \( K \) is accessible form \( K' \) but not conversely. This accounts for the difference between (27.a) and (27.b) in an obvious way. The preliminary DRSs for the slightly simplified versions of (27.a) and (27.b) in (28) are given in (29.a,b).

(28)  a. If a boy invites a girl and she likes him, she accepts.
      b. ?? If she likes him and a boy invites a girl, she accepts.

(29)  a.  

\[
< u,v,w | < t e x y > ; < u , v , t' > > \\
\begin{array}{cccc}
  n & \subseteq & t & \text{boy}'(x) \\
  e & \subseteq & t & \text{girl}'(y) \\
  e: & \text{invite}'(x,y) \\
\end{array}
\begin{array}{cccc}
  \text{hum}(u) & \text{hum}(v) \\
  \text{fem}(u) & \text{male}(v) \\
\end{array}
\begin{array}{cccc}
  n & \subseteq & t' \\
  t' & \subseteq & s' \\
  s': & \text{like}'(u,v) \\
\end{array}
\Rightarrow \quad < \{ \begin{array}{c}
  \text{hum}(w) \\
  \text{fem}(w) \\
\end{array} \}, t'' e'' > \\
\begin{array}{cccc}
  \text{hum}(w) & n & \subseteq & t'' \\
  \text{fem}(w) & e'' & \subseteq & t'' \\
\end{array}
\begin{array}{c}
  e'': & \text{accept}'(w) \\
\end{array}
\]
b.

\[
< u, v, w \mid < \{ \begin{array}{c}
  u \\
  v \\
  t' \\
  s'
\end{array} > > ; \\
\begin{array}{ccccccc}
  \text{hum}(u) & \text{hum}(v) & n \subseteq t' & n \subseteq t & \text{boy}'(x) \\
  \text{fem}(u) & \text{male}(v) & t' \subseteq s' & e \subseteq t & \text{girl}'(y)
\end{array}
\]

\[
\Rightarrow \langle \{ \begin{array}{c}
  w \\
  t'' \\
  e''
\end{array} > \rangle,
\begin{array}{ccccccc}
  \text{hum}(w) & n \subseteq t'' & e'' \subseteq t'' \\
  \text{fem}(w) & e'' \subseteq t'' & 3\text{spr}
\end{array}
\]

Given what we have said about ; and accessibility it should be clear that the pronouns represented by \( u \) and \( v \) should be resolvable to \( y \) and \( x \) in (29.a) but not in (29.b).

Once the presuppositions generated in the first and second conjuncts of a ;-condition \( K;K' \) have been resolved, the extra structure that the condition provides is no longer needed and \( K \) and \( K' \) can be merged with the DRS that contains \( K;K' \) as a member of its condition set. So (29.a) can be converted into the DRS in (30).

\[
(30)
\begin{array}{ccccccc}
  t & e & x & y & t' & s' & u & v
\end{array}
\Rightarrow
\begin{array}{ccccccc}
  n \subseteq t & \text{boy}'(x) & n \subseteq t' & (\text{hum}(u) & \text{hum}(v)) \\
  e \subseteq t & \text{girl}'(y) & t' \subseteq s' & (\text{fem}(u) & \text{male}(v))
\end{array}
\]

\[
\begin{array}{ccccccc}
  e: \text{invite}'(x,y) & u = y & v = x & s': \text{like}'(u,v)
\end{array}
\]

\[
\begin{array}{ccccccc}
  t'' & e'' & w
\end{array}
\begin{array}{ccccccc}
  n \subseteq t'' & \text{hum}(w) & e'' \subseteq t'' & \text{fem}(w)
\end{array}
\]

\[
\begin{array}{ccccccc}
  w = y & e'': \text{accept}'(w)
\end{array}
\]

• Note that ;-conditions have a somewhat different status from other complex DRS conditions. Because conjunction is built into the architecture of DRSs, they are not needed for logico-semantic reasons, but only so as to give more structure needed in the definition of accessibility. That is why they can be eliminated once they have made their contribution to anaphora resolution.

• Salience constraints on 3-d person pronouns
In addition to the syntactic and semantic constraints we have been looking at, pronoun resolution is also subject to various ‘pragmatic’ constraints. Often the word ‘salience’ is used in this connection: pronouns should be resolved to the most ‘salient’ potential antecedent. But the notion tends to be used in a rather intuitive sense and efforts to make it more precise – and ‘operational’ in computational accounts of language interpretation have thus far been quite rare. For anaphoric pronouns salience is often equated with recency: a pronoun should be resolved to the most recently introduced entity modulo the constraints imposed by its gender, number and person features. (The chosen antecedent has to be compatible with these.) That often makes the right predictions, which is why it is so hard for automated resolvers based on more sophisticated theories of pronoun resolution to beat those who steadfastly go by the simple-minded rule that the antecedent is always the one that you find first when going back from where the pronoun occurs. But cases where recency is beaten by other factors are common enough no less. It is just not easy to see precisely what they are, let alone convert such insights into tractable algorithms of the kind one wants in applied NLP. An interesting proposal for defining salience can be found in (Roberts, 2003).

One of several questions in this area to which there is to my knowledge no firm answer at present is whether salience is to be seen as a kind of ‘collective’ property: an antecedent candidate for a pronoun in virtue of being more prominent than any of its competitors on account of all the factors that are relevant to prominence, or whether salience is to be seen as one factor among - and competing with - others. Here we don’t have anything to say on these matters.

(v) First and second person pronouns

• There is one plausible sense in which 1-st, 2-nd and 3-d person pronouns form one big family. They differ in one respect, viz. in terms of their ‘person feature’, just as pronouns can also differ in one of the other ‘ϕ-features’ (person, number, gender): English 3-person pronouns can differ in number (she as opposed to they) or in gender (she as opposed to he), and 1-st and 2-nd person pronouns are subject to similar distinctions (if perhaps not always marked by explicit morphology on the pronoun itself. Semantically, the members of this family cover all possible referents, carving that large pie up between them according to divisions that are drawn fairly reliably by their ϕ-features. The demarcation lines may vary somewhat from one language to the next, but there is a fair degree of cross-linguistic consistency.

In particular the distinction between singular pronouns in the 1-st, 2-nd and 3-d person typically amounts pretty much to what the term suggests: the referent of a first person pronoun is always the one who counts as the speaker (though this need not always be the one who physically produces the given utterance – who speaks it or writes it or projects into a screen or whatever, but who may count as doing this on someone else’s behalf). 2-nd person pronouns are reserved for the addressee: by using such a pronoun the speaker indicates that she is addressing someone, and that someone then is, by definition, the referent of her use of the pronoun. And the 3-person pronouns are for everything else.

• But the fact that the range of possible referents is carved up between 1-st, 2-nd and 3-d person pronouns in this way is the reason why semantics has tended to treat 1-st and 2-nd person pronouns as radically different from 3-d person pronouns. 1-
person pronouns are *indexicals*: any occurrence of such a pronoun gets its reference from the utterance context. On the one hand that makes their reference context-dependent (and in a particularly straightforward and transparent way). But on the other hand, when their reference has been contextually fixed, it is rigid, i.e. the same in all possible worlds context and that irrespective of where the given token of the indexical occurs – irrespective of how deeply it is embedded within modal and other intensional contexts, it is always the utterance context that fixes its reference and it does so for all possible worlds at once. In true fact, this – the standard way of describing the semantic behavior of indexicals – is an overstatement, but it is close enough to the truth to have passed for the truth for several decades and to have shaped the general understanding of how indexicals function.

On this characterization 1-st and 2-nd person pronouns may look like they are as distant from 3-d person pronouns as two types of definite noun phrases can possibly get: on the one hand expressions that refer rigidly, on the other expressions that often display a behavior that is reminiscent of the bound variables of formal logic.

• The account of 3-d person pronouns we have given here already takes much of the pungency out of this contrast. 3-d person pronouns aren’t like the variables of logic. They are definite noun phrases like others, coming with presuppositions of referential identifiability. True, the resolution regimes for the reference presuppositions of 3-d person pronouns enable them to play, when occurring in the right syntactic configurations, a role that is strongly reminiscent of logical variables. But we should not forget that even in those cases the contribution of the pronoun is not to provide the (quantificationally) bound variable itself – that role reserved for e.g. the referential arguments of DPs beginning with *every* and other quantificational DPs – but only to extend the range of the bound variable, providing it with an additional argument position (that to which the pronoun is linked).

• But even when this has been taken into account, 1-st and 2-nd person pronouns still look dramatically different from 3-d person pronouns. And they are. One way in which the difference manifests itself is in their respective interpretation rules. For 3-d person pronouns that rule is, we have seen, remarkably complex. It involves in the first place the construction of their reference presuppositions. This is simple enough, but the real problems have to do with how these presuppositions may be resolved. We have gone into some of the complications connected with this, but the result of our deliberations may be summed up by saying that the end was not yet firmly in sight. For the 1-st and 2-nd person pronouns on the other hand the principles governing their interpretation appear to be extremely simple: *I* refers to the speaker of the utterance, *you* refers to its addressee, and that’s it.

• If this is how the semantics of *I* and *you* are stated, however, then they come to look as curious exceptions to what we said was the general semantic pattern common to all definite noun phrases: all of them come with some kind of presupposition to the effect that the referent must be identifiable in independent terms. But the rules for *I* and *you* seem to leave no room for any kind of presupposition.

• Or do they? If we reflect on the matter, we see that ultimately this isn’t really all that clear. Suppose we assume that *I* comes with a reference presupposition, but one that can be resolved only by identifying the referential argument α of the given occurrence of *I* with the producer of the given utterance. Since presumably the occurrence of *I* is
part of an utterance, there must also be a producer of that utterance and we can resolve the presupposition by taking \( \alpha \) to represent that producer. So this is a presupposition that cannot fail: a constraint imposed on the context that no normal context could fail to meet.

With *you* the matter is similar but not quite the same. When you hear a speaker produce an utterance containing the word *you*, then you infer that the speaker must have some addressee in mind; and if that is indeed so, then that person will be the referent of the occurrences of *you* in her utterance. But is this condition invariably fulfilled? Wouldn’t it be possible at least in principle that someone makes an utterance containing *you* without targeting any addressee? And wouldn’t that then be a case where the reference presupposition of *you* fails?

I don’t think so. A speaker who uses *you* without targeting a particular addressee just isn’t using English correctly. Contexts in which that happens are defective because they involve a violation of the conventions of language, much as if an utterance was produced that is ungrammatical beyond reconstruction. Such contexts are excluded from consideration. A speaker who uses *you* in a context that is not excluded must be addressing someone an so the reference presupposition of her use of *you* will be resolvable.

• We set out on this survey of definite noun phrases on the premise that all of them come with reference presuppositions. It would be awkward to have to go back on this commitment now. And as we have just seen, there is no reason to do so. To give an analysis of and that fut he general pattern, we need to have a way of stating what their reference presupposition come to. To this end we introduce two new *indexical* discourse referents sp and ad. Sp represents the utterer of the utterance represent in the DRS in which sp occurs as a constituent These discourse referents are ‘indexical’ in the same way as the discourse referent n, which we have been using to represent the utterance time. As we have been doing in the case of n, we do not place sp and ad overtly in any DRS universe; like n they are part of the household inventory of any DRS that serves to represent an utterance.

These various commitments lead us to the following lexical entries for *I* and *you*.

(31) a. (lexical entry for the pronoun *I*)

\[
I \quad \text{(personal pronoun)} \\
x
\]

Sel Restr: --

Sem. Repr: \(<\{ x \}, > \\
x = \text{sp}
\]

b. (lexical entry for the pronoun *you*)

\[
you \quad \text{(personal pronoun)} \\
x
\]

Sel Restr: --
As argued above neither of these presuppositions can fail and their resolution leads to making the utterer the referent of \( I \) and the addressee (in those cases where there is one) the referent of \( you \).

We end with a very simple example to show how this works. The preliminary representation for the sentence in (32.a) is given in (32.b) and the final representation in (32.c). (32.d) is an obvious simplification of (32.c).

(32)  

a.  

I like you.

b.  

\[
<\{ x, y \}, t, s > \\
x = \text{sp} \\
y = \text{ad} \\
n \subseteq t \\
t \subseteq s \\
s: \text{like}'(x,y)
\]

c.  

\[
<\{ x, y \}, t, s > \\
x = \text{sp} \\
y = \text{ad} \\
n \subseteq t \\
t \subseteq s \\
s: \text{like}'(x,y)
\]

d.  

\[
<\{ x, y \}, t, s > \\
x = \text{sp} \\
y = \text{ad} \\
n \subseteq t \\
t \subseteq s \\
s: \text{like}'(sp,ad)
\]
Before we turn to definite noun phrases there is one more example involving *again* that deserves to be discussed at this point. This example was also mentioned under (7) in the introductory part of this section. (37) repeats it in a form that is best suited for the present discussion.

need not be *recherchées*.

(37)  

a. I’ll come with you to Disneyland tomorrow. But I will never come with you to Disneyland again.
b. I’ll come with you to Disneyland tomorrow. But I will never come with you to Disneyland.

As noted earlier, (37.b) is a plain contradiction: the first sentence asserts that there will be a future event of the subject going to Disneyland, the second sentence denies it. The presence of *again* in the second sentence of (37.a) makes it possible to interpret it in such a way that it doesn’t contradict the first sentence. The question is: How does it do this?

Let us once more resort to our current stopgap routine for dealing with definite DPs. We treat the pronouns *I* and *you* as if they were a kind of proper names and place discourse referents and reference determining conditions for each ‘name’ into the main DRS as soon as the name requires semantic interpretation. We shall take the DRS construction for the first sentence for granted and assume that its DRS is as in (38).

(38)  

\[
\begin{array}{cccccc}
  t_1 & e_1 & t'_1 & j_1 & y_1 & d_1 \\
  n \ < \ t_1 & e_1 \ \subseteq \ t_1 & \text{tomorrow}(t'_1) & \text{speaker}(j_1) & \text{addressee}(y_1) & \text{Disneyland}(d_1) \\
\end{array}
\]

\[e_1 : \text{come-with-to}'(j_1, y_1, d_1)\]

(a) If Dean told the truth, Nixon is guilty too.
(b) If Haldeman is guilty, Nixon is guilty too.
(c) If Miss Woods destroyed the missing tapes, Nixon is guilty too

(5) *again*

(a) I will/won't go to Disneyland ever again.
Presupposes: (i) either I have gone to Disneyland before, 
or I am in Disneyland right now.

(b) I am coming with you to Disneyland tomorrow. But I won't go to Disneyland ever again.

(c) * I am coming with you to Disneyland tomorrow. But I won't go to Disneyland ever.*

Kripke:
(d) If we have pizza on Mary's birthday, we won't have pizza on John's birthday.

(e) If we have pizza on Mary's birthday, we won't have pizza again on John's birthday.
(ii) John believes that he went to the concert.

(iii) There was a unique concert (satisfying some further conditions.)

(iv) There is some particular person called "John" that the speaker is talking about.

(v) The entity referred to by "John" is an "agent" capable of propositional attitudes.
("selectional restriction of "regret")

(b) John knows that Mary is in Paris.

Presupposes: (i) (?)Mary is in Paris.

(ii) There is some particular person called "Mary" that the speaker is talking about.

(iii) There is some particular place called "Paris" that the speaker is talking about.
(2) Change of state verbs.

(a) Mary arrived in Paris last Monday (at 10.30)

Presupposes:  
(i) Mary was not in Paris for some time last Monday (until 10.30).
(ii) There is a particular day that is the referent of "last Monday" (trivial).
(iii) There is some particular person called "Mary" that the speaker is talking about.
(iv) There is some particular place called "Paris" that the speaker is talking about.

(b) Yesterday John killed his guiney pig.

Presupposes:  
(i) John's guinea pig was alive until some time yesterday
(ii) There is a particular day that is the referent of "yesterday" (trivial).
(iii) There is some particular person called "John" that the speaker is talking about.
(iv) There is a unique guinea pig which belonged to John yesterday (possibly satisfying additional conditions)

(3) Aspectual verbs

(a) Last month John stopped smoking

Presupposes:  
(i) Until some time last month John smoked.
(ii) ... I am staying here.

Presupposes:  
(i) I am here now.

(4) too, also, as well, etc.

(d) Nixon is guilty too.

Presupposes:  
(i) Someone other than Nixon is guilty.

Karttunen:

(a) If Dean told the truth, Nixon is guilty too.
(b) If Haldeman is guilty, Nixon is guilty too.
(c) If Miss Woods destroyed the missing tapes, Nixon is
guilty too

(5) again

(a) I will/won't go to Disneyland ever again.

Presupposes: (i) either I have gone to Disneyland before, or I am in Disneyland right now.

(b) I am coming with you to Disneyland tomorrow. But I won't go to Disneyland ever again.

(c) * I am coming with you to Disneyland tomorrow. But I won't go to Disneyland ever.

Conclusion: the reference to the event described in the first sentence of (b) in the verification of the again-presupposition of the second sentence leads to the restriction of the quantifier never to times after that event.

Kripke:

(d) If we have pizza on Mary's birthday, we won't have pizza on John's birthday.

(e) If we have pizza on Mary's birthday, we won't have pizza again on John's birthday.

Conclusion: So as to be able to use the event mentioned in the antecedent in order to justify the again-presupposition in the consequent the interpreter is led to assume that Mary's birthday will be before John's birthday. On this assumption the antecedent event satisfies the again-presupposition

(f) Walter's rabbit is on the loose again.

Here two presupposition triggers:

(i) again and
(ii) the definite description Walter's rabbit.

(We ignore the presupposition associated with Walter.)

These presuppositions interact. The again-presupposition can either be interpreted as saying that there was an earlier occasion when the same rabbit was on the loose, or that there was an earlier occasion when the rabbit was on the loose which John had the time. (That was never found again and so he got a new one, which is on the loose now.)

Similar ambiguities arise in connection with the presuppositions of (g) and (h).

(g) Mary has lost/forgotten her handbag again.

(h) Maria hat ihren Termin/Geldbeutel wieder vergessen. (Kamp 2001)
(6) *since*-clauses and *da*-clauses

(a) We went to the cinema since it was raining.
(a') Since it was raining, we went to the cinema.

(b) Wir sind ins Kino gegangen, da es regnete.
(b') Da es regnete, sind wir ins Kino gegangen.

Presupposition: it was raining/Es regnete..

To see that this is a case of presupposition compare (c), (c') and (d), (d'):

(c) We didn't go to the cinema since it was raining
(c') We didn't go to the cinema because it was raining.

(d) Wir sind nicht ins Kino gegangen, da es regnete.
(d') Wir sind nicht ins Kino gegangen, weil es regnete.

(7) Clefts

(a) It was/wasn't Fred who solved the problem.

Presupposition: Someone solved the problem.
"Positive" Quantifiers (all, most, many, five, at least five, more than five, ..) presuppose that the domain of quantification is non-empty.

(a) All/most/many heirs to the throne were present at the funeral.
(b) Not all/most/many heirs to the throne were present at the funeral.

Question: Is there is similar non-empty domain-presupposition for (i) no/kein; (ii) few/wenige?

Wh-questions: presuppose that the predication they express of the wh-element has instances.

(a) Who has been in the kitchen?

Presupposition: Someone has been in the kitchen.

Question: Is this really a presupposition?

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Presupposition

ESSLLI 2001, Helsinki

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I. Introduction. A VERY brief History.

1. Before Frege & Russell:

i. Awareness of presupposition as a rhetorical phenomenon.

In antiquity: Begging the Question

(First: = Asking a question so designed that any answer to it ("yes" or "no") amounts to admitting what the questioner wants you to admit.

Later: = Deriving a conclusion from premisses which presuppose it.)

Eubulides' Paradox of the Horns:
   Have you lost your horns?

(At issue: Presupposition of the verb *lose.*)
Middle Ages: First(?) signs of awareness of presuppositions of particular words and grammatical constructions:

Peter of Spain: Tantum homo est rationalis.
(Only man is rational.)

Presupposes: Man is rational.
Asserts: Nothing else is.

2. Frege and Russell

Frege: We need, in mathematics and elsewhere, the means of defining things as the unique satisfiers of certain (usually complex) predicates.

In natural language: singular definite descriptions.
In formal logic: The iota operator

Problem: When do we know that such a term properly denotes?

(Since then we have learned that the queston whether a predicate logic formula has a unique satisfier is undecidable.

This renders Frege's problem even more dramatic.)

Frege: Sentences containing such singular terms carry the presupposition that their terms properly denote.

Presupposition associated with the term "The unique x such that f(x)":

(1) (∃x)( f(x) & (∀y) (f(y) → y = x))
Russell: We do not want the problem of possibly non-denoting terms to mess up our logic. The Theory of Descriptions shows us how to avoid this:

- "The King of France is bald." is false if there is no King of France.
- The golden mountain doesn't exist." is true (on one construal) if there is no golden mountain.

Problems for Russell's account of definite descriptions in natural language:

1. Definite descriptions in natural language just don't work this way.
   In particular, consider questions:
   Is the successor of the largest prime divisible by three?

2. Even if the Theory of Descriptions was the right way to handle singular definite descriptions as constituents of formalized languages, it is not at all clear that it correctly captures the attitudes of the speakers of natural languages. Moreover, quite apart from how speakers react to utterances with definite descriptions that fail to denote properly, natural languages involve presuppositions of a great variety of other types, which create very similar problems for logic as descriptions.

Main problem of presuppositions for logic:

1. If P is presupposed by A, then it is as a rule also presupposed by ¬A.
2. If P is presupposed by a A, then P is logically entailed by A.

Conclusion: If logic is classical, then all presuppositions are tautologies.
Interlude: A formal deduction of the conclusion that all presuppositions are logically necessary:

Ass. 0: Presupposition is a relation between sentences.

Ass. 1: \( \text{Pres}(s,p) \rightarrow \text{Pres}(\neg s,p) \)

Ass. 2: \( (\text{Pres}(s,p) \& s) \rightarrow p \)

Ass. 3: \( \text{Pres}(s,p) \rightarrow \Box \text{Pres}(\neg s,p) \)

("Presupposition is a logical relation"; \( \Box \) stands for logical necessity.)

Together with the Law of Excluded Middle Ass.s 1 -3. lead to the conclusion that every presupposition is a logical necessity:

\( \text{Pres}(s,p) \vdash \Box p \)
Derivation:

1. (1) \( \text{Pres}(s,p) \rightarrow \text{Pres}(\neg s,p) \)  
   Ass. 1

2. (2) \( (\text{Pres}(s,p) \& s) \rightarrow p \)  
   Ass. 2

3. (3) \( (\text{Pres}(\neg s,p) \& \neg s) \rightarrow p \)  
   Ass. 2

4. (4) \( \text{Pres}(s,p) \rightarrow \Box \text{Pres}(s,p) \)  
   Ass. 3

5. (5) \( \text{Pres}(s,p) \)  
   Ass.

6. (6) \( s \lor \neg s \)  
   LEM

7. (7) \( s \)  
   Ass.

5, 7. (8) \( \text{Pres}(s,p) \& s \)  
   5, 7, &-Intr.

2, 5, 7. (9) \( p \)  
   2, 8, MP

10. (10) \( \neg s \)  
    Ass.

1, 5. (11) \( \text{Pres}(\neg s,p) \)  
   1, 5, MP

1, 5, 10. (12) \( \text{Pres}(\neg s,p) \& \neg s \)  
   10, 11, &-Ind

1, 3, 5, 10. (13) \( p \)  
   3, 12, MP

1, 2, 3, 5. (14) \( p \)  
   6, 7, 9, 10, 13, v-El

1, 2, 3. (15) \( \text{Pres}(s,p) \rightarrow p \)  
   5, 14, CP

1, 2, 3. (16) \( \Box (\text{Pres}(s,p) \rightarrow p) \)  
   1, 2, 3, 15, Necessitation principle of Modal Logic (using that Ass. 1 and Ass. 2 are logically necessary)

1, 2, 3. (17) \( \Box \text{Pres}(s,p) \rightarrow \Box p \)  
   16, distribution of \( \Box \) over \( \rightarrow \)

1, 2, 3, 4. (18) \( \text{Pres}(s,p) \rightarrow \Box p \)  
   4, 17, Prop. Logic

Note well: 1, 2, 3, 4 are all instances of the Assumptions 1-3. If we want to hold on to these Assumptions and avoid the obviously absurd conclusion that every presupposition is logically necessary, then we need to change our logic. Various escape routes have been suggested.

- One (supposed) way out: go from 2-valued to 3-valued (or >3-valued) logic.

- A second option: switch to partial truth definition. This need not result in giving up classical logic. (We can exclude logical forms/semantic representations that suffer from presupposition failure from the logical process.)

A formal logic with a presupposition operator

1. Syntax

Logical constants

1. (individual) variables: \( v_1, v_2, v_3, .. \) (also: \( x, y, z, .. \))

2. connectives: \( \neg, \& \), \( v, \rightarrow, \leftrightarrow \)

3. quantifiers: \( \forall, \exists \)

4. presup. operator: \( \delta \)

5. identity: \( = \)

Non-logical constants:

n-place predicates \( P^n \) (for \( n = 0,1,2, .. \))
Terms

Term:= the set of variables

Formulas

Form:= \( P^n(Term_1, ..., Term_n) \mid Term_1 = Term_2 \mid \neg Form \mid (Form \lor /\rightarrow /\leftrightarrow Form) \mid (\forall /\exists v_i)Form \mid \delta (\{Form\}, Form) \)

(Here \( \{Form\} \) stands for arbitrary finite sets of formulas.)
Semantics:

We assume the notion of a model for first order logic to be familiar. Models are denoted as "M" or as "<U,F> ".

A context C is a set of models.

For simplicity we limit attention to contexts C in which all models have the same universe:

if <U,F> ∈ C & <U',F'> ∈ C, then U = U'.

This set is then called the universe of C. Notation: U_C.

We define the value of a term t and the truth value of a formula A in a context-model pair <C,M>, where M ∈ C, under an variable-assignment g into the universe of C.

Notation: [[t]]_{C,M,g}, [[A]]_{C,M,g}, respectively.

Terms. [[t]]_{C,M,g} = g(t)
Formulas

1. \([[[P_n(t,\ldots,t_n)]]<_{C,M},g > 1\) iff \([[[t_1]]]<_{C,M},g >, [[t_n]]<_{C,M},g > \in F(p^n)\)

\(0\) iff \([[[t_1]]]<_{C,M},g >, [[t_n]]<_{C,M},g >\) are defined and not \(< [[[t_1]]]<_{C,M},g >, [[t_n]]<_{C,M},g > > \in F(p^n)\)

undefined otherwise

2. \([[[A \& B]]]<_{C,M},g > = 1\) iff \([[[A]]]<_{C,M},g > = 1\) and \([[[B]]]<_{C,M},g > = 1\)

\(0\) iff \([[[A]]]<_{C,M},g > = 0\) or \([[[B]]]<_{C,M},g > = 0\)

undefined otherwise

(Similarly for the other binary connectives.)

3. \([(\forall x)A]<_{C,M},g > = 1\) iff for all \(a \in U_C\) \([[[A]]]<_{C,M},g[a/x] = 1\)

\(0\) iff for some \(a \in U_C\) \([[[A]]]<_{C,M},g[a/x] = 0\)

undefined otherwise

(Similarly for \(\exists\))

4. \([\delta(G,A)]<_{C,M},g > = 1\) iff for all \(B \in G\) and all \(M' \in C\), \([[[B]]]<_{C,M'},g > = 1\)

and \([[[A]]]<_{C,M'},g > = 1\)

\(0\) iff for all \(B \in G\) and all \(M' \in C\), \([[[B]]]<_{C,M'},g > = 1\)

\([[[A]]]<_{C,M'},g > = 0\)

undefined otherwise.

When for all \(M \in C\), \([[[A]]]<_{C,M},g > = 1\) or \([[[A]]]<_{C,M},g > = 0\), then we say that \(A\) is defined throughout \(C\) (under \(g\)). Notation: \(C \models_{(g)} A\).

If \(C \models_{(g)} A\), we can form the update of \(C\) with \(A\) (under \(g\)), \(C +_{(g)} A\).

For the system defined above ‘\(C +_{(g)} A\)’ can be defined as:

\(C +_{(g)} A = \{M \in C: [[[A]]]<_{C,M},g > = 1\}\)

Logical consequence:
G |= A iff for all pairs <C,M>: if for all B ∈ G. [[B]]_{C,M} = 1, then [[A]]_{C,M} = 1.

(Other definitions of "|=" are also possible; partial truth definitions generally leave scope for a number of non-equivalent definitions of logical consequence.)

**Question:** What is an axiomatization of this logic?
Additions:

1. Dynamic connectives, for instance ; and ⇒. Model-theoretic clauses:

5. \[[A;B]\]<_{C,M,g} =
   \begin{align*}
   1 & \quad \text{iff } C \supset (g) A, [A]<_{C,M,g} = 1, C' \supset (g) B, \text{ and } [B]<_{C',M,g} = 1, \text{ where } C' = C + (g) A; \\
   0 & \quad \text{iff } C \supset (g) A \text{ and (either } [A]<_{C,M,g} = 0 \text{ or } C' \supset (g) B \text{ and } [B]<_{C',M,g} = 0, \text{ where } C' = C + (g) A; \\
   \text{undefined otherwise.}
   \end{align*}

6. \[[A\Rightarrow B]\]<_{C,M,g} =
   \begin{align*}
   1 & \quad \text{iff } C \supset (g) A \text{ and (either } [A]<_{C,M,g} = 0 \text{ or } C' \supset (g) B \text{ and } [B]<_{C',M,g} = 1, \text{ where } C' = C + (g) A; \\
   0 & \quad \text{iff } C \supset (g) A, [A]<_{C,M,g} = 1, C' \supset (g) B, \text{ and } [B]<_{C',M,g} = 0, \text{ where } C' = C + (g) A; \\
   \text{undefined otherwise.}
   \end{align*}

Logical consequence can be defined as before. Again the question of axiomatization appears to be open.
2. The "iota" operator:

**Syntax:** If A is a formula and v a variable, then (iv)A is a term.

**Semantics:**

7. \[(ivj)A\] \[\text{iff} \quad \text{a is the unique } b \in U \text{ such that } [A] \text{ is equal to 1;}
\]

\[\text{undefined otherwise}\]

**Def.** A proper formula A of the new system is one such that:

- each atomic subformula ‘P\(n(t_1,...,t_n)\)’ or ‘\(t_1 = t_n\)’ of A is part of a larger subformula \(\delta(G, P^n(t_1,...,t_n))\) or \(\delta(G, t_1 = t_n)\) of A, where G contains for each term \(t_k\) in the given subformula that is of the form (iv)B, a formula of the following form:

\[(\exists x)(B(x) \& (\forall y)(B(y) \rightarrow y = x))\]

It is now natural to restrict the question of logical consequence to proper formulas:

**Question:** What is an axiomatization of the relation \(G \models A\), where A and the members of G are proper formulas of the new system.
The presented system and the logical questions it raises come closer to our own understanding of how presupposition works in natural language.

But it doesn’t get there completely, as it leaves out the issue of accommodation.

Our general picture is the following:

1. Interpret an utterance in context.

2. If not all its presuppositions are satisfied in the context as is, try to accommodate the context so that the presuppositions are satisfied.

3. If this is not possible, then interpretation aborts, and the question what is entailed by the utterance, or what it is entailed by its negation, is moot and need not be answered.

4. If an interpretation does succeed (with or without accommodation), then all further matters of entailment concerning it can be handled in classical two-valued logic.

More generally, our theory of presupposition is based, following Van Der Sandt (1992), on the following fundamental assumption:

**Utterance interpretation proceeds in two stages:**

1. The construction of a preliminary semantic representation of the uttered expression.

   This step is based only on the syntactic structure of the sentence and lexical information.

   In the preliminary representation all presuppositions generated by presupposition triggers in the uttered expression are explicitly represented and their representations inserted into the preliminary representation (at places corresponding to the occurrences of their triggers in the represented sentence).

2. The preliminary representation is integrated into the given context.

   This process involves justifying all presuppositions represented in the preliminary representation, using accommodation when that is necessary and permissible.

The result is an update of the (possibly accommodated) context with the non-presuppositional content of the preliminary representation.
Beaver, D. *Presupposition and Assertion in Dynamic Semantics*, CSLI, 2001


(Translation by M. Black in: Geach, P., and Black, M. (eds. and trans.), *Translations from the Philosophical Writings of Gottlob Frege*; Blackwell, 1952)


(Reprinted in S. Davis (ed.) *Pragmatics*, Oxford University Press, 1991)


Kiparsky, P. and C. Kiparsky. „Fact“ In: D. D. Steinberg


A salient point that emerged in our first discussion of tense and aspect is that an important role of the tenses is to connect the eventualities ev introduced by the verbs to which they attach temporally to the antecedent discourse.

But as we saw in connection with example (1) ((4) in our introduction to tense and aspect), the way in which the eventuality ev gets connected with a time or event of the antecedent discourse differs depending on whether ev is an event or a state.

(1) When Alan opened his eyes he saw his wife who was standing by his bedside.
   (i) She smiled
   (ii) She was smiling.

The state of (1.ii), it was suggested, gets interpreted as holding at the time of the event e1 described by the first sentence, because its location time is interpreted as anaphoric to e1 (or to its location time t1; so far we had no way to decide between these two options).

The way in which the event e2 of (1.i) gets temporally connected to e1 is, we saw, different and also more complicated. There are various possibilities in cases of this type, of which the one that is suggested by (1.i) – e2 follows e1 – is only one. The different options are illustrated by the three continuations in Webber’s example (2) (our earlier example (3)): e2 can be understood as preceding e1 (3.b), included within it (3.c), or following it (3.a). To determine which of these relations applies we have to rely on non-grammatical information – rhetorical relations and ultimately, to determine these, world knowledge.

(2) a. Fred went to Rosie for dinner. He came home in a state of euphoria.
   b. Fred went to Rosie for dinner. He put on clean trousers and his nicest shirt.
   c. Fred went to Rosie for dinner. He bought flowers on the way.
   (Webber)

One account of these different temporal relations, we noted earlier, relies heavily on the requirement imposed on the interpreter of a coherent piece of discourse to establish rhetorical relations between the successive clauses and sentences of a discourse. How these relations get established is one thing; but once such a relation has been established, the temporal relation usually follows, as one aspect of it.

On such an account there is no need to assume that the tenses of the second sentences in (3.a-c) are anaphoric in the sense that the location times they introduce must be resolved to some other time represented in the discourse context. An alternative option might be to assume that in cases where the eventuality described by the new sentence is an event the new location time is anaphoric as well, but that it can be resolved to a period of time large enough to include both the previous event and the new event. The rhetorical relation between the new sentence and its predecessor can then be used to infer additional information about the temporal relation between the two events that are both included within this time.

I do not know of decisive evidence that would decide this question. But the example in
John proved the theorem in twenty lines. Mary proved it in ten lines.

One point demonstrated by (3) is the importance of rhetorical relations for event location. Insofar as the sentences in (3) are connected by any kind of rhetorical relation at all, it is one of comparison between the achievement of John and that of Mary: Mary’s proof was only half as long as John’s. Sometimes this relation is classified as (some form of) ‘parallelism’. This relation implies nothing about the order in which the two events occurred. Moreover, it doesn’t tell us anything about how close to each other the events were in time. And that means that for the present case the assumption that the location time of the second event is in some way anaphoric to the first event or its location time, but must be large enough to contain both events becomes vacuous: All that we know about the two events is that they were both in the past, and that is what is conveyed by their respective tenses in any case.

We will therefore adopt the first of the two options. As we will see, this fits well within the more comprehensive account of tense we are about to present.

• A crucial ingredient to that more comprehensive account is the analysis of compound tenses like the past perfect. Consider the two-sentence discourse in (4), our earlier (2.a).

John proved the theorem in twenty lines. Mary had proved it in ten lines.

In contrast to (3), (4) makes the temporal relation between the two events perfectly clear: Mary’s coming up with her proof was before the time when John came up with his. The reason, evidently, must have to do with the tense in the second sentence. In (4) this is the past perfect, as opposed to the simple past in the second sentence of (3).

• It was in essence this observation of the way in which the past perfect locates its eventualities – as preceding some time that is itself in the past and that is in some way salient in the discourse – which led Reichenbach to his famous 2-dimensional theory of tense (Reichenbach, 1947).

Reichenbach saw that the past perfect is “2-dimensional” in the following sense: Its interpretation involves two temporal relations, one between the event time E and the “reference time” R and one between the reference time R and the speech time S. In the case of the past perfect both of these relations are “past”:

Reichenbach’s analysis of the past perfect:

\[ E \text{ is in the past of } R \quad (E < R) \text{ and } R \text{ is in the last of } S \quad (R < S). \]

Reichenbach proceeded to analyze all tenses of English in such terms. (Some other parts of his proposal: (i) the simple present tense is given by the pair of relations \( <E = R, R = S> \) - that is, the reference time coincides with the speech time and the event time with the reference time; (ii) the simple present tense is given by the pair \( <E = R, R < S> \); (iii) the simple future tense is given by the pair \( <E < R, R = S> \). Quite a number of the 2-dimensional analyses that Reichenbach offers for particular tense forms have been controversial for a long time; and given all we now know about...
the tenses of languages like English, some are hard to defend. But Reichenbach’s observation about the “2-dimensional” character of the past perfect and some other tenses is as valid and important today as it was when he made it.

• One aspect of Reichenbach’s insight into the functioning of the past perfect – this is clear from the examples he cites as well as from his terse discussion of them, though it is not an explicit part of his 2-dimensional theory of tense – is that the past perfect has an anaphoric element. The Speech time is fixed by the utterance context. (In verbal communication it is the time at which the utterance is made; for written texts the matter is more complicated, but for present purposes the idea of S as the time at which the utterance is produced and received will do well enough.) The Reference time on the other hand, has to be retrieved somehow from the context, and often, as in (4), the relevant context is the discourse context. In those cases the interpretation of the past perfect is anaphoric, in that the discourse context must provide an anaphoric antecedent for the Reference time that the interpretation of it must come up with.

• Reichenbach uses the term “Reference time” for two different purposes. One of them is illustrated by the Role of R in his statement of the semantics of the past perfect. A second use is illustrated by what he has to say about examples like (1.i) and (5) below. (1.i), we saw, conveys that the smiling event e_2 followed the event e_1 of Alan opening his eyes. That shows, one might want to say, that in some intuitive sense the duration time of e_1 serves as ‘referent time’ for the interpretation of the second sentence. But on the account we have indicated of how that works the reference time plays a very different part in it than does – again given the account we have proposed – in the interpretation of (1.ii).

• Often interpretations of successive past tense sentences do not come on their own but as part of longer sequences of such sentences. An example is given in (6).

(6) Bill got up at six thirty. He cooked himself a full breakfast, and washed up after finishing it. He left the house in time to catch the 7.54 train at the central station.

Here there are four successive simple pasts which describe events e_1, e_2, e_3 and e_4, such that e_1 < e_2 < e_3 < e_4, where each precedence relation results from interpreting the clause of the event on the right as related to the clause of the event to the left in the sense of Narration. In the same spirit as above we might say that here too each of the first three clauses provides a ‘reference time’ for the interpretation of the next clause. But again, that skims over the very different way in which these temporal relations are established as compared with the inclusion relation of (1.ii).

The different functions come into sharper focus when we consider extended flashbacks like that in (7).

(7) Bill arrived at noon. He had got up at six thirty, had cooked himself a full breakfast, and had washed up after finishing it. He had left the house in time to catch the 7.54 train at the central station.

All sentences in (7) except for the first are in the past perfect. And the succession of these sentences exactly mimics the sequence in (6): In either case each pair of successive past tense clauses is related by Narration and hence the second event is
understood as coming after the first. In that sense each of the earlier events plays as much a role of ‘reference time’ in (7) as it does in (6). But at the same time each of the clauses is in the past perfect and so requires a “reference time” as part of the interpretation of its tense. It is obvious that for each of the past perfects in (7) this “reference time” is the time of the event of Bill arriving, described by the simple past sentence with which (7) begins.

• In earlier work ((Kamp & Rohrer, 1986), (Kamp & Reyle, 1993)) we took this evidence to show that Reichenbach’s use of the notion of ‘reference time’ suffers from overload and we wanted to guard against that by renaming one of what we saw then and see now as two distinct roles in two radically different interpretational strategies. To this end we introduced a new term - “Temporal Perspective Time” (in short “TP time”); also sometimes “TP-point” or “TPpt”) for the role that Reichenbach’s Reference time plays in the analysis of the past perfect (and of other tenses, see below)

In the light of what we have been saying about cases like (1.i), (3) and (6) it no longer seems clear to me that these cases involve a notion of “reference time” at all. What drives interpretation in these cases, we have argued, are rhetorical relations and those are temporal relations at best in a derivative sense.

If we abandon the use of ‘reference times’ in connection with those cases, then we might as well retain the term for the use that we make of Reichenbach’s notion here. If I stick to the term ‘TP-time’ here nevertheless, then that is only to be faithful to an earlier self.

• Lexical Entries for Tenses
In our first exploration of tense and aspect we described the rules for the interpretation of tenses in a purely algorithmic way, as instructions to temporally locate the referential arguments of the representation of the sister node of T in a particular way. Since then we have had a closer look at the lexical entries for a number of expressions. In the light of that experience we return to the three tenses discussed so far – the simple past, the simple present and the simple future – before we turn to the past perfect.

• We have treated adjuncts – among them temporal adverbials like yesterday, on Wednesday, on the first of January 1900 and so on – as operating on the representations of their adjunction sites via unification of their referential arguments with those of the adjunction site representations. This is nothing but the predicate modification operation of Heim and Kratzer. This is an operation that interprets a number of different syntactic configurations, of which adjunction (of the kind we have so far encountered is only one. Another one is the configuration of a head noun and a complement of it, e.g. a relative clause.

The operation which incorporates the information provided by tense can be treated as an instance of this too. For instance, suppose that we adopt (8) as lexical entry of the past tense as it applies to event representations.

(8) lexical entry for the simple past tense as applying to event representations
Lexical insertion of the semantic representation of past for a particular occurrence of the feature ‘past’ is subject to the by now familiar principle that a new discourse referent is to be chosen for the referential argument e, which replaces e in the semantic representation of past and is also put into store. Thus, to take a very simple example, assuming (9.b) as the syntactic representation of (9.a), we get as semantic representations for T and its sister VP the representations shown in (9.c).

(9)  
\begin{align*}
\text{a.} & \quad \text{Mary arrived.} \\
\text{b.} & \quad S \\
\ & \quad \text{Comp} \quad \text{TP} \\
\ & \quad \emptyset \quad \text{DP}_1 \quad T' \\
\ & \quad Mary \quad T \quad VP \\
\ & \quad t < n \quad e: \text{arrive}(x_1) \quad > \\
\ & \quad e' \subseteq t \\
\end{align*}

Combining these two representations via unification amounts to identifying e’ with e, with the familiar outcome in (10) for the representation of T’:

(10) \[ T' \Rightarrow <e| > \]
\[ t < n \]
\[ e \subseteq t \]
\[ e: \text{arrive}(x_1) \]

Note that this unification is possible only because the two referential arguments satisfy
the same selection restriction. (Both are events.)

• The entry in (8) is only for ‘past’ as it applies to event representations (i.e. representations whose referential argument is an event). The application of ‘past’ to state representations would require a separate entry, as in (11).

(11) lexical entry for the simple past tense as applying to state representations (preliminary)

\begin{align*}
\text{past}_{(\text{state})} & \quad (\text{tense feature}) \\
& \quad s
\end{align*}

Sel Restr: \quad \text{state}

Sem Repr:

\begin{align*}
t < n \\
t \subseteq s
\end{align*}

• Having two separate entries for the past tense as it applies to events and as it applies to states is clearly not optimal. But how can we reduce them to a single one?

In order to unify the entries for $\text{past}_{(\text{event})}$ and $\text{past}_{(\text{state})}$ we make use of a special underspecification device that was introduced to be able to represent local ambiguities, especially within the lexicon (Reyle, Rossdeutscher and Kamp, 2008). It involves the ‘ambiguity operator’ $\!//$. $\!//$ is like the disjunction operator of DRT in that it forms a complex DRS condition out of two DRSs $K_1$ and $K_2$. But ‘$K_1 \!// K_2$’ is not a DRS condition of the by now familiar kind. It does not contribute its truth (= verification) conditions to a completed DRS, which has well-defined truth conditions as it is. Rather, a condition of the form ‘$K_1 \!// K_2$’ is to be understood as coming with the instruction to resolve it in favor of one of its ‘disjuncts’. Thus, a representation which contains such a condition is ipso facto not a completed DRS. To turn it into one, the condition should first be resolved.

With the help of $\!//$ we can unify (8) and (11) into the single entry given in (12).

(12) lexical entry for the simple past tense (preliminary)

\begin{align*}
\text{past} & \quad (\text{tense feature}) \\
\quad & \quad \text{ev}
\end{align*}

Sel Restr: \quad --

Sem Repr:

\begin{align*}
t < n \\
\text{event(ev)} \quad \!// & \quad \text{state(ev)} \\
\text{ev} \subseteq t & \quad t \subseteq \text{ev}
\end{align*}

Insertion of the semantic representation of (12) into (9.b) gives the representation in
Resolution of the \(!/\) condition in (13) is now a matter of *coercion*: Since ev must unify with e and e satisfies the predicate ‘event’ ev must too. That rules out the right hand side DRS of the \(!/-\)condition in (13), leaving the left hand side one. Unification of the left hand side of the \(!/-\)condition with the VP representation then of course leads to the same representation for T’ as before, see (10).

- An entry for the simple future tense can be given along the same lines as (12). For the simple present tense – that is, that ‘standard’ use of the present tense that we are focusing on here – the matter is different, and simpler. This tense exclusively selects state representations as complements. Its entry, therefore does not involve a \(!/-\) condition. The entries for simple future and standard simple present are given in (14) and (15).

(14) lexical entry for the simple future tense (preliminary)

future (tense feature)

\[\text{ev} \]

Sel Restr: --

Sem Repr:

\[\text{t} \]

\[\text{n} < \text{t} \]

\[\text{event(ev)} \ \text{\(!\)} \ \text{state(ev)} \]

\[\text{ev} \subseteq \text{t} \quad \text{t} \subseteq \text{ev} \]

(15) lexical entry for the simple present tense (preliminary)

\[\text{t} \]

\[\text{n} < \text{t} \]

\[\text{event(ev)} \ \text{\(!\)} \ \text{state(ev)} \]

\[\text{ev} \subseteq \text{t} \quad \text{t} \subseteq \text{ev} \]
We now turn to the past perfect.

Our discussion of the past perfect has revealed that its semantics has both a presuppositional and an indexical aspect: The past perfect comes with a presupposition that requires identification of a TP-time, but the constraint imposed on this time - viz. that be situated in the past – involves an indexical element: the TP-time must be before n. (In this regard the past perfect is indexical in much the same way as the simple tenses whose entries have just been presented.)

A lexical entry for the past perfect along the lines of the tense entries above is given in (16).

(16) past prefect (tense feature) ev
Sel Restr: --
Sem Repr:  \[
\begin{tabular}{ll}
\text{tp} < n & t < \text{tp} \\
\langle \text{event(ev)} \rangle & \text{state(ev)} \\
\text{ev} \subseteq t & t \subseteq \text{ev}
\end{tabular}
\]

As an illustration of the use of (16) consider the two sentence discourse in (17).

(17) Mary arrived at noon. She had left at seven.

We can assume that the DRS for the first sentence is as in (18.a). The syntactic structure of the second sentence, with the semantics of the verb already inserted and passed on to the VP node, may be assumed to be as in (18.b).

(18) a. \[
\begin{tabular}{llllll}
{t_1} & e_1 & m & t’_1 \\
\text{t}_1 < n & e_1 \subseteq \text{t}_1 & \text{Mary(m)} & \text{noon’(t’}_1) \\
e_1 \subseteq t’_1 & & & & & \\
e_1; \text{arrive(m)}
\end{tabular}
\]
b.  

\[
\begin{align*}
S &  \\
\text{Comp} & \quad TP \\
\emptyset & \quad TP \quad PP \\
DP_1 & \quad T' \quad P \quad DP \\
She & \quad T \quad VP \quad \text{at} \quad seven \\
\end{align*}
\]

\[
\begin{align*}
\text{past} & \quad < e_2 | e_2: \text{leave}(x_1) > \\
\text{perf} & \\
\end{align*}
\]

Insertion of the semantics for ‘past perf’ turns (18.b) into (19).

\[
(19)
\begin{align*}
S &  \\
\text{Comp} & \quad TP \\
\emptyset & \quad TP \quad PP \\
DP_1 & \quad T' \quad P \quad DP \\
She & \quad T \quad VP \quad \text{at} \quad seven \\
\end{align*}
\]

\[
\begin{align*}
< e_2 | e_2: \text{leave}'(x_1) >
\end{align*}
\]

\[
\begin{align*}
t_1 < \text{tp} & \quad \{ \}
\end{align*}
\]

\[
\begin{align*}
t_2 < \text{tp} & \quad >>
\end{align*}
\]

\[
\begin{align*}
\text{event(ev)} & \quad \lor/ \quad \text{state(ev)} \\
\text{ev} \subseteq t_2 & \quad t_2 \subseteq \text{ev}
\end{align*}
\]

Again unification of the T-representation with the VP-representation leads to elimination of the right hand side of the \lor/-condition, so that the T’-representation now becomes that in (20).
The remaining construction steps then lead to the preliminary representation of the second sentence given in (21), in which the presupposition triggered by the definite DPs *she* and *seven* have been represented explicitly as well. After resolution of these the representation reduces to that in (22), in which only the presupposition of the past perfect remains to be resolved.

The remaining tp-presupposition can be resolved in the discourse context provided by (18.a): the obvious antecedent for tp is the discourse referent \( t_1 \). Resolution of tp to \( t_1 \) and merge of the now presupposition-free DRS with (18.a) yields the DRS in (23).
Which tenses are ‘2-dimensional’?

There is at least one tense for which a 2-dimensional analysis seems as plausible as it is for the past perfect. This is the ‘future of the past’, exemplified in (24).

(24) Kissinger arrived in Cairo on the seventh. He had set off from Washington the day before. He would travel on to Jerusalem on the ninth/in two days.

There is an important similarity between the function of the tense form would travel in the third sentence and that of the past perfect in the second. Both locate the eventuality described by the verb they modify in relation to some time which itself is in the past of the utterance time – here: the time of Kissinger’s arrival in Cairo introduced in the first sentence. The difference between the two forms is that the future of the past would travel locates its eventuality in the future of that time, whereas the past perfect locates it in the past of that time.

This suggests that the entry for the future of the past should, in close analogy with that for the past perfect, be as in (25).

(25) future of the past (tense feature)
    ev

Sel Restr: --

Sem Repr:    < { },  t<tp  t<tp

event(ev)     state(ev)
    ev<=t          t<=ev

Exercise: Construct a DRS K for the first sentence of (24) and then, use the entries in (16) and (25) to construct preliminary representations for the second and the third sentence. Show that resolution of the tense (and other) presuppositions using K leads to a DRS for the 3-sentence discourse that correctly captures the truth conditions of (24).
The future of the past appears to be the only tense besides the past perfect for which a strong case can be made for a two-dimensional anaphoric analysis of the kind we have proposed.

But there are some other tenses which suggest a 2-dimensional analysis for other reasons (which, however, are quite closely connected with those that speak in favour of a 2-dimensional analysis of past perfect and future of the past).

Furthermore, for those tenses on which these arguments have no purchase it is nevertheless possible that they too can be given a 2-dimensional analysis, even if in their case a 1-dimensional analysis would have done as well.

We already encountered an example of a tense of the first of these two types. This was the past tense of the sentence ‘She was smiling’ in (1.ii). We treated this sentence as involving an anaphoric relation between its temporal location time and the location time of the first sentence. In the light of what we have said about past perfect and future of the past we can reinterpret that analysis now as a 2-dimensional one: Like the past perfect and the future of the past, the past tense of (1.ii) carries a presuppositional requirement for a past TP-time. It differs from the tenses for which a 2-dimensional has already been adopted in that the eventuality is located at the TP-time, and not before or after it.

With the requirement that the eventuality be located at the TP time, and not before or after it, comes an aspectual restriction: the eventuality must have imperfective aspect (i.e., in our account it must be a state rather than an event). This is why the analysis we proposed for (1.ii) is appropriate to the progressive (and thus imperfective) aspect of (1.ii), but not to the perfective aspect of (1.i).

This aspectual restriction on an interpretation of the past tense is congruent with what we have noted in connection with the present tense and at the same time it provides justification for the term ‘Temporal Perspective time’. What we have called the standard use of the present tense is restricted to describing what is going on at the utterance time. This is what requires the use of the present progressive of accomplishment phrases like eat an apple: Except for the special uses of the present we decided to set aside, ‘John eats an apple’ is strange, we noted, and may identify the speaker as non-native. The correct form is ‘John is eating an apple’.

The choice of a past TP time can be seen as entailing a shift into the past of the ‘present tense’ perspective that we normally associate with the utterance time. Put in terms closer to the terminology we have been using already: the Temporal Perspective, which is normally located at the utterance time, can under certain conditions be shifted to the past. 2-dimensional tenses that require the choice of a past Temporal Perspective force such a shift. And if in addition the TP-shifting tense requires that the described eventuality hold at this shifted perspective time, then that requirement imposes on the described eventuality the same aspectual restriction that we also find with the present tense which also requires that the eventuality hold at the perspective time, but does not shift it. In either case locating the eventuality at the perspective time signals the ‘internal viewpoint (Smith, 1991), which presents eventualities from within - as the things that hold or are going on at the time from which they are seen and presented. It is this consideration which motivates the term ‘Temporal Perspective Time’ as a replacement for Reichenbach’s ‘Reference Time’.
Additional evidence for an interpretation of the past tense as shifting the temporal perspective into the past and locating the described eventuality at that past TP time is the fact that it can combine with the word *now*. Consider the examples in (26).

(26) a. Alan went straight to his bedroom and plunged himself down on his bed. He had rarely been as tired as he was now.

b. We were sitting around the table talking the situation over once more. We realized that now was the time to come to a decision/that we had to reach a decision now or never.

Evidently, *now* in (26) refers to the past time introduced by the first sentence of (26), at which Alan went to his bedroom and plunged down on his bed. Likewise for the occurrences of *now* in (26.b).

Occurrences of *now* that refer to times in the past provide additional evidence that the tenses of the clauses containing them involve a past shift of Temporal Perspective. The argument is as follows:

1. Temporal locating adverbs serve to locate the eventualities described by the clauses of which they are part - or, in the more specific account we have adopted, the eventualities that are the referential arguments of the phrases to which they are adjoined. *now* appears to be a temporal locating adverb in this sense.

2. When *now* occurs together with the present tense, as in the sentences in (27), it refers to the utterance time n, or perhaps to some period of time including it. (This is the reason why in philosophical discussions *now* is often classified as an indexical, which always picks out a component of the utterance context, viz. the utterance time (Kaplan, 1970, 1989). The examples in (26) show that this cannot be the whole story. But there is enough to it for people to hold on it to this day.)

(27) a. John lives in Austin now.

b. Now she is spending time with her grandchildren.

c. We are now in the process of trying to find out what went wrong.

d. Now is the time to come to a decision.

When *now* occurs in conjunction with a standard use of the present tense, the present tense will locate the described eventuality as temporally including n. This is what *now* does as well, so from the point of temporal location it is strictly speaking redundant. Its function is rather one of emphasis, e.g. to highlight a contrast with other times.

A further feature of *now* in the sentences in (27) is that the eventualities it locates are all states (eventualities with the asp feature ‘- perfective’). This is not surprising, and it arguably not the effect of a selection restriction imposed by now, for, as noted earlier, standard uses of the present tense without *now* are subject to the same restriction. But the fact should nevertheless be kept in mind.
3. The sentences in (26) obey the same aspectual restriction as those in (26). And that is not just an accidental feature of those particular examples. Recall our earlier discourse (6).

(6) Bill got up at six thirty. He cooked himself a full breakfast, and washed up after finishing it. He left the house in time to catch the 7.54 train at the central station.

We can, if we want, insert the word then at the beginning of one of the sentences of (6), as in (28.a). But inserting the word now in the same position, as in (28.b), produces a strongly marked - not to say quaint - effect. The insertion improves considerably, however, when the AspP of the sentence is changed into a (- perf.) one – i.e. into the description of a state -, as in (28.c).

(28) a. Bill got up at six thirty. He cooked himself a full breakfast, and washed up after finishing it. Then he left the house, in time to catch the 7.54 train at the central station.

b. Bill got up at six thirty. He cooked himself a full breakfast, and washed up after finishing it. Now he left the house, in time to catch the 7.54 train at the central station.

c. Bill got up at six thirty. He cooked himself a full breakfast, and washed up after finishing it. Now the time had come/was the time for him to leave the house in order to catch the 7.54 train at the central station.

Contrasting data like those in (28.b) and (28.c) show that past tense sentences with now show the same preference for states over events that we find in standard uses of the present tense (with or without now).

4. If at all possible, now should be ascribed a uniform semantics, which accounts for what now does both when it occurs together with a present tense and when it occurs together with a past tense.

The use we have already made of TP times and our earlier analysis of the past tense of (1.ii) give us a way to do this: now always refers to the TP time. The TP time is sometimes shifted towards the past – that is what we see in (26) and in (28.c) – but unless it is forced to do so, it will be identified with the utterance time and that is what we see when now combines with the present tense.

This suggestion leads to the lexical entry for now given in (29). It is assumed in (29) that the word class of now is the class of indexicals. Indexicals are words that behave syntactically like pronouns and proper names – all are capable of forming DPs all on their own. Adverbial occurrences of now, of which almost all of the occurrences in the examples above are instances, are to be construed as PPs with a tacit presupposition, just as we have assumed for adverbials like tomorrow or last Wednesday.

The entry is in accordance with our general principle that definite noun phrases come with a reference presupposition. However, as with the indexical pronouns I and you, this presupposition will always be resolvable.
(29) (lexical entry for the word *now*)

\[
\text{now (indexical)} \\
t \\
\text{Sel Restr:} \quad ---
\]

\[
\text{Sem Repr:} \quad \{ \quad t = \text{tp} \quad \}
\]

N. B. A comment is wanted on the use of the discourse referent ‘tp’. The first us we made of ‘tp’ was in the lexical entries (16) and (25). There it represents the TP time that is required for the interpretation of those tenses. This is also what ‘tp’ stands for in (29). However, when we build representations for input involving more than one tensed clause, different TP-times will in general be needed for the different tenses that occur in those clauses. To deal with such cases we make use of a potential infinity of discourse referents of this general shape: tp, tp’, tp”, .., tp\textsubscript{1}, ..

5. Representing the semantics of *now* as in (29) carries with it two further commitments.

First, occurrences of the past tense that are accompanied by now must be analysed along the lines of our analysis of (1.ii). The entry for this use of the past tense is given in (30)

(30) (lexical entry for the simple past (in one use of its uses))

\[
\text{simple past (tense feature)} \\
ev
\]

\[
\text{Sel Restr:} \quad \text{state}
\]

\[
\text{Sem Repr:} \quad \{ \quad \text{tp} \subseteq \text{ev} \quad \}
\]

Second, on the present account the present tense is one which does not require a shift of the Tp time. In the light of what has been said about the ways in which the different tenses function it now seems natural to build the information that the present tense does not shift the TP-time into its lexical entry. So we replace our earlier entry (15) by the one in (31).
(31) (lexical entry for the standard use of the present tense)

\[ \text{pres (tense feature)} \]
\[ \text{ev} \]

Sel Restr: state

Sem Repr: \[
\begin{align*}
\text{tp} & \subseteq \text{ev} \\
\text{tp} = n & \quad t = \text{tp}
\end{align*}
\]

Note that this entry gives the present tense a 2-dimensional analysis: the TP time \( \text{tp} \) coincides with the utterance time and the location time \( t \) with the TP time. In Reichenbachian notation: \( R = S, E = R \).

Our new entry (31) for the present tense incorporates it into the family of 2-dimensional tenses. What can we say, in the light of this move, about the remaining tenses?

First a general remark. Now that we have allowed the present tense to qualify as a 2-dimensional tense, but one which designates the utterance time \( n \) itself as the TP time, all other tenses that keep the TP time at \( n \) can be classified as (at least) 2-dimensional as well. Let us resolve to do this, as this will give us a more uniform account of the semantics of the English tense system over-all. Since, according to the present conception, all tenses locate their eventualities in relation to their TP times, this makes all of them at least 3-dimensional. So the question whether all tenses are 2-dimensional now becomes the question: “Are none of them more than 2-dimensional?”

The answer to that question is not completely obvious. In fact, suggestions that there are also 3-dimensional tenses have been made. One example, suggested in the early days when Tense Logic was thought to provide a viable logical form language for tensed sentences of natural language, is “will have been going to”, as one finds it in a sentence like (32).

(32) At that point he will have been going to hand in his book ms. for more than a year.

“will have been going to \( \varphi \)” arguably amounts to there being a time \( t \) in the future of \( n \) such that there is some time \( t’ \) before \( t \) such that there is a time \( t’’ \) after \( t’ \) such that \( \varphi \), (Prior once suggested this to me somewhere between ’65 and ’68, in the days where tense logic was thought to be the right formalism for dealing with temporal reference in natural language. I do not recall whether the remark occurs somewhere in his writings.) By our reckoning, however, “will have been going to” is not a tense. It is a compound expression involving apart from its finite tense also the perfect and the ‘progressive prospective’ “be going to”. The latter two are more naturally analysed as aspect operators, since they can freely combine with different tenses; and that is how we will treat them. In fact, on such an analysis the only tense involved in “will have been going to \( \varphi \)” is the simple future tense. According to the account adopted here this is one of the tenses which leave TP time at \( n \) and thus could also have been analysed as just one-dimensional (see (14)).
Once we analyse complex expressions like “will have been going to $\varphi$” as combinations of tenses and aspect operators there is no need to assume tenses with more than two dimensions. At least this is so for English, and it appears to be true for a range of other languages as well. However, there are no principled reasons that I can see why there couldn’t be natural languages with more complex tense morphology than is found in English, which includes tense forms whose semantics requires more than two dimensions. So the claim that the tenses found in natural languages generally involve no more than two dimensions should be considered as an empirical hypothesis.

- The English tenses that remain to be discussed can be divided into three groups:

  1. Uses of the simple past tense that are not covered by (30).
  2. Future tenses (other than the future of the past, which has already been dealt with).
  3. Perfects other than the past perfect.

1. Simple pasts.

Many of our examples contained event sentences in the simple past tense. According to the commitments we have made, the past tenses of such sentences cannot be analysed as instances of the entry in (30). For as we saw, the coincidence of the location time with the TP time requires stative aspect. Event sentences do not have this aspect feature – they are sentences in which AspP has the feature (+ perfective), and the referential argument of its semantic representation of AspP is therefore an event, and not a state. So, given the commitments we have made, we are forced to assume that these tenses do not involve coincidence of location time and TP time.

The natural alternative is that the simple pasts of such sentences leave the TP time at the utterance time and locate the event in the past of it. This alternative interpretation of simple past tense morphology is given in entry (33).

(33) (lexical entry for the simple past (second type of use); preliminary)

\[
\text{simple past (tense feature)} \\
\text{ev}
\]

Sel Restr: \text{event}

Sem Repr: \begin{align*}
\text{tp} & \in \{ \} \\
\text{tp} & = n \\
\text{t} & < \text{tp} \\
\text{ev} & \subseteq \text{t}
\end{align*}

It is this entry that is needed to process a simple past tense narrative like (6). Here each successive event is situated in the past of the utterance time, while the details of the narrative fabric are provided by the discourse pragmatics of narration. With this the analysis of (6) becomes closely parallel to that of the past perfect passage in (7). The only difference is that in (6) the PT time is located at \(n\) whereas in (7) it is located at the past time of Bill’s arrival.
• In this way we have been led to an account of the simple past according to which it is sensitive to the aspect of the representation of its sister node. One consequence of this is that the analysis of a simple past tense narrative in which (+ perf.) and (- perf-) sentences alternate, the analysis of the past tense must alternate accordingly, with the TP time switching back and forth between the utterance time and some time or times in its past. An example would be the following variant of (6).

(34) Bill got up at six thirty. The sun was shining brightly. He cooked himself a full breakfast, and washed up after finishing it. He felt happy and full of energy. He left the house in time to catch the 7.54 train at the central station.

According to our account as it stands the TP time of the first sentence must be n, that of the second sentence the time of Bill’s getting up, that of the third sentence would again be n, and that of the fourth once more a past time, presumably that of Bill’s cooking himself a full breakfast, or – more likely – the culmination of the cooking, the implicit eating and possibly the washing up. The switching back and forth of the TP time that is required in such an account might well be thought excessive and unmotivated. Earlier versions of the present account (Kamp and Rohrer, 1986), (Kamp an Reyle, 1993, Ch.5) tried to accommodate such qualms by allowing the tenses of stative sentences to be analysed also as instances of an entry much like (33). This entry is given in (35).

(35) (lexical entry for the simple past (second type of use); preliminary)

simple past (tense feature)

\[ \text{ev} \]

Sel Restr: state

\[ \begin{align*}
\text{tp} & \quad \text{t} \\
\text{Sem Repr:} & < \{ \text{tp = n} \}, \quad \text{t < tp} \\
& \quad \text{t} \subseteq \text{ev}
\end{align*} \]

If we allow for such an alternative analysis of stative sentences in the simple past, then their interpretation too must rely on the mechanisms that identify rhetorical relation or relations in which the sentence stands to one or more sentences that precede it and from which temporal relations between the eventualities described by the sentences can be inferred. (For instance, the first stative sentence in (34) could be interpreted as standing in the rhetorical relation known as ‘background’ to the event sentence preceding it, with the implication that the state it describes held while the event occurred. For the second stative sentence the story would presumably have to be somewhat different.)

Allowing the tenses of simple past stative sentences to be analysed not only as instances of (31) but also as instances of (35) adds a further choice point, and therewith a further element of complexity to the processing of such sentences. Note well that we could not abandon (31) in favour of (35), as it is needed to deal with past tense sentences containing now. Even now, after more than 25 years, it is not clear to me how this question – do we allow for (35) as an alternative to (31) or should all
stative sentences in the simple past be analyzed in accordance with (31)? - should be resolved.

• Perhaps this is a case of *underspecification of grammatical analysis*. Underspecification of grammatical analysis arises when sentences of a certain form can be analysed as instances of two distinct grammatical templates, but where each analysis leads to the same interpretation. Neither of the analyses can be dispensed with, as each of them is needed for certain other (related, but slightly different) sentences, to which the other analysis cannot be applied. (In the present case, these would be (a) past tense event sentences on the one hand, and (b) past tense stative sentences with an adverb like *now* on the other hand.) But for the sentences in question – past tense stative sentences without such adverbs - both analyses are possible, and they lead to the same interpretation.

• The formally simplest account is obtained by allowing only (31) for stative sentences. On that assumption we can, making use of ‘!/’, combine the two entries for the simple past that we adopted for the cases of (+ perf.) and (- perf.) TP representations (viz. (33) and (31)) into a single entry. (36) gives an entry that does this. (36) somewhat resembles our earlier (12), but there are also a couple of differences.

First, (36) differs from (12) in that each of the ‘!/’ disjuncts comes with its own tp-presupposition. Given the notational decisions we have made, the most natural place in which we can put the conditions ‘event(ev)’ and ‘state(ev)’ that enforce the choice between (+perf.) and the (- perf.) disjunct into the DRSs following these presuppositions. That may seem a little unnatural insofar as the choice between the two options that they represent should intuitively come before any processing of the past tense information can get properly under way. But even in these positions the conditions will do the work they are supposed to, since they guarantee that the ‘!/’-disjuncts to which they belong will clash with the representation of the sister TP if its referential argument doesn’t match the sortal restrictions they impose, thereby eliminating that disjunct and leaving the other disjunct as the only viable option.

Furthermore, a second presupposition has been added to the first disjunct, which covers the case of event sentences. In the form in which it is given, this presupposition only serves as a reminder that in the case of an event sentence in simple past tense, the temporal location of its event ev depends on the identification of a reference time r and of a temporal relation ρ which relates ev in some way to r. As we have argued, the resolution of this presupposition involves rhetorical structure (and perhaps other aspects of discourse structure as well; see (Asher and Lascarides, 2003) and related literature), and thus involves much that goes beyond what we can deal with here. So the second presupposition in (36) does no more than remind us that such further processing is not needed. Note that no such additional presupposition is needed for stative sentences (second ‘!/’-disjunct), since here the temporal relation is always ‘t ⊆ ev’.
(36) (lexical entry for the simple past)

simple past (tense feature)
  ev

Sel Restr: eventuality

Sem Repr:

\[
< \{ \text{tp}, \text{r}, \rho \}, t > \quad \ni \quad < \{ \text{tp} \}, t >
\]

\[
\begin{align*}
\text{tp} &= n \\
\text{event(ev)} &= t < \text{tp} \\
\text{tp} &< n \\
\text{state(ev)} &= t = \text{tp} \\
\text{ev} &\subseteq t \\
\rho(\text{ev}, \text{r}) &\subseteq \text{ev}
\end{align*}
\]

In order to get a sense of how the entries for past tense and now interact let us go in some detail through one - comparatively simple - example of DRS construction, for the 2-sentence discourse in (37).

(37) Mary stepped outside. The sun was shining now.

We start at the point where the sister to T of the first sentence has been assigned its semantic representation. (We may ignore the Asp projection level in this case and assume that the sister of T is VP.) For simplicity we treat step outside as an intransitive verb which we do not analyse further.

(38) S

Comp

TP

∅

DP_1

T'

Mary T

VP

\[< e_1 | e_1 : \text{step-outside}(x_1) >\]

The VP representation has to be combined with the semantics of the feature ‘past’, as given in (36), and repeated below.

(36)

\[
< \{ \text{tp}, \text{r}, \rho \}, t > \quad \ni \quad < \{ \text{tp} \}, t >
\]

\[
\begin{align*}
\text{tp} &= n \\
\text{event(ev)} &= t < \text{tp} \\
\text{tp} &< n \\
\text{state(ev)} &= t = \text{tp} \\
\text{ev} &\subseteq t \\
\rho(\text{ev}, \text{r}) &\subseteq \text{ev}
\end{align*}
\]
Since the referential argument of the VP representation is an event, the first disjunct of (36) is selected and we get as T’-representation the structure in (39).

(39)

\[
S \\
\text{Comp} \quad \text{TP} \\
\emptyset \quad \text{DP}_1 \quad \text{T'} \\
\text{Mary}
\]

\[
t_p \quad r \quad \rho \quad t_1 < e_1, t_p, r, \rho | \{ \}, e_1: \text{step-outside'}(x_1) \\
\text{tp} = n \\
t_1 < t_p \\
e_1 \subseteq t_1 \\
\rho(e_1, r)
\]

The next two steps lead from (39) to the preliminary representation in (40).

(40)

\[
t_p \quad r \quad \rho \quad m \quad t_1 \quad e_1 < t_p, r, \rho, m | \{ \}, e_1: \text{step-outside'}(m) \\
\text{tp} = n \\
t_1 < t_p \\
e_1 \subseteq t_1 \\
\rho(e_1, r)
\]

Of the presuppositions in (40) the first can be resolved automatically. Strictly speaking this leads to adding the discourse referent tp and the equation ‘tp = n’ to the non-presuppositional representation, but we can simplify this by substituting n for tp and dispensing with both tp and ‘tp = n’. The second presupposition, involving r and ρ, cannot be resolved, since we have no context that could provide antecedents for r and ρ. This is a general problem with discourse-initial sentences, and a special proviso must be added to the construction algorithm to the effect that presuppositions related to discourse structure, of which the r-ρ-presupposition generated by the past tense is one, may be ignored when the generating sentence is discourse-initial. Finally, the presupposition generated by the proper name Mary has to be accommodated. Dealing with the presuppositions of (40) in these respective ways leads to the representation in (41).

(41)

\[
t_1 \quad e_1 \quad m \\
t_1 < n \\
e_1 \subseteq t_1 \\
\text{Mary'}(m)
\]
e₁: step-outside’(m)

We enter into the construction of the second sentence also at the point where the VP has been assigned its semantic representation. This time the Asp projection level is needed. Once more we simplify things somewhat be treating *the sun* as a proper name.

(42)

\[
\begin{array}{c}
\text{S} \\
\text{Comp} \quad \text{TP} \\
\emptyset \quad \text{TP} \quad \text{PP} \\
\text{DP} \quad \text{T'} \quad \text{P} \quad \text{DP} \\
\text{the sun} \quad \text{T} \quad \text{AspP} \quad \emptyset \quad \text{now} \\
\text{past} \quad \text{Asp} \quad \text{VP} \\
\text{-perf.} \quad \langle e_2 \mid e_2: \text{shine}(x_1) \rangle
\end{array}
\]

The Asp feature -perf. transforms the VP representation into the representation of a progressive state s₂, as shown in (43).

(43)

\[
\begin{array}{c}
\text{S} \\
\text{Comp} \quad \text{TP} \\
\emptyset \quad \text{TP} \quad \text{PP} \\
\text{DP} \quad \text{T'} \quad \text{P} \quad \text{DP} \\
\text{the sun} \quad \text{T} \quad \text{AspP} \quad \emptyset \quad \text{now} \\
\text{past} \quad \langle s_2 \mid s_2: \text{PROG}(\langle e_2, e_2: \text{shine}(x_1) \rangle) \rangle
\end{array}
\]

This time it is the second disjunct of the entry for ‘past’ that gets selected. Interpretation of the ‘proper name’ *the sun* is as usual and we get as representation for the lower TP node the one displayed in (44).
Using the entry (29) for now and making use of \(!/\) to represent the two different realizations of the empty preposition we get (45) as representation for the PP.

\[
\begin{align*}
\text{(45)} & \quad \left< \text{ev} \mid \left< \left< \text{event(ev)} \right| \text{state(ev)} \right> \right> \\
& \quad \left< \text{t}_2 \right> \\
& \quad \left< \text{h} \right> \\
& \quad \left< \text{t}_2 \right> \\
& \quad \left< \text{s}_2 : \text{PROG}(\text{e}_2 \cdot \text{e}_2 : \text{shine}'(h)) \right>
\end{align*}
\]

When we combine (45) with the TP representation from (44) it is the second disjunct that gets selected and after transferring \(s_2\) from the store to the universe of the non-presuppositional DRS we obtain (46).

\[
\begin{align*}
\text{(46)} & \quad \left< \text{h}, \text{tp}_2 \mid \left< \left< \left< \text{t}_2 \right> \right| \text{h} \right> \right> \\
& \quad \left< \text{t}_2 \right> \\
& \quad \left< \text{s}_2 \right> \\
& \quad \left< \text{t}'_2 \right>
\end{align*}
\]

We can make use of our semantic representation in (41) for the first sentence of (37) to resolve the presuppositions of (46). (41) is no help with the proper name presupposition, which must be accommodated, but it offers a unique suitable antecedent for the tp-presupposition, viz. \(t_1\). Resolving \(\text{tp}_2\) to \(t_1\), and then \(t'_2\) to \(\text{tp}_2\) we obtain (47) as the representation for the two sentence discourse (37).
Note the redundancy of the temporal information contributed by *now* to (47), which is embodied in the two conditions \( t_1 \subseteq t_2 ^\prime \) and \( t_2 ^\prime \subseteq s_2 \).

2. Future tenses.

The simple future poses a question that mirrors that which came up in connection with the simple past: What is the role of the TP-time in the interpretation of a sentence in the simple future tense? For event sentences the answer should once more be the one we gave for event sentences in the simple past: TP time remains at \( n \) while the location time \( t \) is situated in the future of it.

But what about state descriptions in the simple future tense? Can we duplicate the argument we used to establish the possibility of interpreting the simple past as involving a shift of TP time away from \( n \)? Recall that that argument depended upon the possibility of combining the simple past with the adverb *now*, with the effect that *now* must be interpreted as referring to some time in the past of \( n \). Are there similar examples of sentences in the simple future tense in which *now* is used to refer to a future time?

The answer to this question is less obvious than it is for past-shifted *now*-interpretations. Nevertheless, such cases can be found even though they are quite rare (Sandstrom, 1992(?)). These examples indicate that at least some sentences in the simple future tense must be analysed as involving a TP time that is shifted in the direction of the future. (Once again these are state describing sentences and the states they describe are located as including the future TP time.)

However, since such cases are quite rare, the question whether state describing sentences do not also allow for an interpretation according to which the TP time is identified with \( n \) looms even larger than it does in connection with the simple past. In fact, it could well be thought that this latter interpretation is the default for simple future sentences - for those that describe states as well as for those that describe events.

More work will be needed to determine the best way of dealing with the future tense, (just as more work is needed to determine whether the treatment of the simple past incorporated in our final entry (36) is the best way of dealing with that tense form). As an illustration of an alternative to the treatment of the past tense embodied in (36), (48) embodies a treatment of the simple future in which the TP-time never shifts. This
treatment will have to include the possibility of overruling this entry for the (quite rare) cases in which only an interpretation involving a future shifted TP time will yield the right interpretation. (This proviso is not part of the entry (48) as given, and would have to be stated in some way alongside it.)

(48) (lexical entry for the simple future)

simple future (tense feature)

ev

Sel Restr: eventuality

Sem Repr:

\[
< \{ \text{tp}, r, \rho \}, t > \\
\text{tp} = n \\
t > \text{tp}
\]

\[
\text{event(ev)} \setminus \text{state(ev)} \\
\text{ev} \subseteq t \\
\rho(\text{ev, r})
\]

(48) has a single tp-presupposition which covers the case of state sentences as well as event sentences and a single presuppositional constraint that a reference time r and a temporal relation \( \rho \) should be recovered from context. For event-describing sentences the role of r and \( \rho \) has been discussed at length. For state-describing sentences \( \rho \) serves not to temporally relate r to the described state itself, but rather as a way of relating the location time t to r. (This will then also establish a temporal relation between ev and r as we have ‘t \( \subseteq \) ev’.)

2.i. Other tense forms that are often classified as ‘future tenses’ are the future perfect, as in (49.a), the ‘future of the past’, as in (49.b) and the ‘future perfect of the past’, as in (49.c).

(49)

a. He will have eaten (by then)
b. Henry arrived on Wednesday. He would leave (again) on Sunday.
c. Henry arrived on Wednesday. On Sunday he would have spent three very busy days of negotiations.

Of these we already considered the future of the past, as our second unequivocal example of the tense form that involves shifting of TP. The other two forms in (49) are perfects; and perfect forms raise a question which we briefly touched upon when discussing the possibility of tenses of dimensionality \( > 2 \). This is the question whether the perfect shouldn’t be analyzed as an aspect operator rather than as an integral part of different tense forms.
Indeed it is as an aspectual operator that we will analyze the perfect here. (This means that we will have to revise our earlier treatment of the past perfect; but we will see that the revisions will be minor as far as their actual consequences are concerned.)

More precisely, we will analyze the perfect in essence as an operator that transforms the eventuality representations that it gets as inputs into representations of result states of those eventualities. But we will see that this can only be a first approximation.

3. Perfects.

There is much that speaks in favour of treating the perfect as an aspectual operator and not as an integral part of tense morphology in the narrow sense. For English and many other languages the evidence is partly morphological. Perfects are formed with the help of an auxiliary – in English this is always have – and tense morphology can then modify the auxiliary in the same way that it modifies main verbs (including have itself when it plays the part of a main verb, rather than an auxiliary). This is how we get the different finite perfects of English – has written, had written, will have written – as well as the infinite forms to have written and having written.

But there are also semantic reasons for according perfects an aspectual analysis. One natural way of seeing the perfect is as an operator that shifts from the eventuality described by the verb (or, more accurately, by the semantic representation on which it operates) to a state resulting from that eventuality. On the one hand this view promises to give us a way of making sense of observations that have often been made in relation to the present perfect of English: In many instances the English present perfect conveys that the result of the event described by the main verb is still ‘live’. For instance, to say (50.a) is odd, whereas (50.b), in which the present perfect has been replaced by a simple past, is unexceptionable.

(50)

a. John has arrived, but he left again an hour ago.
b. John arrived, but he left again an hour ago.

Furthermore, if perfects are treated as operators which shift from eventualities to their result states, the semantics of the simple present, simple past and simple future we have adopted give us what appears to be the right temporal location for the corresponding finite perfects as well: The present perfect locates the result state at the utterance time, and therewith the eventuality ev whose result state it is in the past of n; the future perfect (will have written) locates the result state in the future and therewith at least part of ev as well (given that eventualities and their result states abut: the result state starts the moment the eventuality ends); and a past perfect locates, according to the way of analysing perfects we are now exploring, the result state at some time in the past, which means that eventuality must have occurred at some time before that past time.

The morphology of English perfects not only suggests that the perfect should be analysed in a different way than the tenses but also carries implications about where it should apply. The perfect can be applied to progressive as well as to non-progressive forms. For instance, has been writing is a perfectly well-formed expression, but is having written is not, and seems to qualify as plain ungrammatical. This indicates that
when building verbal projections starting with the verb, the progressive operator is applied before the perfect operator. To account for this we will, in the spirit of our assumptions about syntactic structure so far, assume that the perfect has its own projection level, with nodes Perf and PerfP, which is located between Asp and T’. The information provided by Perf can be given in the form of a binary feature ‘Perfect’ with values ‘+ Perfect’ and ‘- Perfect’. This feature should not be confused with the feature ‘perf(ective)’, the value of which is specified at Asp. The feature value ‘+ Perfect’ means that the sister of Perf is transformed into a perfect, whereas ‘- Perfect’ means that the sister is passed up unchanged. Thus for the sentences in (51.a,b,c) we get the syntactic structures in (52.a,b,c). The features that are not constant throughout (52.a,b,c) are presented in boldface.

(51) a. Mary has been writing a letter.
    b. Mary has written a letter.
    c. Mary was writing a letter.

(52) a. 

\[
\begin{array}{ll}
\text{Comp} & \text{TP} \\
\emptyset & \text{DP} & \text{T'} \\
\hline
\text{Mary} & \text{T} & \text{PerfP} \\
\text{pres} & \text{Perf} & \text{AspP} \\
- \text{perf} & \text{V} & \text{DP} \\
\text{write} & \text{Det} & \text{NP} \\
\text{a} & \text{letter}
\end{array}
\]

b. 

\[
\begin{array}{ll}
\text{Comp} & \text{TP} \\
\emptyset & \text{DP} & \text{T'} \\
\hline
\text{Mary} & \text{T} & \text{PerfP} \\
\text{pres} & \text{Perf} & \text{AspP} \\
+ \text{Asp} & \text{VP} \\
+ \text{perf} & \text{V} & \text{DP} \\
\text{write} & \text{Det} & \text{NP} \\
\text{a} & \text{letter}
\end{array}
\]
When the feature value of Perf is ‘- Perfect) and thus nothing happens at this projection level, we will usually omit displaying it, just as we have been doing in connection with the projection level of Asp.

The perfect is like the progressive in that it transforms its input into the description of a state. Moreover, it can be argued that like the progressive it comes with a selection restriction to the effect that its input should be the description of an event. In the case of the Progressive, we have seen, this restriction leads either to straight incompatibility (and thus ungrammaticality), is in cases like *’He is knowing the answer.’ Or else to coercion, form a straight state description to something like an activity, as in ‘He is being obnoxious.’ In connection with the perfect, coercion of a state into a + perf. eventuality is always possible. In many languages the coercion from state description to event description can take only one form. English is special in that there it can take two forms.

The form of coercion that the interpretation of the English perfect shares with the perfects of many other languages is that according to which the state s described by the representation K of the sister node to the Perfect operator involves maximization of the state s and then turning the description of this turns the description of the resulting ‘maximal’ state s’ into the description of an event e to the effect that the description of s (as given by K) obtained for the duration of s’. Here the maximization of s (with respect to the description of s given by K) is to be understood in a temporal sense: it is the state s’ that (i) satisfies the description K, (ii) temporally includes s and (iii) is the temporally most extended state satisfying (i) and (ii).

The second form of coercion permitted by the English perfect, which is unique to English among the (few) languages that I have looked at, is that of reinterpreting the state description presented by the sister representation K ‘inchoatively’, i.e. to transform K into the representation of the event that was the onset of s (or, alternatively, of s’s maximization). This coercion leads to the interpretation of a sentence like ‘Mary has lived in Paris since she moved there in 2001’ as stating that the condition of Mary living in Paris has obtained continuously from the event of her moving to Paris in 2001 to the time at which the sentence is uttered. (Details will follow.)
In the first pass account of the English prefect presented at this point the second coercion option will be ignored. Furthermore, since the coercion of input state descriptions to event descriptions that on our account the perfect requires is always possible (and, given the restriction to coercion to ‘maximal state events’, will always take this one form), we will build this coercion into the semantics of our lexical entry for the perfect, rather than entering the restriction to event description inputs as a Selection Restriction and articulating the coercion options as part of some separate module of the interpretation algorithm (for which our present set-up has not provided room as things stand).

This decision will lead eventually to the preliminary entry for the English perfect given below in (57). The first step is the maximization operation given in (53), with the input structure to the left of ⇒ and the representation that results from applying the maximization operator to it on the right. Input and output representations are given schematically in this specification of the maximization operation, with K being any non-presuppositional part of the representation structures we are now using and ‘..’ standing for any set of presuppositions (including the empty set). K[sₘ/s] stands for the result of replacing s in K throughout by sₘ, and likewise for {..}[sₘ/s].

\[(s.. | <{..}, K>) \Rightarrow <sₘ.. | <{..}[sₘ/s], K[sₘ/s]>>\]

(N. B. Note that the right hand side of (53) captures the intuition that sₘ must temporally include s because its referential argument is sₘ and it will therefore be sₘ that will get located by T, in the same way that s would have been had maximization not taken place. That is, we get ‘t ⊆ sₘ’ in lieu of ‘t ⊆ s’, whether t is location time introduced in processing the tense information provided by T.

The next operation we need must turn the maximization result of (53) into an event e. But what sort of event is this, and how precisely is it related to the state sₘ? These questions are not all that easy to answer. The reason is that the difference between sₘ and e is more a matter of perspective – that difference between internal and external viewpoint which is discussed at length in (Smith, 1991) – than of the way the world is. But the following example should give a sense of what we are after. Consider a situation which we could describe by saying “Mary was ill from Monday till Wednesday”. Such a situation can be informally denoted as an illness, or a bout of illness, of Mary. And illnesses in this sense – bouts of illness – we often treat as a kind of event. “Anything happened the last few weeks?” A asks and B answers “Well, the week before last our dog died, and aunt Mathilda came to visit. And last week, from Monday till Wednesday, Mary was ill.” Each of the three things B mentions seems to qualify quite naturally as an event, the third one no less than the first two. In this sense maximal states – lasting for the entire continuous period during which the description that characterizes them obtains – can be regarded as events. Or, put in the terms of our ontology, for each such maximal state which represents its characterizing condition as viewed ‘from the inside’, there is a corresponding event which consists in that condition obtaining over that continuous period of time.
But how can we characterize such events within the representation formalism we are using? Here is a proposal. We have already made use of the operator PROG, which forms out of an event description a description of a state which consists in the described event’s being in progress. What we want here is the inverse of this transformation: given the state $s_m$ we want an event $e$ such that $s_m$ qualifies as the state of $e$ being in progress. Using the representational resources at our disposal we can represent this last condition as ‘$s_m$: PROG($^e$. $e' = e$).

Adopting this way of associating an event $e$ with the state $s_m$, we can represent the event $e$ that we obtain from the referential argument $s$ of the left hand side of (53) via maximization as in (54).

$$
\begin{align*}
\langle e, .. | < \{..\}[s_m/s], \quad K[s_m/s] \quad >> \\
\quad s' \quad \forall \quad K[s'/s] \quad s' \subseteq s_m \\
\quad s_m: PROG(^e'. e' = e)
\end{align*}
$$

Let us now return to the perfect itself. The perfect, we said, changes an event description into a description of a corresponding result state $s_{res}$. We will represent the result state relation between $e$ and $s_{res}$ as ‘$res(s_{res}, e)$’. Exactly what this condition amounts to will be discussed later, when we will look at the perfect more closely. For now we leave at one observation: result states start the moment that the events whose result states they are come to an end; or, in the terminology and notation we have been using: event and result state abut: ‘$e \supset\subset s_{res}$’. Thus we have the following meaning postulate.

$$
\begin{align*}
\forall \quad e \quad res(s_{res}, e) \quad \Rightarrow \quad e \supset\subset s_{res}
\end{align*}
$$

With the help of the relational predicate ‘$res$’ the transformation effected by the perfect operator can be stated as in (56) in case the input representation to the perfect operator is an event description with referential argument $e$.

$$
\begin{align*}
\langle e, .. | < \{..\}, K >> \Rightarrow \quad <s_{res}.. | <\{..\}, \quad K \quad >> \\
\quad res(s_{res}, e)
\end{align*}
$$

The entry for the perfect we shall adopt for now specifies that when the input representation is
the representation of an event, then the result of the transformation is the right hand side of (56); in the other case, where the input representation is a state description, the result is like the right hand side of (56) except that in this case the referential argument \( s \) of the input representation first has to be coerced into a corresponding event \( e \), as described in (54). The two possibilities can be represented once again as ‘disjuncts’ of a \( \lor \)-disjunction. Note that because of the substitution of for \( s \) in the input representation when it is a state description implies that we must specify the relevant components of the input representation as parameters.

\[
(57) \quad \text{(the perfect operator; preliminary version)}
\]

\[
<\text{ev},.. | <\{..\}, K >> \Rightarrow
\]

\[
\text{ev} \quad \text{ev} \quad s_m \quad e
\]

\[
<s_{\text{res}},.. | <\{..\}, \text{event(ev)} \lor <\{..\}[s_m/ev], \text{state(ev)} > >
\]

\[
K \quad K[s_m/ev]
\]

\[
\text{res(s}_{\text{res}},\text{ev}) \quad s' \quad \forall
\]

\[
K[s'/ev] \quad s' \quad s' \subseteq s_m
\]

\[
s_m; \text{PROG}('e' \cdot e' = e)
\]

\[
\text{res(s}_{\text{res}},e)
\]

As in earlier entries that make use of \( \lor \), the conditions ‘\text{event(ev)}’ and ‘\text{state(ev)}’ in the two disjuncts ensure that whatever the input representation, the disjunct incompatible with it gets eliminated because of a clash with the sortal restriction that the input specifies for its referential argument.

Again a few sample DRS constructions may help to see what our entry for the perfect does for us. Our first example is the present perfect sentence (51.b).

\[(51.b) \quad \text{Mary has written a letter.}\]

We assume the syntactic structure (52.b) and pick up the construction at the point where the VP representation has been constructed and has been passed up to AspP.
The application of the perfect operator in (58) represents one of the easy cases, since its input is an event description. This selects the left hand disjunct from the entry for perf; the result is shown in (59).

Tense location now concerns the new referential argument $s_{res}$. Using the entry in (31) we get the T’ representation in (60).
The remaining steps, including the accommodation of the proper name presupposition introduced by *Mary* and the tp-presupposition, lead to the representation in (61).

(61) \[ \begin{array}{ccccccc}
& t & p & t & e & y & m \\
\text{tp} & n & t & \subseteq & s_{\text{res}} & \text{res}(s_{\text{res}},e) & \text{letter}'(y) & \text{Mary}'(m) \\
\end{array} \]

Now consider the sentence (51.a).

(51.a) Mary has been writing a letter.

This time the feature associated with Asp causes transformation of the event description delivered by the VP into the description of a progressive state, see (62).

(62) \[ \begin{array}{ccccccc}
& t & p & t & e & y & m \\
\text{tp} & n & t = \text{tp} & \subseteq & s_{\text{res}} & \text{res}(s_{\text{res}},e) & \text{letter}'(y) & \text{Mary}'(m) \\
\end{array} \]

\[ e: \text{write}'(m,y) \]
When this state description is given as input to the prefect operator, it is the right hand disjunct of (57) that gets selected. So the representation of PerfP now becomes the structure given in (63).

\[(63)\]
\[\begin{s}_{\text{res}} \mid y >
\begin{s}^\prime \quad y \quad \forall \quad \text{letter}'(y) \quad s' \quad s' \subseteq s_m
\begin{s}' \quad \text{PROG}(^e. \quad \text{e}: \text{write}'(x_1,y) )
\end{s}' \quad \text{PROG}(^e. \quad \text{e}: \text{write}'(x_1,y) )
\]

\[s_m: \text{PROG}(^e. \quad \text{e}: \text{write}'(x_1,y) )
\]

It is important to see what (63) says. It describes \(s_{\text{res}}\) as a result state of an event \(e''\) such that the state \(s_m\) is the state which consists in \(e''\) being in progress. At the same time \(s_m\) is described as the maximal state to the effect that \(x_1\)'s writing of a letter is in progress. So \(e''\) is the event that we might characterize as the bout of activity which consists in \(x_1\)'s being engaged in writing a letter (at the time in question). Note well that \(e''\) need not be an event of \(x_1\) completing the writing of a letter. In this respect it differs from an event \(e\) that is characterized by the condition \(e: \text{write}'(x_1,y)\).

The remaining steps are as before and we end up with the representation given in (64).

\[(64)\]
\[\begin{array}{cccccccc}
\text{tp} & t & s_{\text{res}} & e'' & s_m & y & m \\
\text{tp} = n & t = tp & t \subseteq s_{\text{res}} & \text{res}(s_{\text{res}}, e'') & \text{letter}'(y) & \text{Mary}'(m) \\
\end{array}
\]

\[s_m: \text{PROG}(^e. \quad \text{e}: \text{write}'(x_1,y) )
\]

\[\begin{s}' \quad \text{PROG}(^e. \quad \text{e}: \text{write}'(x_1,y) )
\]

s_m: PROG(‘e’. e’ = e’’)

WARNING: One problem with the treatment offered here of (51.a) are the scope relations that this treatment imposes upon the indefinite *a letter* and the aspectual operators PROG and the perfect. In our treatment *a letter* is assigned narrow scope with respect to the aspect operators, but that is arguably not right. The maximization of the progressive state that is part of our treatment should yield a state s_m which covers the complete duration of the writing of some one letter, not of any letters that the writer my have been working on at the same time and may have continued working on after ceasing to work on the letter in question. Because of the narrow scope of *a letter* the state s_m would be more properly described as the maximal state of writing *letters* on the given occasion, rather than of writing *a letter*.

We will not try at this point to change our treatment in a way that resolves this problem. But it should be kept in mind that the problem exists.

Our last example is the two-sentence discourse (17), repeated below, in which the second sentence has a past perfect. We already dealt with this discourse earlier, using a Reichenbachian, 2-dimensional analysis of the past perfect, according to which the TP time tp is in the past of n and the location time t in the past of tp.

(17) Mary arrived at noon. She had left at seven.

We will now construct a DRS for the second sentence of (17) on the assumption that its tense form is a past perfect in the literal sense of the word: a perfect the tense of which is the simple past.

There is no difference as regards the interpretation of the first sentence of (17), so we take over the DRS (18) that we assumed for this sentence the first time we dealt with (17).

(18.a) \[ t_1 \quad e_1 \quad m \quad t’_1 \]
\[ t_1 < n \quad e_1 \subseteq t_1 \quad \text{Mary}(m) \quad \text{noon’}(t’_1) \]
\[ e_1 \subseteq t’_1 \quad \text{e}_1: \text{arrive}(m) \]

This time we have to assume a different syntactic structure for the second sentence of (17), in which there is a separate Perf projection. The structure we assume is given in (65).

(65) \[ S \]
\[ \text{Comp} \]
\[ \emptyset \quad \text{TP} \]
\[ \text{DP}_1 \quad \text{T’} \quad \text{P} \quad \text{DP} \]
Since the representation associated with the sister of Perf is an event description (viz. the structure $<e_2 | e_2: \text{leave}'(x_1) >$), this is one of the ‘simple’ (i.e. coercion-free) applications of the perfect operator, like in (51.b) and unlike in (51.a). So we get for PerfP the representation shown in (66).

(66) \[ S \\\n\text{Comp} \quad \text{TP} \\\n\emptyset \quad \text{TP} \quad \text{PP} \\\n\text{DP}_1 \quad \text{T'} \quad \text{P} \quad \text{DP} \\\n\text{Sh}e \quad \text{T} \quad \text{PerfP} \quad \text{at} \quad \text{seven} \\\n\text{past} \quad \text{e}_2 \quad <s_{\text{res}} | e_2: \text{leave}'(x_1) > \quad \text{res}(s_{\text{res}}, e_2) \]

The next step now involves an application of the simple past. Since its input is a state description it is the right hand side $\text{!/}-\text{disjunct}$ of () that is selected and we get as T’ representation the one displayed in (67).

(67) \[ S \\\n\text{Comp} \quad \text{TP} \\\n\emptyset \quad \text{TP} \quad \text{PP} \\\n\text{DP}_1 \quad \text{T'} \quad \text{P} \quad \text{DP} \\\n\text{Sh}e \quad \text{T} \quad \text{PerfP} \quad \text{at} \quad \text{seven} \\\n\text{past} \quad \text{tp}_2 \quad \text{t}_2 \quad \text{e}_2 \quad \text{at} \quad \text{seven} \\\n<\text{s}_{\text{res}}, \text{tp}_2 | \{\}_{\text{tp}_2} \text{t}_2 \quad \text{e}_2 \quad \text{at} \quad \text{seven} \\\n\text{tp}_2 < \text{n} \quad \text{t}_2 = \text{tp}_2 \]
The next step, dealing with the subject she, is familiar, and we make things a little easier for ourselves by resolving the pronoun presupposition right away to the discourse referent m that represents Mary in the context DRS (18.a).

So we get for the lower TP the representation shown in (68).

\[(68)\]

\[
\text{S} \quad \text{Comp} \quad \text{TP} \\
\emptyset \quad \text{TP} \quad \text{PP} \\
\{t_2\} \quad t_2 \quad e_2 \quad u \quad \text{P} \quad \text{DP} \\
\langle s_{\text{res}}, t_2 \rangle \langle \text{leave}'(x_1) \rangle \quad \text{res}(s_{\text{res}}, e_2) \\
\]

But what is to be done next? Temporal locating adverbials, such as the PP adjunct in (68), have so far been treated as constituents that locate the described eventuality; and in (68) this eventuality – the referential argument of the adjunct’s adjunction site, is the result state \(s_{\text{res}}\).

So if we proceed in the way we have been dealing with temporal locating adverbials, then we end up with the preliminary representation for the second sentence of (17) that is given in (69).

\[(69)\]

\[
\{t_2, t_2'\} \langle \text{seven}'(t_2) \rangle \quad t_2 \quad s_{\text{res}} \quad e_2 \quad u \\
\langle t_2, t_2' \rangle \quad t_2 = t_2 \quad t_2 \subseteq s_{\text{res}} \quad \text{res}(s_{\text{res}}, e_2) \quad u = m \\
e_2: \text{leave}'(u) \\
\]

After resolution of \(t_2\) to the location time \(t_1\) of the discourse context (18.a) we get an interpretation according to which Mary was in the state of having left at noon and was also in that state at ‘seven’. That clearly cannot be right, whichever time we take ‘seven’ to be (i.e.
whichever way we resolve the presupposition concerning \( t_2 \).

(17), then, appears to be an example for which we need our Reichenbachian analysis. For as things stand, the analysis of the past perfect in (17) as the past of a perfect assigns what is evidently the wrong semantics.

On the other hand there are also instances of the past perfect which (given the assumptions we have been making) require an analysis as combinations of the perfect operator and the simple past. Salient among these are sentences and discourses in which the word now is used to locate the result state. An example is (70).

(70) John had been under considerable pressure. But now he had handed in his honors thesis, and he felt much better.

The time denoted by now in (70) is a time at which the thesis has been handed in, not the time at which it is handed in. If it is true that now always refers to the TP time, and also serves to locate the described eventuality, then the eventuality described by the second sentence of (70) must be located at the past TP time, and the only way we can get this with the tools of analysis at our disposal so far is by analyzing the sentence as the description of a result state, i.e. as involving the perfect operator as we have defined it here.

This suggests that both analyses for the past perfect are needed, and thus that in that it is ambiguous. However, we should not be too hasty. For there is a quite fundamental difficulty with the our present analysis of the perfect as a ‘pure result state operator’, which simply transforms its input eventuality description into the description of a corresponding result state and then assumes that tense locates this state just as it locates other eventualities that are the referential arguments of its input structures. This difficulty shows up in the sentence in (71).

(71) a. Mary has written a letter today.
   b. Today Mary has written a letter.

A pure result state analysis of these sentences assigns them readings according to which it is true at the utterance time \( n \) that Mary has written a letter (i.e. that the result state of an event of Mary writing a letter holds at \( n \)). But clearly that is not enough. Both (71.a) ad (71.b) entail that a letter was written today, not just that it is true at some time today that a letter was written at some earlier time, maybe today but possibly at some earlier time.

We must leave this problem for now. But it is important to keep in mind that this is one of the problems connected with the perfect that a viable account of the perfect should be able to deal with, and that our present account cannot handle.

4. Winding it up for now

Before putting an end to the present round on the problems of tense and aspect, we return once more to the question what should be the general form of the semantic analysis of tense. In particular, what should be said, in the light of explorations in this round, about the question on which much of the discussion of this section has been pegged what is the ‘semantic dimensionality’ of the different tense? Are all of them 2-dimensional? Are none of them? Or are some, but not all, and if so, which are and which are not?
If there is one thing that the above discussion has taught us, then it is that this question can be given different answers depending on the perspective we adopt. Now that we have seen some independent evidence for temporal perspective, in the sense of TP time, and in particular that the interpretation of each finite verb form requires establishing the temporal perspective somewhere (and perhaps the infinite forms require that as well, although that is matter we still have to look into), that seems to confer 2-dimensionality upon all tenses. (Strictly speaking this entails ≥2-dimensionality, but as we have seen there are independent reasons to assume that - at least for English - the dimensionality is never greater than 2.) The interpretation of every tense involves two decisions: (i) where to locate the TP time, and (ii) where to locate the described eventuality in relation to some given time, before it, including it or after it. As regards (ii), the given time in relation to which the described eventuality must be related as preceding, overlapping or following could be in principle any time that plays a suitable functional role in utterance interpretation. In particular, both the utterance time and perspective time would be possible candidates; and for those tenses for which the TP time coincides with the utterance time, there is of course no way of telling which might be the interpretation constituent in relation to which the described eventuality is located.

However, as Reichenbach appears to have been the first to have seen clearly, when the choice is between utterance time ad TP time, then it must be the TP time. For in the cases where the TP- time does not coincide with the utterance time, it is the TP-time in relation to which the eventuality is located. If we accept this – and we have seen that there are good reasons to do so – then we get an account of tense that is two-dimensional across-the-board, and in Reichenbach’s sense: each tense interpretation is characterized by a pair of temporal relations – that between utterance time and TP time and that between TP time and eventuality time.

This is one way in which to answer the question. But we can also look at it from a different angle, by asking whether evaluation of the locating information provided by a given tense requires more than the utterance time. In this sense none of the tenses for which the TP time coincides with the utterance time are 2-dimensional, as the utterance time by itself is enough. Indeed, we might well ask at this point whether there are any tenses that are 2-dimensional in this sense. That question has become especially acute now that our aspectual treatment of the perfect has cast doubt on the question whether Reichenbach’s and our point of departure for investigating the 2-dimensional nature of tense semantics, viz. the past perfect, really is the unequivocal that it appeared to be to him, and – initially – to us as well. True, it looks at this popint as if there is a need for analysis of the past perfect along Reichenbachian lines as well as one in which a past perfect is the simple past of a perfect (i.e. of a result state description). But as I noted, we haven’t reached a fully satisfactory treatment of the perfect yet and it will be seen that the modifications that are needed to deal with the problem presented by, in particular, (71) will defeat the case that we now seem to have for a Reichenbachian past perfect alongside with a past-shifted perfect.

That leaves us at this point with only one unequivocal example of a tense that is two dimensional in the present sense – if needing a point other than the utterance time from which the temporal location of the described eventuality is determined, viz. the future of the past, which situates its eventuality in the future of a past TP point. Even this case can be questioned, since its form, in English, involves the word *would*: For how can we establish beyond doubt that in the relevant cases *would* is an auxiliary used in the analytic realization of a tense and not a modal, like *ought, might, could or should*? But let us accept that at least in some cases the combination *would* + infinitive does express a tense form with the meaning we have assigned to it, viz. that of a ‘future of the past’, which locates the eventuality in the future of a past TP time. (In any case, there are languages in which this tense is realized.
‘synthetically’, as a bit of conjugational morphology, although it should be admitted that current views of the role of morphology in syntax and semantics even such evidence appears less than conclusive.) Then that will leave us with at least one clear example of a tense that is 2-dimensional in the second sense as well as the first.

But does this really matter all that much? I think not. We have arrived at a point where we can clearly see the role of the TP time, irrespective of whether it is indispensable to state the temporal location constraints that tenses impose on the eventualities described by the verb complexes of which they are part. Since tenses differ in where they require or permit the TP time to be located, and since they also give information about the temporal location of the described eventuality, they are ‘2-dimensional’ at least in the sense of conveying these two different kinds of information. Whether the first information is instrumental in, or indispensable for, the specification of the second is surely an interesting question in its own right. But it is a further question, and whatever its answer, we have 2-dimensionality in the first sense in any case.

Where does all this leave us with regard to a general semantic classification of the tense forms of English? In the light of our deliberations we seem left with only four, or perhaps five, independent forms: present, (simple) past, (simple) future, future of the past, and (perhaps) the past perfect, as an instance of a ‘past of the past’. Some of these locate the TP time at the utterance time, some do not and some – the simple past and, marginally, the simple future - are ambiguous in this regard. (English also allows for a futurite use of the present tense, sometimes referred to as the ‘tine table use’, exemplified by “The train arrives at 4.15”, where 4.15 is known to be in the future of the time at which the sentence is uttered. But that is just saying that the English present allows in certain cases for an analysis distinct from the one that is appropriate to what we have been calling its ‘standard use’. Here we ignore the time table use of the present just as we are ignoring its other ‘non-standard’ uses, such as the reportive present and the historical present.)

We can sum up the information that, according to our diagnoses, each of these tenses provides about TP time and ‘Event time’ in the following table. Here we follow Reichenbach in always relating the Event time to the TP time – in the cases where TP time coincides with the utterance time as well as in those where it does not – and never directly to the utterance time. (We have been operating on this assumption all along, in particular in the ways in which we have formulated lexical entries for the different tenses.)
(72) (2-dimensional characterization of the tenses of English)

<table>
<thead>
<tr>
<th>Tense \ Semantic Forms \ parameters</th>
<th>TP time</th>
<th>temporal relation between eventuality and TP time</th>
</tr>
</thead>
<tbody>
<tr>
<td>present</td>
<td>= n</td>
<td>⪗</td>
</tr>
<tr>
<td>simple past (i)</td>
<td>= n</td>
<td>&lt;</td>
</tr>
<tr>
<td>simple past (ii)</td>
<td>&lt; n</td>
<td>⪗</td>
</tr>
<tr>
<td>simple future (i)</td>
<td>= n</td>
<td>&gt;</td>
</tr>
<tr>
<td>simple future (ii)</td>
<td>&gt; n</td>
<td>⪗</td>
</tr>
<tr>
<td>future of the past</td>
<td>&lt; n</td>
<td>&gt;</td>
</tr>
<tr>
<td>past perfect</td>
<td>&lt; n</td>
<td>&lt;</td>
</tr>
</tbody>
</table>

If this qualifies as a true schematic characterization of the semantics of the tenses mentioned in the column on the left, then there should be a general recipe for generating the lexical entries we have given for these tenses from the pair of features that this table gives of each of them. It is intuitively clear that such a principle exists. To make it fully explicit is a non-trivial task and a bit of a bother. But it is worth thinking about how one might go about stating it.
(3)  a. Fred went to Rosie for dinner. He came home in a state of euphoria.
    b. Fred went to Rosie for dinner. He put on clean trousers and his nicest shirt.
    c. Fred went to Rosie for dinner. He bought flowers on the way.

(Webber)

(4)  When Alan opened his eyes he saw his wife who was standing by his bedside.
     (i) She smiled
     (ii) She was smiling.

(5)  A man entered The White Hart. He was wearing a back jacket. Bill served him a beer.
     The man paid. He drank the beer. It was exceptionally good.
     (Kamp & Reyle, 1993))

(6)  Bill arrived at noon. He had got up at six thirty, had cooked himself a full breakfast,
     and had washed up after finishing it. He had left the house in time to catch the 7.54
     train at the central station.

(7)  a. Henry arrived on Wednesday. He left again on Sunday.
    b. Henry arrived on Wednesday. He would leave again on Sunday.
    c. Henry arrived on Wednesday. He will leave again on Sunday.

Another source of complications are the temporal relations between the eventualities
mentioned in indirect discourse clauses and the tenses of the matrix verbs under which these
clauses are embedded. Illustrative examples are (8) – (11).

(8)  a. Mary said she ate an apple.
    b. Mary said that she felt sick.
    c. Fred and Mary told us of the horrible scene they had watched when coming out
       of the train station. Mary said she felt sick.

(9)  Fred told me that Mary is expecting.

(10) a. It was predicted once that civilisation would come to an end through a
      world-wide epidemic (in the year 3000/in the year 2000).
    b. It was predicted once that civilisation will come to an end through a worldwide
       epidemic (in the year 3000/# in the year 2000).

(11) Mary told me last week that she was going to file for a divorce in a couple of weeks
      but that she would tell Fred only then that she had (filed for a divorce).
Semantics II. UT Spring 2010. Intensionality and Propositional Attitudes.

General program for this part of the course.

I. Extensionality, Non-Extensionality Modality and Intensionality.
1. What is non-extensionality? What forms can it take?
2. Intensionality vs. (a) intentionality and (b) sense.
3. The origins of intensionality: the semantics for modal logic.
4. Allowing for intensionality as such vs. treatment of particular intensional operators or predicates.
5. Modality and Time.
6. Metaphysical modality, epistemic modals, propositional attitudes, evidentials and evidence-related discourse particles. (For instance, German “ja doch”, “ja”, “doch”.)

II. Propositional attitudes and attitude reports.
1. Representations of discourse and representations of thought.
2. Referential connections between the contents of thoughts with different attitudinal modalities (e.g. a belief and a thought).
3. The importance of being able to represent complex mental states, consisting of thoughts with diverse attitudinal modes.
4. Representations of entities and representations of propositional contents.
5. Anchored representations, indexicals; attitudes de re and de se.
6. An extended DRS language in which agents can be described as having complex attitudinal states at different times
7. A formalism for the semantic analysis and representation of attitude reports.
I. Extensionality, Non-Extensionality Modality and Intensionality.

1. What is non-extensionality? What forms can it take?

- Arguably the most salient form of non-extensionality are expressions that take sentential complements or sentential arguments and where the truth value of the whole is not determined just by the (actual) truth value of the complement of argument. (Examples: “probably”, “necessarily”, “might”, “ought to”, “believes”, “wants”, “belief”, “suspicion”, ..)

N.B. For present purposes the difference between operators and predicates is immaterial. For instance, it doesn’t matter whether we treat the that-clauses that combine with the verb “believes” as formulas, and the verb as a sentential operator that turns these formulas into other formulas, or as arguments and the verb as a predicate with an argument slot for those arguments.

- Other examples of non-extensionality:
  verbs with opaque direct object arguments. Examples: “seek”, “want”, “owe”; “resemble”, “similar to”; ‘privative’ verbs (e.g. “prevent”, “refuse”, “miss”, “lack”)

- The general question all these cases raise: if it is not (just) its extension that the argument contributes to the truth conditions of the predication, what is its contribution?

- The standard answer within formal semantics has been: in non-extensional contexts expressions contribute their intension.

Intensions are functions from possible worlds to extensions

Suppose that E is an expression of type \( \tau \). Then the intension of \( E \) in an intensional model \( M = <W,M> \) is a function \( \text{Int}(E) \) which maps each \( w \in W \) to the extension of \( E \) in \( M(w) \).

(\( M(w) \) is the extensional model for the given language \( L \) that corresponds to, and is determined by \( w \). \( M \) is a function that assigns to each world \( w \) the model it determines.)

2. Intensionality vs. (a) intentionality and (b) sense.

- Intensions are made to play the same role in formal semantics that senses are meant to play in Frege’s “theory” of sense and reference.

However, it is not clear that intensions can fully fill this bill. (Cf. for instance the line pursued by Church in his “Logic of Sense and Denotation” and the critical discussion of it in D. Kaplan’s dissertation and the subsequent work by Tony Anderson.) Especially in the context of propositional attitudes intensions are arguably too coarse-grained.

- Intensions are sometimes contrasted with intentions. Here again the notion of an “intention” usually serves as an informal foil, to bring out the potential inadequacies of intensions.
The notion of an “intention” is (I believe) seen as related to “intentionality” in the sense of Brentano – that in virtue of which thoughts and statements relate to their subject matter and which endows them with referential and propositional content.

3. The origins of intensionality: the semantics for modal logic.

- The formal notion of an intension derives from what was perceived at the time as the dramatic break-through that had been achieved in the model-theoretic semantics for model logic, most of all through the work of the teenager Saul Kripke.

- In retrospect, however, it is important to reflect on exactly what was achieved. Kripke’s results were hailed (and rightly) because they gave a new handle on distinguishing between the by then many different axiomatically defined systems of modal logic, mostly in the work of C.I. Lewis. But do they really help us to better understand the “meanings” of the operators of those different systems?

We must make a difference here between:

(i) the consequences that assuming certain general properties for the accessibility relation R has for the logic of the operator that is defined in terms of R; and

(ii) semantic reasons why certain properties should be adopted for the various accessibility relations.

- Note well: the models that are used in the Kripke semantics for modal logics are not just intensional models of the form <W,M>, but are rather of the form <W,R,M>, where R (the “accessibility relation”) is a relation on W. The truth conditions of “[] A” ("It is necessary that A") are then given by clause (1):

(1) [] A is true in <W,R,M> at world w iff for every w’ ∈ W such that wRw’, A is true in <W,R,M> at w’.

4. Allowing for intensionality as such vs. treatment of particular intensional operators or predicates.

- The success of the semantics for modal logic led to a flurry of work in which similar semantics were developed for other non-extensional sentential operators.

- It is important to distinguish here between two different concerns:

(i) Developing a semantic framework that makes room for intensions, so that non-extensional operators and predicates can be treated semantically as taking intensions as inputs; and

(ii) Giving an intensional/modal analysis of the semantics of particular non-extensional items (among them: subjunctive and counterfactual conditionals, deontic and epistemic operators, attitudinal operators/predicates).
For this second purpose one needs various kinds of structure of the set $W$ of possible worlds. (Cf. the difference between Kripke models and general intensional models.)

- Perhaps even today the most convincing and useful instance of this approach is the treatment of various types of conditionals, as pioneered by Sobel, Stalnaker and, most prominently, Lewis, and best known to linguists in the form in which these ideas are presented in the work of Kratzer.

In Lewis’ version conditionals are analyzed in terms of a relation $\geq$ of comparative similarity to a given world. This is a 3-place relation on $W$; “$w' \geq_w w''$” reads “$w'$ is at least as similar to $w$ as $w''$ is”. The truth clause for a conditional “$A \square \Rightarrow B$” is then as in (2)

\begin{equation}
\square A \text{ is true in } <W,\geq,M> \text{ at world } w \text{ iff there is a world } w' \in W \text{ such that}
\end{equation}

(i) $A$ is true in $<W,\geq,M>$ at $w'$;
(ii) $w'$ is a ‘minimal $A$-world’ in that there is no $w'' \in W$ such that $A$ is true in $<W,\geq,M>$ at $w''$ and $w'' \succ_w w'$;
(iii) for every world $w''$ such that $w'' \geq_w w'$ and $A$ is true in $<W,\geq,M>$ at $w''$, $B$ is true in $<W,\geq,M>$ at $w''$.

5. Modality and Time.

- Originally, the role of time in natural language and formal systems designed to capture some of its essential semantic and logical properties was also treated on the model of modal logic: tenses and other devices of temporal reference were treated as tense operators – the temporal counterparts of modal operators like “possibly” and “necessarily”.

- We briefly discussed this option when talking about tense and aspect and quickly rejected it, opting instead for a representation formalism (= logical form formalism) which has devices (discourse referents) for representing times directly (and in that sense “referring” to times).

The models for this formalism are “histories”, which include a time structure as part of their ontology, and encode the facts that are relevant to the interpretation of the formalism at the various different times of that time structure.

Intensional models corresponding to such extensional models are pairs $<W,M>$ in which each $M(w)$ is such a “(model of a) history”. It is convenient, and conceptually defensible for most applications, to assume that all models $M(w)$ of a given intensional model share the same time structure. This makes it possible to assign to each logical form K which represents the content of an utterance made at a time $t$ the proposition consisting of those worlds $w'$ such that $K$ is true in $M(w')$ at $t$.

6. Metaphysical modality, epistemic modals, propositional attitudes, evidentials and evidence-related discourse particles. (For instance, German “ja doch”, “ja”, “doch”.)
• Since Kripke’s “Naming and Necessity” philosophers are careful to distinguish between “metaphysical” and “epistemic” modalities. For linguistics the epistemic modalities seem the more important. Speakers who use modal expressions either seem to have an epistemic interpretation firmal in mind or else their use is neutral with respect to the distinction, and it seems very hard, and usually contentious, to argue that it was really the metaphysical interpretation that they must be construed as having referred to.

• Epistemic modals are much closer to attitudinal predicates and operators than metaphysical modalities. They all have much in common with “evidentials” - bits of morphology or independent particles that indicate the nature of the source of the propositional content expressed by the sentence. However, evidentials for the most part share with attitudinal expressions the feature that it is clear whose “knowledge” – i.e. whose mental state – is at issue. Epistemic modals come in general with an implication of shared attitudes. In this regard they are more like certain discourse particles like, e.g., the German particles “ja doch”, “ja” and “doch”.

II. Propositional attitudes and attitude reports.

1. Representations of discourse and representations of thought.

• Work on the semantics and pragmatics of discourse provides evidence for the form in which verbally expressed content is mentally represented. (By the interpreter of a verbal “input”, but also by its producer.

This provides a basis for a theory of mental representations of at least some thoughts.

2. Referential connections between the contents of thoughts with different attitudinal modalities (e.g. a belief and a thought).

• The same evidence also points towards the importance of the connections between different thoughts (derived from verbal input, but also more generally). Of special importance are referential connections between thoughts of different attitudinal mode. (For instance a belief and an intention can be about the same entity in a purely internal, “intentional”, sense.)

• A formalism fit for describing complex mental states consisting of several connected attitudes and which also is to do justice to the representational forms of those attitudes, must in particular be capable of capturing these referential connections.
3. The importance of being able to represent complex mental states, consisting of thoughts with diverse attitudinal modes.

- Complexes composed of referentially connected attitudes of different mode are the structures that drive practical reasoning. It is crucial that we be in a position to represent these correctly.

**Example:** A hunter is aiming at what he takes to be a deer and fires. Three possibilities:

a. There is a deer that the hunter perceives and fires at.

b. There is something other than a deer (e.g. the friend with whom he has set out on his hunting venture) and which he makes the target of his shot.

c. There is nothing there, just a “trick of the light”. Still there is an entity in the hunter’s mind at which he tries to take aim and shoot at.

From the point of view of the hunter these cases are indistinguishable and they all lead to the same complex mental representation, which drives his cogitations and actions.

- Here is one way in which the complex of the hunter’s belief and intention relating to the deer he sees (or thinks he sees) can be represented using the DRS language we have been using as representation formalism for much of the seminar. We take it that the content of the belief is that there is a deer $x$ and an oak tree $z$ and that the deer is behind the tree. The intention is for our hunter to shoot $x$.

\[
\begin{align*}
&t \quad s \quad x \quad z \\
&\{ <\text{BEL}, \quad \text{deer}(x) \quad \text{oak tree}(z) >, \\
&t = n \quad t \subseteq s \quad \text{behind}(x,z) \\
&\quad e \quad \text{shoot}(i,x) > \\
&\quad s: \text{behind}(x,z) \\
&\quad e: \text{shoot}(i,x) \}
\end{align*}
\]

Note that the DRS of the intention has a free occurrence of $x$. This $x$ is bound in the belief DRS. But what does this mean for the semantic of the intention DRS, or for the semantics of the complex consisting of belief and intention together? This is a non-trivial challenge for a model-theoretic semantics for any formalism that countenances combinations of referentially connected attitudes with varying attitudinal modes.

4. Representations of entities and representations of propositional contents.

- The possibility of representing different thoughts as referentially connected is related to another aspect of human cognition: our mental states are composed not just of
representations of propositional content but equally of representations of entities. These entity representations can enter as constituents into the representations of the contents of propositional attitudes.

- Existing work on this topic has for the most part only acknowledged anchored entity representations. These are representations that represent entities as the causes of certain cognitive events involving the agent, which lead to the emergence of the representation or to its confirmation or reinforcement.

- We assume that anchored representations have the following form:

  \(<[\text{ANCH}, \alpha], K(\alpha)\>\)

Here “[ANCH,\(\alpha\)]” indicates what kind of representation the representation is. In this respect “[ANCH,\(\alpha\)]” is on a par with mode indicators like “BEL” and “INT”.

“[ANCH,\(\alpha\)]” indicates (i) that we are dealing with an entity representation and that the discourse referent \(\alpha\) is used as representative of the entity represented by the representation as a whole, and (ii) that the representation is anchored.

\(K(\alpha)\) is a DRS which describes in what kind of causal relation the agent (the one who is in the mental state which includes the given representation) takes himself to stand to the represented entity; \(K(\alpha)\) may also contain further information about the kind of entity that the agent takes the entity representation to represent.

- In relation to the case of our hunter \(h\) it is natural to assume that anchored entity representations are involved too, viz. that \(h\) has perceptually anchored representations for both the oak tree and the deer. We assume that these anchored representations have the following forms:

\[(A(x)) \quad <[\text{ANCH}, x], <x, s \mid \text{deer}(x), n \subseteq s, \text{see}(i,x) > >\]

\[(A(z)) \quad <[\text{ANCH}, z], <z, s' \mid \text{tree}(z), n \subseteq s', s': \text{see}(i,z) > >\]

Assuming that these are part of \(h\)’s mental state at the moment he thinks he has detected the deer and is ready to shoot we get as representation of the relevant part of his mental state at that moment:

\[(D1) \quad s' \quad x \quad \{ <[\text{ANCH}, x], n \subseteq s' \quad \text{deer}(x) \quad s': \text{see}(i,x) > >,\]

\(s'' \quad z \quad \} <[\text{ANCH}, x], n \subseteq s'' \quad \text{tree}(z) \quad s'': \text{see}(i,z) > >,\]

\(<\text{BEL}, t \quad s > >,\]
5. External and internal indexicals; attitudes de re and de se.

- Having an anchored representation of a thing to which one attributes a property in thought is different from self-attribution. (Cf. Lewis: “Attitudes de dicto and de se”.)

There is a crucial distinction between de se thoughts and de re thoughts (assuming, as we do here, that the latter are a genuine possibility).

- We use “i” as an “internal indexical” representing the agent’s self and always part of the representation of a self-attribution. (“i” only occurs as part of descriptions of mental states; in our final formulation given below: within the scope of an occurrence of the predicate Att.)

- When “n” occurs internally to a mental state description, then it acts as an internal indexical representing the psychological present of the agent (i.e. the time at which the agent entertains the given thought or thoughts).

- These occurrences are different from those of “n” we have considered hitherto. In these latter occurrences “n” acts as an “external indexical”, representing the time of the represented utterance. Other external indexical discourse referents are “sp” for the speaker and “ad” for the addressee (assuming there is any).

These different indexicals make it possible to represent both the public content of an utterance involving 1st and or 2nd person pronouns and the thoughts that are expressed through and recovered from such an utterance.

Example:

(1) I like you.

(i) (representation of the (public, semantic) content of (1))

(K.i) t s

\[ t = n \quad t \subseteq s \]

s: like(sp,ad)

(K.i) is true in a given context C if there is a verifying embedding f such that f(n), f(sp) and f(ad) are the time of C, the speaker of C and the addressee of C and there is at f(n) a state F(s) that consists in f(sp) liking (f(ad). (i. e. (K.i) is true if the speaker of C likes
the addressee of C at the time of C.)

(ii) (representation of the speaker’s thought expressed by (1))

\[ \{ <[ANCH,x], \quad s' \quad y > \]

\[ n \subseteq s' \quad \text{person}(y) \]

\[ s': \text{talk-to} \quad (i,y) \]

\[ t \subseteq s \]

\[ <\text{BEL}, \quad t = n \quad t \subseteq s \]

\[ s: \text{like}(i,y) \]

\((de \ se \ with \ respect \ to \ the \ subject \ of \ “like”; \ de \ re \ with \ respect \ to \ the \ object \ of \ “like”)\)

(ii) (representation of the addressee’s thought recovered from (1))

\[ \{ <[ANCH,x], \quad s' \quad x > \]

\[ n \subseteq s' \quad \text{person}(x) \]

\[ s': \text{talk-to} \quad (x,i) \]

\[ t \subseteq s \]

\[ <\text{BEL}, \quad t = n \quad t \subseteq s \]

\[ s: \text{like}(x,i) \]

\((de \ re \ with \ respect \ to \ the \ subject \ of \ “like”; \ de \ se \ with \ respect \ to \ the object \ of \ “like”)\)

Syntax and semantics of the formalism:

1. Descriptions of single attitudes and complex mental states.

Assume as underlying formalism L a DRS language of the kind we have been using so far, in which temporal and aspeuctual phenomena can be represented using discourse referents for times, events and states and which has predicates denoting the necessary temporal relations \((<, \leq , \geq , ..)\).  

- An attitude description is a pair \(<\text{MOD},K>\), where

  (i) \text{Mod} is an attitudinal mode indicator (here, and minimally, BEL, DES, INT);

  (ii) \text{K} is a DRS, which specifies the content of the represented attitude

- An attitudinal state description is a set the members of which are either (a) attitude descriptions or (b) entity representations. (Here we only consider anchored entity representations, as defined above.)

Attitudinal state descriptions must satisfy some well-formedness constraints. While the
DRSs occurring in the description do not need to be proper in general - i.e they may have free occurrences of discourse referents - , every discourse referent \( \alpha \) occurring anywhere in the description must be bound somewhere within the description. (i.e. \( \alpha \) must occur in the universe of some DRS occurring in the description and that is accessible from the DRSs that contain free occurrences of \( \alpha \).) Accessibility is constrained by the attitudinal hierarchy. (For instance, BEL is accessible from both DES and INT, but not vice versa.)

- To integrate attitudinal state descriptions within our DRS language L we extend L with the predicate “Att”. “Att” has a referential argument slot for a state as well as three “non-referential” argument positions, one for the agent of the attitudinal state in question, one for an attitudinal state description as defined above, and one for external anchors corresponding to internally anchored entity representations that are part of the description in the second argument position.

(When there are no external anchors, the third argument position is often conveniently suppressed.)

Example:

Suppose that we want to represent the information that at some time before now a hunter \( h \) was in the mental state described by (D1). The following DRS (D2) will do this. (N.B. (D2) assumes that the internally anchored entity representations involving \( x \) and \( z \) are externally anchored to entities of the right sorts. Representations corresponding to other possible scenarios we considered can be constructed analogously.)

(D2)

\[
\begin{align*}
& t_0 < n \quad t_0 \subseteq s_0 \quad \text{hunter}(h) \quad \text{oak tree}(z') \quad \text{deer}(x') \\
& \{ <[\text{ANCH},x], \quad s' \quad x \quad [\text{ANCH},x], \quad s'' \quad z \quad [\text{ANCH},x], \quad s'' : \text{see}(i,z) \} \\
& s_0 : \text{Att}(h, \quad t \quad s \quad [\text{BEL}, \quad t = n \quad t \subseteq s \quad s : \text{behind}(x,z) \}
\end{align*}
\]
It should be clear that in the extension $L'$ of $L$ with Att-predications we can also describe $h$ as being in complex attitudinal states at different times, and so that we can describe changes in $h$'s mental state.

The formalism also enables us to represent “nested” attitudes. For instance, the belief that Mary has now that at some earlier time John thought that she didn’t like him can be represented as in (D3).

(D3) \[
\begin{array}{cccc}
\text{t} & \text{s} & \text{m} & \text{j} \\
\text{t} < \text{n} & \text{t} \subseteq \text{s} & \text{Mary(m)} & \text{John(j)} \\
\end{array}
\]

\[
\langle[\text{ANCH}, \text{j'}], \text{K(j')} \rangle,
\]

\[
\text{s}: \text{Att(m, \{} \text{t}, s' \text{,} \{<\text{j'}, \text{j}>\} \text{,} \{<\text{j'}, \text{j}>\})}
\]

\[
\langle[\text{ANCH}, \text{m'}], \text{K'(m')} \rangle,
\]

\[
\text{s'}: \text{Att(j', \{} \text{s''} \text{,} \{<\text{m'}, \text{i}>\})}
\]

\[
\langle[\text{ANCH}, \text{m'}], \text{K'(m')} \rangle,
\]

\[
\text{s'':} \text{\neg-like'(m',i)}
\]

The formalism is designed to allow for the systematic representation of attitude-reporting sentences and sentence sequences. For a couple of examples see pp. 13-17.

Semantics for $L'$

The model-theoretic semantics for $L'$ is complicated because it has to cater for a number of different representational capacities that $L'$ incorporates:

- referential connectedness of two or more attitude descriptions that make up the description of a complex mental state.
- the possibility of attitude “nesting” (as in (D3)).
- the presence of internally anchored entity representation, with or without corresponding external anchors.
• the correct interpretation of internal indexicals.
• the “logical omniscience”/“logical equivalence” problem

The existing model theory for L’ makes use of dynamic semantics in that it assumes that the
DRSs that specify the contents of individual attitudes denote CCPs (Context Change
Potentials) – partial functions from information states to information states. Only proper
DRSs define CCPs that are total functions and that can be identified with information states.

The models for L’ are intensional models for the underlying language L which in addition
assign intensional mental states to those individuals a in the different worlds w of the model
at the times at which a exists and is conscious. Intensional mental states are assumed to be
sets of pairs <MOD,J>, where MOD is a mod indicator and J is a CCP. Moreover, intensional
mental states are subject to well-formedness constraints similar to those imposed on
attitudinal state descriptions.

The truth value of a DRS K of L’ in an intensional model M in a world w at a time t involves
evaluation of conditions of the form “s: Att(α,K,EA)” at the relevant times in the relevant
worlds.

Drawbacks:
• The model-theory does not deal adequately with the logical omniscience problem (as
  probably no model-theoretic account could). If at all, then this problem can only be
tackled making use of the syntactic properties of L’.
• The model-theoretic semantics of nested attitude description is very hard to trace.
• In general, the model theory is very complex and seems to provide little by way of
  immediate guidance as regards the actual meanings of the representations that L’ makes
  available. (At least, it hasn’t been of much practical use to us so far.)
Exercises on propositional attitude reports

(1) Phoebe thinks that a prowler broke into her garden last night. She thinks he took her prize zucchini (and she wants him to be apprehended).

Representation of the first sentence:

(1.a) 

\[ \text{p} \quad \text{t}_1 \quad \text{s}_1 \quad \text{t'} \quad \text{g} \]

\[ \text{Phoebe(p)} \quad n = t_1 \quad t_1 \subseteq s_1 \quad \text{“last night”}(t') \quad \text{“p’s garden”}(g) \]

\[ s_1: \text{Att(p, } \{<\text{ANCH},t’’>, <| >, \{<\text{ANCH},g’>, <| >, <\text{BEL}, K>, \{<t’, t’>, <g’, g>\}) \}

Here K is the DRS:

(1.b) 

\[ \text{x} \quad \text{t’} \quad \text{e}_1 \]

\[ \text{prowler(x)} \quad t_1' \prec n \quad e_1 \subseteq t_1' \quad t_1' \subseteq t'' \]

\[ e_1: \text{break-into’}(x,g’) \]

N.B. In this representation the DPs her garden and last night have been given de re interpretations: Phoebe is assumed to have anchored representations for these entities, with the discourse referents g’ and t’’. These are externally anchored to the discourse referents g and t’ that are “declared” in the universe of the main DRS. (The referential presuppositions associated with possessive DPs - which were treated in some detail earlier - and definite DPs like last night - with which we have not dealt explicitly - warrant that these discourse referents represent unique entities.)

This means that the propositional content of the represented belief is singular both with respect to the garden and the temporal location of the event that is provided by the temporal adverb. According to the approach of which this is our first illustration singularity is very common- almost the rule rather than the exception. I believe that is in the nature of the way in which we report attitudes. And to the extent that our attitude reports are credible, it is also in the nature of the reported thoughts themselves.

Preliminary representation of the 2\textsuperscript{nd} sentence of (1):
Here $<\text{PRES, K'}>$ is the following structure:

\[(1.d)\]

\[
< \{ <y | \text{pers}(y), \text{male}(y)>, <t_2 | \rho_2(t_2, t'_2) > \}, <e_2 | t'_2 < n, e_2 \subseteq t'_2, e_2: \text{take}'(y,z'') \}> > \\
\text{PRES} \quad K'
\]

The pronoun presuppositions of the main DRS can be resolved in the "primary context" provided by the main DRS of the representation for the first sentence; for both $p$ is a suitable antecedent. (We have already relied on the plausible assumption that "Phoebe" names a female person by resolving the "her" of the first sentence to $p$.) The referential presupposition of the possessive DP her zucchini has to be accommodated.

The presupposition set PRES adjoined to K’ is a different matter. For these resolution involves the "secondary context" provided by the representation K of the belief attributed in the first sentence. Some checking is needed to verify that this representation can be used for the resolution of these presuppositions. In this case the result is unequivocal: same attitudinal agent ($p$, after resolution of $u$ to $p$), same time (utterance time $n$ of the report), same attitudinal mode (BEL). Using $K$ we can resolve the pronoun presupposition by identifying $y$ with $x$, and the tense presupposition by identifying $r_2$ with $t'_1$. (We can then also resolve $\rho_2$ to "<", with the effect that $e_1 \subseteq t'_1 < t'_2 \subseteq e_2$.)

Since after these resolutions the first and the second sentence of (1) attribute attitudes to the same person ($p$) at the same time ($n$), the attributions can be combined into a single representation of the mental state (of $p$ at $n$). The remainder of the DRSs of the two representations can then be merged in the usual way. The result is as follows:

\[(1.e)\]

\[
\begin{array}{ccccccc}
  p & t_1 & s_1 & t' & g & C \\
  t_2 & s_2 & u & v & z \\
\end{array}
\]

Phoebe(p) \quad n = t_1 \quad t_1 \subseteq s_1 \quad "\text{last night}'(t')" \quad "p's garden"'(g) \\
\quad u = p \quad n = t_2 \quad t_2 \subseteq s_2 \quad u = p \quad v = p \quad \text{pr.'zucch.'}(z'), \\
\quad \text{poss}(z', v) \quad C(z') \\
(\exists!z') < z' | "\text{prize zucchini}'(z'), \text{poss}(z', v), C(z') > \\
\]

$s_1: \text{Att}(p, \{<[\text{ANCH}, t''], \text{< | >},\{<[\text{ANCH}, g'], \text{< | >},\{<[\text{ANCH}, z''], \text{< | >},\{<\text{BEL, K'}, <\text{BEL, K''}> \}, \{<t', t''>, <g', g>, <z'', z'> \} \}$

(1.c)
Here \( K \) is, as before, the DRS:

\[
\text{(1.f)} \quad x \quad t'_1 \quad e_1
\]

\[
\text{prowler}(x) \quad \quad t'_1 < n \quad e_1 \subseteq t'_1 \\
\text{e}_1: \text{break-into}'(x,g')
\]

\( K'' \) is the DRS:

\[
\text{(1.g)} \quad t'_2 \quad e_2 \quad y
\]

\[
t'_2 < n \quad t'_1 < t'_2 \quad e_2 \subseteq t'_2 \quad y = x \\
\text{e}_2: \text{take}'(y,z'')
\]

Note that the representation \( K'' \) of the second belief “depends on” the representation \( K \) of the first belief in having free occurrences of the discourse referents \( t'_1 \) and \( x \). By virtue of sharing these discourse referents the two beliefs are referentially connected.

We have ignored the parenthetical second conjunct of the second sentence. Processing of this conjunct adds an attitude of a different attitudinal mode (“want”, which we represent by the mode indicator DES) to the attitudinal state described. The content representation of the reported want will also be referentially connected with the two beliefs, via the resolution of the pronoun “him”.

Now consider example (2) (with “was in” as verb of the complement clause of the second sentence).

(2) Phoebe thought that a prowler was in her garden last night.  
    She thought he was taking her prize zucchini.

We interpret the tenses of the complement-clauses as “bound by” the tenses of their matrix verbs. For the first sentence this will have the effect that the state \( s'_1 \) described by the complement clause will be located by the location time \( t_1 \) of the state described by the matrix verb \textit{think}. We get the following representation:
This time K is the DRS:

(2.b) 
\[
\begin{align*}
&x & t'_{1} & s'_{1} \\
&\text{prowler}(x) & t'_{1} = n & t'_{1} \subseteq s'_{1} \\
&s'_{1}: & \text{be-in'}(x,g')
\end{align*}
\]

The preliminary representation for the second sentence of (2) is given in (2.c).

(2.c) 
\[
\begin{align*}
\langle t_{2}, s_{2}, u, v, z, y, t'_{2}, s'_{2} | < & \{ < u | \text{pers}(u), \text{fem}(u) > , < v | \text{pers}(v), \text{fem}(v) > , < t_{2} | \rho_{2}(r_{2}, t_{2}) > \\
&< \{ < C | > , (\exists ! z') < z' | \text{"prize zucchini"}(z'), \text{poss}(z', v), C(z') > > \}, \\
&< s_{2} | t_{2} < n, t_{2} \subseteq s_{2}, s_{2}: \text{Att}(u, \{ < [\text{ANCH}, z''], < | > , < \text{BEL}, K' > , \{ < g', g > \} > > >
\end{align*}
\]

\(< \text{PRES}, K' > \) is the structure given in (2.d):

(2.d) 
\[
\begin{align*}
\langle < y | \text{pers}(y), \text{male}(y) > , < t'_{2} | > \rangle , < s'_{2} | t'_{2} \subseteq s'_{2}, s'_{2}: \text{PROG}(\wedge e_{2}, e_{2}: \text{take'}(y, z'')) > > \\
\text{PRES} & K'
\end{align*}
\]

The presuppositions adjoined to the main DRS that are shared with the preliminary representation for the 2\textsuperscript{nd} sentence of (1) are resolved as before. However, there is one additional representation now, the one related to t\_2 and introduced by the past tense of thought. The natural resolution here is to identify \(t_{2} = t_{1} \) and \(\rho_{2} = '\='\). If we implement these instructions as we have so far, we get the condition “\(t_{2} = t_{1} \)”. However, we will encode this information here in a slightly different way, viz. as “\(t_{2} = n \)”. Here \(n\) represents the ‘now’ from the temporal perspective of the thinker \(u\) at the time of the thinking. (Note well that this implies that when \(n\) occurs within the second argument of an occurrence of ‘Att’, it does not represent the utterance time of the represented report, but the time of the reported thought. In
other words, the time represented by an occurrence of \( n \) is a function of its position within the DRS.

The one presupposition in PRES is once again resolved using the secondary context provided by \( K \). Note that the use of \( K \) can now be shown to be legitimate only after \( u \) has been resolved to \( p \), \( t'_2 \) to \( t_2 \) and \( t_2 \) to \( t_1 \) (via resolution of \( <t_2|\rho_2(t_2,t_2)> \)). Once the use of \( K \) as secondary context has been vindicated, \( y \) can be resolved to \( x \) (as in the DRS construction for (1)).

The final joint DRS for the two sentences of (2) is the one in (2.e):

\[
\begin{array}{cccccccc}
  & p & t_1 & s_1 & t' & g & C \\
  t_2 & s_2 & u & v & z \\
\end{array}
\]

\[
\text{Phoebe(p)} \quad t_1 < n \quad t_1 \subseteq s_1 \quad \text{“last night”}(t') \quad \text{“p’s garden”}(g) \\
\quad u = p \quad t_2 < n \quad t_2 \subseteq s_2 \quad u = p \quad v = p \quad \text{pr.’zuch.’}(z'), \quad \text{poss}(z',v) \quad C(z') \\
\quad t_2 = t_1
\]

\( (\exists!z') < z’ \mid \text{“prize zucchini”}(z’), \text{poss}(z’,v), C(z’) > \)

\[
s_1: \text{Att}(p, \{<[\text{ANCH},g'], < | >, <[\text{ANCH},z’'], < | >, <\text{BEL}, K>, <\text{BEL}, K''> \}, \\
\{<t'',t'>, <g',g>,<z'',z> \})
\]

Here \( K \) is the DRS (2.b):

\[
(2.f) (= (2.b)) \quad x \quad t'_1 \quad s'_1
\]

\[
\text{prowler}(x) \quad t'_1 = n \quad t'_1 \subseteq s'_1
\]

\( s'_1: \text{be-in’}(x,g') \)

and \( K'' \) is the DRS:

\[
(2.g) \quad t'_2 \quad s'_2 \quad y
\]

\[
t'_2 = n \quad t'_2 \subseteq s'_2 \quad y = x
\]

\( s'_2: \text{PROG}(<e_2,e_2>: \text{take’}(y,z'’)) \)
Propositional attitudes and Propositional Attitude Reports

1. The classical approach:
   a. Focus on the semantics of attitude report sentences (i.e. sentences which are used to ascribe a propositional attitude to some agent) in some given ‘object language (e.g. English).
   b. Concentrate on attitude sentences of some specific form, in which an attitudinal verb (usually in the present tense) is followed by a that-clause or embedded question.
   c. Analyze the verbs of such sentences as modal operators, with a semantics given in terms of Kripke structures.

2. Problems:
   i. Treatment of attitudinal verbs as modal operators leads to head on clash with the Logical Omniscience Problem.
   ii. The restriction to attitude reports of the specific forms mentioned under b. is extremely and absurdly restrictive. Much of what we have to say about our own and others’ attitudes has to do with how they change (we learn, forget and change our minds); and they exploit a much wider range of linguistic forms; and as often as not they extend over several connected sentences.
   iii. We are unlikely to get the semantics of such reporting sentences and discourses right without some independently motivated assumptions about the way in which mental states are structured and about the mental representation of the contents of the propositional attitudes that are part of them. This applies even to the limited repertoire of attitude report sentences to which most studies have been limited.

It seems that the approach characterized by a. - c. above came about because Kripke semantics for modality had proved so very fruitful that it came to be seen as a cure for all ailments. (But what works for hay fever doesn’t necessarily work for a slipped disc.)

The willingness to take the Logical Omniscience Problem as a kind of collateral irritation, which can be set aside while one is dealing with the important problems, and will be addressed once the central issues have been resolved, is perhaps the most notable example of our willingness to swallow the unswallowable just so that we can apply methods of analysis which have little more to recommend them for the problem at hand than that we feel reasonably at home with them. The Logical Omniscience Problem was well-known from the moment that the methods of modal semantics and logic came to be applied to the analysis of attitudinal verbs. And interestingly enough the problem shows itself in its most blatant form in precisely those cases where people are the most careful about their beliefs and other attitudes and go to the greatest length to decide what they should believe and what not. What I am referring to are mathematicians who are trying to decide what mathematical statements the
can and should believe and which they should reject. The business of the working mathematician is to turn mathematical conjecture into knowledge and belief, and the transition from one to the other normally takes place only if someone has succeeded in providing the only evidence that really counts in mathematics, viz. proof. But one feature of mathematical proof is that it shows its results — the theorems proven — to be necessarily equivalent to things that were known and believed already. This means that before the proof was found, those looking for it did not believe, and much less know, the theorem proved, while they did know, and thus believe those necessarily equivalent things.

In other words, the mental states of mathematicians are flagrant, never-ending violations of the logical omniscience principle — the principle that when $\varphi$ and $\psi$ are logically equivalent, then ‘a believes that $\varphi$’ is true iff ‘a believes that $\psi$’ is true. Moreover, mathematicians are fully aware of this sorry state of affairs and their working lives are persistent quests to remove, from their own minds and those of their colleagues, as many violations of the principle as possible, but knowing full well that for every violation they manage to remove there are many other that remain, and new ones — new unsolved questions — that are added to their violation list.

In ‘Prolegomena to a Structural Theory of Belief and other Attitudes’ (Kamp, 1990) an example is given to show that the Logical Omniscience Problem is not restricted to the mental states of the practitioners of pure mathematics. Our daily lives are infected with (homely forms of) mathematics to such an extent that the problem also affects the attitudes that we have towards such contingent propositions as how much money we have in our pocket or in our bank account.

In what follows I will not offer a solution to the Logical Omniscience Problem. But the proposals that follow will at least keep the door ajar to such a solution. In fact, at one point we will encounter, as part of the proposals I will make, the very issue that lies at the heart of the Omniscience Problem: the tension between the syntactic and the semantic properties of semantic representations or logical forms.
Information Structure

‘Information Structure’ is a term with underdetermined extension. Linguists have used the term to cover different ranges of phenomena, and even today there its use is far from consistent.

If taken literally, the term ‘information structure’ may well look as if it should concern almost everything that is of interest to the semanticist of natural language – anything, in fact, that has to do with the relationship between meaning and linguistic form. For what are linguistic forms, if they aren’t ways of ‘structuring the information’ they are meant to express and convey? But within semantic theory the term ‘Information Structure’ has always traditionally been used in a more specific sense: the subject matter of information structure is how different parts of an utterance serve different information-theoretic functions. The central concern has long been the distinction between those parts of a sentential utterance that serve to present something – a ‘theme’ or ‘topic’ – about other parts of the utterance – constituting the ‘rheme’ of the utterance – then make some claim – the ‘comment’. Another way to characterize this distinction is that between ‘given’ and ‘new’: the theme/topic of an utterance is what is in some sense ‘given’ while the rheme/comment gives or is the information that is ‘new’. Equating ‘given’ and ‘new’ in this way with ‘theme’/‘topic and ‘rheme’/‘comment’ in this way oversimplifies the relations between them, but in first approximation the identification is not too far off and it is good enough for a first rough orientation.

Characterized in these general terms ‘Information Structure’ is still a very broad notion. For one thing, the characterization seems to cover quite clearly the distinction between the presuppositional and the non-presuppositional content of an utterance: presuppositional information is presented as familiar – that is, as ‘old’, or ‘given’, information; and the non-presuppositional information, which typically builds upon the presuppositional information, is the information that is presented as ‘new’. So, if ‘Information Structure’ I understood in this somewhat more specific, but still quite broad way, then much if what we have been doing up to this point, counts as information structure as well.

However, as linguistic theory developed over the past three decades, a use of the term has developed that is more specific still, at least within the formal semantics community. The core notions of ‘Information Structure’ in this even more specific sense are ‘focus’, ‘topic’ and, in the most recent developments, also ‘issue’. Of these three, ‘focus’ is the concept that has been the most clearly defined and for which there now exist the most explicit, formally precise and detailed accounts, with genuine predictive power. (I.e. they make specific predications about the meaning and felicitous use of particular utterances in particular contexts.)

Formal accounts of ‘topic’ have also emerged over the past three decades, but here the picture is complicated by the fact that also in the more formally explicit ‘topic’ theories that – much more so than in the case of focus – earlier discussions of ‘topic’, generally conducted in a more informal vein or supported by very different general background assumptions, have bequeathed us with a number of connected and often overlapping, but nevertheless non-identical notions, which any more precise treatment is forced to distinguish. We are still waiting for a definitive, generally agreed-upon answer to the question: ‘What are the different notions of ‘topic’ that a theory of Information Structure should distinguish and deal with, and how are these notions related to each other?’ And so long as an answer to this double question – What are the different topic notions and what are the relations between them? - remains
outstanding, our theories of topic will remain seriously incomplete.

One of these different topic notions is closely connected - perhaps even identical – with the third of the notions mentioned above, that of an ‘issue’. ‘issues’, in this sense are ‘topics of discussion’, questions that demand the center of attention in a discussion – or for that matter in a text – at some particular point in the course of it, with an associated requirements that that question should now be addressed. In even more recent developments one associates with this notion of ‘issue’ that of an utterance (or sentence in a text) being ‘at issue’: Suppose that at some point in a text or discussion the issue is Q, and that the next utterance/sentence S addresses Q. Then as a rule, S will contain certain parts that directly address Q; these are the parts that convey the ‘at issue’ content of S. But more often than not S will contain other material as well, material that conveys information that is ‘not-at-issue’. And such not-at-issue material can take a large variety of different forms. It can serve to specify the topic of the utterance - in more than one sense of ‘topic’ – but is can also be used to slip in information that is ‘collateral’ to the at-issue content, in that it provides a reason why this answer to the issue Q is the right one, or a plausible one, but also to convey information that may be connected with the at-issue content in various other ways, and ways that may be less or more remote.

In what follows we will start with that part of the theory of Information Structure in the current more closely circumscribed meaning of the term that has reached the greatest degree of maturity, the theory of focus. We start out with theories of just focus, and here we will concentrate on work by Mats Rooth, who can be considered the father of formal information structure theory as a branch of natural language semantics.

I. Focus

Literature.

Beaver, D. and B. Clark, Sense and Sensitivity,
Büring, D. The 59-th Street Bridge Accent.
Büring, D.
Rooth, M., Association with Focus. (Ph. D. Diss., Umass, Amherst, 1985)
Rooth, M.,”A Theory of Focus Interpretation”, Natural Language Semantics 1(1), 75-116, 1992
Schwarzchild, R., “Givenness, avoid f and other constraints on the placement of focus”, Natural Language Semantics 7(2): 141-177, 1999

Some classical examples (Rooth, 1985)

(1) a. Mary only introduced [BILL]F to Sue.
b. Mary only introduced Bill to introduced [SUE]F.
c. Mary only [INTRODUCED]F Bill to introduced Sue.

(Here the use of capitals indicates focal stress. For the subscripts F see below.)

Intuitively, these three sentences have different truth conditions. In predicate logic notation these can be rendered as follows:

(1’) a. Intr(m,b,s) & (∀x)((Intr(m,x,s) & Alt(x)) → x = b)
b. \( \text{Intr}(m,b,s) \land (\forall x)((\text{Intr}(m,b,x) \land \text{Alt}(x)) \rightarrow x = s) \)

c. \( \text{Intr}(m,b,s) \land (\forall R)((R(m,b,s) \land \text{Alt}(R)) \rightarrow R = \text{INTRODUCED}) \)

(Here ‘INTRODUCED’ is a constant denoting the 3-place relation of having introduced someone to somebody.)

In Rooth’s *Alternative Semantics* (which we will abbreviate as ‘AltSem’) the sentences in (1) get assigned truth conditions corresponding to the formulas in (1’).

In Rooth’s Alternative Semantics the semantic values of natural language sentences are computed directly from their syntactic structures. (In this regard AltSem follows Montague Grammar). Furthermore, Rooth’s presentations of AltSem assume a model theory that is considerably simpler than the one we have been assuming here ever since we started looking at tense and aspect. For a presentation of the central ideas of AltSem it will be convenient to adopt such a model theory temporarily. In this model theory models are intensional but ‘timeless’. We can think of them as all concerned with just one instant of time and thus can be thought of as ‘time slices’ of the intensional models \( M \) we have been using: Take an intensional model \( M \) in our sense and some time \( t_0 \) from its time structure and keep from each of its extensional models \( M_w \) only the information that it gives about what is going on at \( t_0 \). I such ‘time slice models’ we cannot treat verbs as descriptions of eventualities, but only as relations between their non-referential arguments. (Thus intransitive verbs have to be treated as ‘1-place relations’ (i.e. properties), simple transitive verbs as binary relations and a ditransitive verb like *introduce-to* as a ternary relation. As we have seen, such reductions only make good sense for stative verbs and verb projections, and of course, distinctions connected with tense cannot be captured. For the sentences in (1) with their past tensed verb form *introduced this means that the best we can do to capture its semantics in such models is to treat it as denoting the 3-place relation that corresponds to its result states: the relation which is satisfied by a triple \(<a,b,c>\) in a model \( M_w \) iff - speaking intuitively - there was an earlier event of a introducing b to c in w. (But of course, this event itself falls outside the scope of the time slice model \( M_w \)). We assume (as we have been doing all along) that the extensional models of \( M \) all have the same universe \( D_{e,M} \) of individuals.

In such a model \( M \) the semantic values of the DPs *Mary, Bill* and *Sue* may be taken to be three members of the domain \( D_{e,M} \), viz. the referents in \( M \) of these three names. (So the denotation of *Bill* in \( M \) is fixed throughout \( M \): for every \( w \) it is the referent \( I_M(Bill) \). And likewise for other names.) As said, the denotation in \( M \) of the past tense verb form *introduced to* is a relation-in-intension, a function from W to sets of triples of individuals. It will sometimes be convenient to denote this set as \( \lambda y. \lambda z. \lambda x. \text{introduced}'_{M,w}(x,y,z) \).

For the sentence (2), which is like (1.a) but without *only*, semantic value computation proceeds in the familiar way. More specifically, suppose we assume for (2) the syntactic structure in (3), in which the tense projection has been omitted. (Since the models we are assuming do not handle temporal information, the information provided by tense cannot be properly interpreted, so the tense projection would only be in the way.) The semantic values (relative to a given intensional model \( M \)) for the different constituents of (3) are given in (4).

(2) Mary introduced Bill to Sue.
(3) S

Comp

TP

∅

DP

VP

Mary

V

DP (to) Sue

introduce Bill

(4) $[[[Bill]_{DP}]_{M,w}} = I_M(Bill)$

(Here $I_M$ is the interpretation function of $M$; we assume that $I_M$ assigns the same individual to the name Bill at each $w$ (and likewise for other proper names); we abbreviate $I_M(Bill)$ as ‘b’)

$[[[Sue]_{DP}]_{M,w}} = I_M(Sue) = s$;

$[[[Mary]_{DP}]_{M,w}} = I_M(Mary) = m$;

$[[[introduced]_{V}]_{M,w}} = I_M(introduced)(w)$

(We also write ‘introduced’$_{M,w}(x,y,z)$’ for ‘<$x,y,z>$ ∈ I_M(introduced)(w)’;
so ‘$I_M(introduced)(w)$’ can also be written as ‘$\lambda y.\lambda z.\lambda x.\text{introduced’}_M(w,x,y,z)$’.)

$[[[introduced Bill]_{VP}]_{M,w}} = \lambda z.\lambda x.\text{introduced’}_M(x,b,z)$;

$[[[introduced Bill to Sue]_{VP}]_{M,w}} = \lambda x.\text{introduced’}_M(x,b,s)$

$[[[Mary introduced Bill to Sue]_{S}]_{M,w}} = \text{introduced’}_M(m,b,s)$

Note that from each of the values obtained on the right hand side in (4) we can obtain a corresponding intension by abstracting over $w$. For the first three values this gives us constant functions, e.g. $\lambda w.b$ for the first value. For the last value, abstraction gives us a proposition (a function from possible worlds to truth values); more precisely: the proposition $\lambda w.\text{introduced’}_M(m,b,s)$.

In AltSem semantic values like those in (4) and the corresponding intensions are called ordinary values. The central idea of AltSem is to account for the semantically grounded effects of focus by defining the compositional recursion not just on ordinary values but on pairs consisting of an ordinary value and a focus value. The focus value of an expression is a set one of the members of which is the ordinary value, and of which the other members are entities of the same logical type. (For instance, if the ordinary value of an expression is an individual (i.e. a member of $D_{e,M}$), then so are all the members of the focus value.)

The focus value of a constituent is of interest only when that constituent involves focus marking, or F-marking. In (1.a-c) the focus-marked constituents are the parts presented in
capitals. The use of capitals in linguistic examples is an often used device to indicate that special kind of prominence which in spoken English is normally realized as ‘focal stress’ (a special kind of pitch accent). The means of focus marking vary between languages. Some languages do not use prosodic accentuation for this purpose, but mark focus morphologically or through syntactic position. But these differences do not concern us here. Our interests here are confined to the semantic and pragmatic effects of focus. We therefore assume, as is common in the semantic-pragmatic literature, that some component of the grammar is responsible for identifying the focus-marked constituents of a sentence and to make this information available as part of the input to semantic interpretation or evaluation. We may think of this device as ancillary to the parser that assigns sentences their syntactic structures and that its results are incorporated into the structures that serve as inputs to the semantic component of the grammar.

For instance, suppose that (2) is pronounced, like (1a), with focal stress on Bill. Then the syntactic structure that serves as input to the semantics is assumed to be as in (5).

(5)

\[
\begin{array}{ccc}
S & \text{Comp} & TP \\
\emptyset & DP_1 & VP \\
 & Mary & VP \\
 & & DP_3 \\
 & V & DP_2 \\
 & & (to) Sue \\
 & introduce & [Bill]_F \\
\end{array}
\]

In AltSem any constituent that is neither focus marked itself nor contains any focus marked constituents as subconstituents is assigned a trivial focus value. (It is convenient to identify this value with the singleton set that has the ordinary value as its only element.) But as soon as focus marking gets into the picture, focus values become important. As an illustration we show the pair values for the constituents of (5). The computation follows in essence (Rooth, 1985).

(6)

\[
\begin{array}{l}
[[[Bill]_{DP, w}]_{M, w}] = \langle b, D_{e,M} \rangle; \\
[[[Sue]_{DP, w}]_{M, w}] = \langle s, \{s\} \rangle; \\
[[[Mary]_{DP, w}]_{M, w}] = \langle m, \{m\} \rangle; \\
[[[introduced]_{V, w}]_{M, w}] = \langle \lambda y.\lambda z.\lambda x.\text{introduced}'_{M, w}(x,y,z), \{\lambda y.\lambda z.\lambda x.\text{introduced}'_{M, w}(x,y,z)\} \rangle; \\
[[[introduced Bill]_{VP, w}]_{M, w}] = \langle \lambda z.\lambda x.\text{introduced}'_{M, w}(x,b,z), \{\lambda z.\lambda x.\text{int'd}'_{M, w}(x,d,z) \mid d \in D_{e,M} \} \rangle; \\
[[[introduced Bill to Sue]_{VP, w}]_{M, w}] = \langle \lambda x.\text{introduced}'_{M, w}(x,b,s), \{\lambda x.\text{int'd}'_{M, w}(x,d,s) \mid d \in D_{e,M} \} \rangle; \\
[[[Mary introduced Bill to Sue]_{S, w}]_{M, w}] = \langle \text{introduced}'_{M, w}(m,b,s), \\
\end{array}
\]
\{\text{int'd'}_{M,w}(m,d,s) \mid d \in D_{e,M} \}\rangle.

Note:

i. The constituents with values \(<O,F>\) such that \(F \neq \{O\}\) are he focused constituent \([Bill]_{DP}\) and all those which contain it.

ii. The focus value of \([Bill]_{DP}\) is the set \(D_{e,M}\) of all entities in \(M\) of the type of the ordinary value of \([Bill]_{DP}\).

iii. Every ordinary value \(\text{[[Con]]}_{M,w}\) (where Con is any of the constituents in (6)) is an ‘extension’ (the extension of Con in \(M\) at \(w\)) and every focus value a set of ‘possible extensions’. In particular, the ordinary value of the sentence as a whole is a truth value and its focus value a set of truth values. However, by abstracting over \(w\) we can, on the basis of the definition in (6), associate with every ordinary value, and with each member of every focus value, a corresponding intension. When we make the transition to intensions in both the first and the second member of this last value pair, we get a pair consisting of a proposition and a set of propositions:

\[(7) \quad \langle \lambda w.\text{introduced'}_{M,w}(m,b,s), \{\lambda w.\text{int'd'}_{M,w}(m,d,s) \mid d \in D_{e,M} \}\rangle\]

Similarly, the one but last value, for the upper VP \textit{introduced Bill to Sue}, which is a pair consisting of a ‘property extension’ – viz. a set of individuals - and a set of such ‘property extensions’ – can be transformed into corresponding intensions. This yields a value pair consisting of a property and a set of properties.

What is the point of the focus values that make up the second members of these pairs? For the sentence in (5) it is hard to say anything very definite at this stage and an answer is better postponed till later. But the situation is different for (1a), in which \textit{only} makes use of the focus value of the constituent that is its adjunction site.

The way in which \textit{only} makes use of the value of its sister node is determined by its lexical meaning. Our first specification of the lexical meaning of \textit{only} will be preliminary in more than one way, but even for this first pass we need to deal with a couple of matters that aren’t altogether trivial.

Intuitively, the result of combining \textit{only} with such a value should have the effect of selecting the ordinary value as the only member of the focus value that satisfies the conditions that the context imposes on the semantics of the constituent with which \textit{only} is combined. What this should come to is easiest to explain when we assume that \textit{only} combines with a constituent of type \(t\) (i.e. a constituent whose ordinary value in \(M\) at \(w\) is a truth value; in (5) this is the TP constituent. In that case the result of the combination should be that the ordinary value of the sister is the only member of the focus value which has the distinction of being true.

So let us suppose for the sake of argument (but quite unrealistically) that the adjunction site of \textit{only} in (1a) is TP and that the subject DP has ended up in front of \textit{only} by some kind of movement operation. On this supposition the syntactic structure of (1a) would be as in (8).
Let us suppose also that in computing the semantic values for the constituents in (7) the DP Mary gets interpreted in situ. Proceeding as before we get as value for the lower TP of (7) the pair $<\text{introduced}'_{M,w}(m,b,s),\{\text{int}'d'_{M,w}(m,d,s) | d \in D_{e,M} \}>$ - a pair consisting of a truth value and a set of truth values.

Suppose also that only contributes to the semantics of its mother node an operator ONLY, which operates on the semantics of its adjunction site. That is, to obtain the semantic value of the mother node in $M$ in $w$, ONLY is applied to the semantic value of its sister in $M$ in $w$. According to what we said above, the result of this application should be that the ordinary value of the sister TP should be true and that all the other elements of its focus value should not be true. But what this comes to when ONLY is applied to the semantic value is just this: the ordinary value must be 1 (or ‘true’) and it must be the only member of the focus value that is 1. But the second part of this clause is empty. If the first part holds – that is, the ordinary value is 1 – then there are no possibilities for the focus value – it can be either $\{1\}$ or $\{1,0\}$. In either case 1 is the only element of the focus value that is equal to 1. So, on this way of trying to capture the contribution of only, its contribution is vacuous.

We can get a non-vacuous contribution if we intensionalize the semantic value of the sister node before applying ONLY. In that case the input to ONLY is not the value pair as given in (6), but the corresponding pair in (7), consisting of a proposition and a set of propositions. It is by operating on this pair in $w$ that ONLY produces the result stated in (9), viz. that (i) applying the first member of (7) to $w$ gives the truth value 1 and that applying any of the other propositions in the second member in (7) to $w$ gives the truth value 0. The result is stated more formally in (9). It is easy to verify that (9) is equivalent to our original statement of the truth conditions of (1a) given in (1’a).

(9) $$(\lambda w.\text{introduced}'_{M,w}(m,b,s))(w) \& (\forall d \in D_{e,M})( d \neq b \rightarrow \neg (\lambda w.\text{introduced}'_{M,w}(m,d,s))(w) )$$
(Note well that (9) says something coherent only when for any \( d \) in \( D_{\epsilon,M} \) such that \( d \neq b \) the proposition \( \langle \lambda w. \text{introduced'}_{M,w}(m,d,s) \rangle \) is distinct from the proposition \( \langle \lambda w. \text{introduced'}_{M,w}(m,b,s) \rangle \). In fact, there is a more general tacit presupposition underlying the present analysis, viz. that for any \( d \) and \( d' \) in \( D_{\epsilon,M} \) such that \( d \neq d' \), the proposition \( \langle \lambda w. \text{introduced'}_{M,w}(m,d,s) \rangle \) is distinct from the proposition \( \langle \lambda w. \text{introduced'}_{M,w}(m,d',s) \rangle \). There are could reasons for thinking that this and similar presuppositions are true. But it is not something we can formally prove, and so we do well to keep in mind that this is a presupposition of the present analysis. Similar presuppositions underlie other cases, in which only combines with other sentence material.)

It should by now be clear how the semantics of this operator – let us denote it as ‘\( \text{ONLY}_t \)’ – should be stated. The operator requires as inputs pairs \(<p, Q>\), consisting of (i) a proposition and (ii) a set of propositions containing the first one as one of its members. The result of applying the operator to such a pair produces a proposition \( \text{ONLY}_t (<p, Q>) \) given in (11)

\[
(11) \quad \text{ONLY}_t (<p, Q>) = \lambda w. (p(w) & (\forall q \in Q)( q \neq p \rightarrow \neg q(w) ))
\]

Alternatively, using Montague’s \( v \)-notation, we can state this in the form (11’):

\[
(11') \quad v \text{ONLY}_t (<p, Q>) = v p & (\forall q \in Q)( q \neq p \rightarrow \neg v q)
\]

However, the combination of only with its sister node involves more than just applying ONLY. It consists of two steps: (i) intensionalize the semantics of the sister; (ii) apply ONLY to the result of intensionalization.

**General moral:**

When \( only \) is adjoined to an adjunction site of type \( t \), then its semantic contribution is given by:

- intensionalizing the ordinary value and the members of the focus value; and
- applying the operation defined in (11) on the pair resulting from intensionalization.

(N.B. Intensionalization is possible because although the specification of the compositional processes exemplified in (4) and (6) are specified for particular worlds \( w \), these processes apply to all worlds \( w \) of \( M \). So the definitions (4) and (6) can be seen as defining not just extensional values but implicitly also intensional values.)

Unfortunately, the case we started out with is not one in which \( only \) seems to be adjoined to a constituent whose ordinary semantic value is a proposition. In (1a) \( only \) seems to be adjoined to the VP, at a point before the VP is combined with the subject DP. That is how Rooth analyzes such sentences explicitly in (Rooth, 1992) and there can be little doubt that this is the right analysis for such sentences. In fact, it is doubtful if there are any cases where \( only \) is adjoined to a constituent of type \( t \). (That is: not only is (7) the wrong analysis for (1a), it is not clear that there are any English sentences in which \( only \) occurs as adjunct to TP or S.)

So the syntactic structure that we want for (1a) is that in (12).
Still, the exercise we have just gone through is useful. For *only* seems to be polymorphic in much the same way that this is true for words like *and* or *not*. In particular, both *and* and *not* can be combined with constituents that denote properties rather than propositions, as in ‘lives in Austin and doesn’t like the heat’. This is a complex VP which is the conjunction of the constituent VP ‘lives in Austin’ and the negation (again a VP) of the VP ‘likes the heat’. These occurrences of *not* and *and* can be regarded as operators NOT$^{<e,t>}$ and AND$^{<e,t>}$ on VP meanings, i.e. properties. But the semantics of these operators is related in a very straightforward way to the semantics of *not* and *and* when used as sentence operators NOT$^t$ and AND$^t$. The connections are stated in (13).

\begin{enumerate}
\item For any property P and object x the property NOT$^{<e,t>}_P$(P) is true of x iff the proposition NOT$_t$(P(x)) is true.
\item For any properties P and Q and object x the property AND$^{<e,t>}_Q$(P,Q) is true of x iff the proposition AND$_t$(P(x),Q(x)) is true.
\end{enumerate}

The different occurrences of *only* are similarly related to a basic propositional use – even if no or very few actual instances of this basic use are documented in the given language (viz. English).

In particular, when *only* occurs as an adjunct to VP, then it can be assumed to denote an operator ONLY$^{<e,t>}$ with the following property:

\begin{enumerate}
\item For any pair $<P,Q>$, where P is a property and Q a set if properties which contains P, and any individual x,
\item the property ONLY$^{<e,t>}_Q$(<P,Q>) is true of x if and only if
\item the proposition ONLY$_t$($<P(x), \{Q(x) \mid Q \in Q \}>$) is true.
\end{enumerate}

To see the effects of (14) on the interpretation of (1.a) recall the value pair assigned to the higher VP of (5), repeated here as (15).
Once again intensionalization will be needed. Intensionalisation of the right hand side of \((15)\) gives \((16)\).

\[
\begin{align*}
\lambda w.\lambda x.\text{introduced}' M,w(x,b,s), & \quad \{ \lambda w.\lambda x.\text{int}' d' M,w(x,d,s) \mid d \in D_{e,M} \} >
\end{align*}
\]

According to \((14)\) ONLY \(<e,t>\) turns \((16)\) into the property in \((17)\).

\[
\lambda w.\lambda x.\text{introduced}' M,w(x,b,s) \& (\forall Q \in \{ \lambda w.\lambda x.\text{int}' d' M,w(x,d,s) \mid d \in D_{e,M} \})
\]

\[
(Q \neq \lambda w.\lambda x.\text{int}' M,w(x,b,s) \rightarrow \neg Q(w)(x))
\]

Assuming once more that if \(d \neq d'\), then \(\{ \lambda w.\lambda x.\text{int}' d' M,w(x,d,s) \neq \{ \lambda w.\lambda x.\text{int}' d' M,w(x,d',s) \},\) we can rewrite \((17)\) as \((18)\):

\[
\lambda w.\lambda x.\text{introduced}' M,w(x,b,s) \& (\forall d \in D_{e,M})(d \neq b \rightarrow \neg \text{int}' d' M,w(x,d,s))
\]

This is the property that Mary has in \(w\) iff Mary introduced Bill and nobody else to Sue; and that seems more or less right.

It is arguably only more or less right. That is because often the set of alternatives is more restricted than the definition above can account for. This is almost always so for focus constituents of higher type (and the larger constituents that contain such focus constituents as parts). For instance, a sentence like \((19)\), with focus on the adjective ‘green’, surely doesn’t mean that green is the only property such that Mary wears sweaters with that property.

\[
\text{Mary only wears [GREEN] sweaters.}
\]

Surely there will be properties \(P\) such that Mary wears sweaters that have the property \(P\). For instance the property ‘woollen’ – the sweaters she wears must be made out of something - or the property ‘hand-knitted’ - the sweaters she wears must have been put together in some way; and so on. The natural way to interpret \((19)\) is as saying that green is the only color such that Mary wears sweaters of that color.

There are also counterexamples to the assumption that the set of alternatives for a focused constituent is the set of all entities of the type of that constituent which involve constituents of type \(e\). These are cases in which the set of alternatives is contextually restricted, as in \((20)\).

\[
\text{Bill, Ellen and Frenchie all said that they would come to the party. But only Ellen did.}
\]

The second sentence of \((20)\) can be naturally interpreted as saying that the only one of Bill, Ellen and Frenchie that came to the party was Ellen. In other words, Ellen came, but Bill and Frenchie did not. Apart from Bill any number of other people may have come too, but about these \((20)\) has nothing to say.
(Rooth, 1992) introduces a device which makes it possible for the interpretation to take account of contextual restrictions like that in (20). This is his much hailed ~. In fact, ~ serves more than one purpose at once. On the one hand it offers a way of expressing association with focus. For instance, in the annotated syntactic tree in (21) ~ marks only as the focus-sensitive constituent that exploits the ‘focus-background’ structure of its sister.

\[
\begin{align*}
\text{(21)} & \quad \text{S} \\
\text{Comp} & \quad \text{TP} \\
\emptyset & \quad \text{DP}_1 \\
\text{Mary} & \quad \text{Adv} \\
only & \quad \text{VP}_\sim \\
\text{VP} & \quad \text{DP}_3 \\
\text{V} & \quad \text{DP}_2 \\
\text{introduced} & \quad [\text{Bill}]_F \\
\end{align*}
\]

At the same time ~ gives the opportunity to interpret the alternative set that is used for the interpretation of only as some (contextually motivated) subset of the sister’s focus value, the second member of the pair in (16), which the compositional semantics generates in much the same way as before.

\[
\text{(16)} \quad < \lambda w. \lambda x. \text{introduced}_w(x,b,s), \{ \lambda w. \lambda x. \text{int’d}_w(x,d,s) \mid d \in D_{e,M} \} >
\]

The interpretation of ~ must yield an alternative set S, subject to the following three constraints:

\[
\text{(22)}
\]

(i) The ordinary value o ∈ S. (In the present case o is the first member of the pair in (7).)

(ii) S ⊆ the focus value f. (In the present case f is the second member of the pair in (7).)

(iii) S contains at least one member other than o.

Exactly what S will be chosen will in general depend on context. In particular, when there is a set S satisfying the constraints in (22) that is ‘salient’ in the discourse context, then that may be a proper choice for the interpretation that ~ initiates. (As a matter of fact, the way in which alternative sets are often recovered from the discourse context suggests that the processes involved are much like those operative in other cases of set anaphora, such as those in recovering domain restrictions for quantifiers and definite descriptions. (21) is a case in point. We will follow this suggestion when incorporating a treatment of focus in the syntax-semantics interface we have been using.)

The function of ~ also draws attention to another question, which however could and should have been asked well before: The value that results from applying ONLY to the ordinary
value of its sister node and its alternative set produces what must surely be considered the ordinary value of the mother node. (For instance, (18), the result of applying \text{ONLY}_{\text{e,t}} \text{ to (16), gives us, when applied to w and then to Mary, the truth value in w of (1.a). But the general form of the compositional semantic requires that we get pairs of an ordinary value and a focus value at all nodes. So the question arises: What is the focus value of the upper VP in (21)?}

There are two answers to this question that come to mind:

(i) The focus value of the lower VP has done its work by supplying the needed input to \textit{only}; \textit{only} ‘absorbs’ the focus value, so to speak, so from this point on- and upwards it is as if the constituents determined by the syntactic nodes contained no focus constituents. In other words, the focus value should be the default value set aside for such cases, i.e. the singleton set of the ordinary value.

(ii) Although the focus has now served in the interpretation of the associated operator \textit{only}, it may serve further purposes as well. This suggests that we should either retain the focus value as given - i.e. the focus value of the lower VP in (21) – or that we should retain the alternative set that has result from the interpretation of \textit{~}.

In many earlier accounts of focus there seems to have been the (sometimes implicit) assumption that the right answer was (i). But evidence points the other way, and we will assume that the correct answer is one that is compatible with (ii).

One piece of evidence has to do with the role of focus in answers to \textit{wh}-questions. If the answer to a \textit{wh}-question is given in the form of a compete sentence, then it is the constituent in the answer that corresponds to the \textit{wh}-element of the question that must receive focal stress. One illustration of this is provided by the question answer pairs in (23).

(23) a. A: Who did Mary introduce to Sue?
   B: √ Mary introduced BILL to Sue.
   B: * Mary introduced Bill to SUE.

   b. A: Who did Mary introduce Bill to?
   B: * Mary introduced BILL to Sue.
   B: √ Mary introduced Bill to SUE.

(There is a systematic and obvious correlation between this constraint on the prosody of full sentential answers to \textit{wh}-questions and the usually more natural ‘term’ answers to such questions, which consist of just the constituent corresponding to the \textit{wh}-element of the question, as in (24))

(24) a. A: Who did Mary introduce to Sue?
   B: √ BILL.

   b. A: Who did Mary introduce Bill to?
   B: √ SUE.

Clearly it is the constituents that in (24) function as term answers on their own which carry the relevant new information, which provides the actual answer to the questions they are answers to. In the well-formed sentential answers in (23) all else is basically just repetition of
information that is already present in the question and that, in the answer, does no more than provide a suitable syntactic frame for the constituents that in (24) appear on their own. In fact, we normally prefer the more concise term answers to wh-questions than full sentential answers with all their extra verbal baggage. And we tend to reserve full sentence answers for those occasions where it is important to keep track of which wh-question is being answered, for instance when the questioner poses two wh-questions at once, as in (25).

(25)  
A: Who came to the party and who stayed till the end?  
B: Mary, Fred, Sue, Carl Ellen and Bill came but only Sue and Bill stayed till the end.

The focus constraints on full answers to wh-questions can be explained in the semantic terms that are already available to us: Questions, and in particular wh-questions, can be seen as presenting sets of alternatives from which an answer to the question should (ideally) select one. And one way of thinking of this set of alternatives is as a set of propositions. A true and complete answer to the question is then an answer which selects from the different alternative propositions that the question presents to the answerer the one proposition that is true. For instance, the question in (23.a) can be seen as presenting to the answerer the set of all propositions of the form “Mary introduced D to Sue.”, where D can be any set of people; and a true and complete answer to the question will select the true proposition from among this set – that proposition of the form “Mary introduced D to Sue.” With the property that the individuals in D are all and only those that Mary introduced to Sue.

But in a language like English answers to wh-questions are required to do a little more than just select the true proposition from the alternatives that the question presents: the answer must also bear witness to the set of alternatives from which it select the proposition it expresses. In full sentential answers this is accomplished by focusing the constituent corresponding to the wh-element of the question. According to Alternative Semantics this has the effect of assigning to the answer a pair consisting of its ordinary meaning (the proposition that is presented as the answer to the question) and a non-trivial set of alternatives. And – this is the explanation Alternative Semantics allows us to give for the prosodic constraint on full answers to questions – this set of alternatives must match the set of alternatives presented by the question.

We can now return to the matter of multiple uses of one and the same focus constituent. Cases of multiple use of focus can be found in answers to wh-questions which involve focus-sensitive operators like only. For instance, A’s question in (23.a) could also be answered as in (26).

(26)  
A: Who did Mary introduce to Sue?  
   i. B: Mary only introduced BILL to Sue.  
   ii. B: Only BILL.

In the full sentential answer (26.i) the focal stress on Bill serves two purposes: (i) it guides the interpretation of the contribution made by only; and (ii) it links the answer in the right way to the question that it is meant to be an answer to in that it induces a focus value that matches the set of alternatives presented by the question. But if that is so, then we should not discard the focus value that serves to interpret only in (26.i); for it will still be needed to verify that (26.i) is fitting as an answer to A’s question in (26).
In (26.i) the focus on Bill serves two functions, that of guiding the interpretation of *only* and that of making sure that the answer fits the question. But it is also possible that these two functions are performed by different constituents. This is what we see in the answer in (27).

(27)  
A: Who only eats vegetables?  
B: BILL only eats vegetables.

Here it is the prosodically marked *Bill* which insures that the answer fits the question, while the focus constituent associated with *only* is the DP *vegetables*.

B’s answer in (27) shows two further points of interest. First, although from a semantic point of view *vegetables* is clearly the ‘focus associated with *only*’, it is not prosodically marked in the way that is typical for focus constituents; that marking is reserved for the ‘new’ focus constituent *Bill*. Cases like *vegetables* in B’s reply are often referred to as *second occurrence focus*. As this term indicates, second occurrence focus occurs in utterances which repeat some sentence material that has been used immediately before, and where this material contains a focused constituent. In such cases it is enough if this constituent has been clearly marked as focused in the use that has just been made of the material; that is enough to fix its status within the repeated material, so that the focal stress that we typically use in English to mark focus can now be used to some other purpose. (In B’s answer in (27) it is used to single out *Bill* as the new focus.)

The second point is that when a sentence contains more than focus constituent and these constituents serve different functions, then the structure from which its semantics is computed must make clear which function each constituent serves. This is so in particular when the sentence contains a focus-sensitive operator like *only*: Which of the focus constituents contained in the sentence is associated with *only*? Consider the example in (28).

(28) Farmers who only grow RICE, also only EAT rice.

In the restrictor of (28) the focal stress on *rice* makes it clear that it is the constituent associated with *only*. But for the nuclear scope the matter is more complicated. The intuitively natural interpretation is that according to which the now distressed *rice* is still the constituent associated with *only*, while the stressed *eat* is associated with the focus-sensitive operator *also* – conveying that what such farmers do is not only grow nothing but rice but, in addition, eat nothing but rice.

In order that a syntactic tree provide the right basis for computing the AS-values that we want for such a sentence their information-structural annotation has to be more differentiated than the mere use of $[]_F$ and *~* can give us. We need co-indexing of some kind or other of focused constituents and the operators with which they are associated, as in (29).
(29) makes explicit (through co-indexation involving the indices 2,3,4) which constituents are associated with which operators. But by itself that isn’t good enough. We must also make sure that we keep the focus values associated with the different focus constituents are kept properly apart. The simple recursion proposed by Rooth doesn’t do that. This is something that could be fixed within Rooth’s directly compositional framework. But the repair is not completely straightforward. So given our general commitments it is preferable to try and do this within our own architecture.

There is one further phenomenon that complicates a general account of focus. It was noted in (Krifka, 2003?). It is exemplified by the sentence in (30).

(30) The teacher only asked [BILLIE]F’s mother to bring cookies.

The scenario in which we are to consider this sentence used is as follows: There is some party of the school class that has both Billie and his twin brother Charlie. Parents have been asked to contribute in natura and Billie’s mother is the only one who has been asked to bring cookies. The problem is this. Billie is not the only one in the class whose mother was asked bring cookies – for the simple reason that his mother is also Charlie’s mother. So when we compute the focus value for the sister of only in (30) in the way we have been doing we get the wrong result: an interpretation of the sentence according to which Billie’s mother was asked to bring cookies and Charlie’s mother was not, which in the given circumstances is a plain contradiction.

What we want in this case is, intuitively speaking, a set of alternative parents, not a set of alternative classmates. To get an interpretation that conforms to this intuition, we must, Krifka proposes, distinguish between focus constituents and focus phrases. In (30) ‘[BILLIE]F’ is the focus phrase and ‘[BILLIE]F’s mother’ the focus constituent. The semantic computation must now be modified in such a way that it is the set of individuals that can be described as ‘x’s
mother’ for some child x in Billie’s class which gets passed on higher, to get the intended set of alternative properties as focus value for the sister of only.

Since we do no longer need ~ to mark association with focus we can use it to mark focus constituents. So we get as syntactic structure for (30) the tree in (31).

(31)

```
S
  Comp
    TP
      ∅
        DP
          VP
            Det
              NP
                Adv
                  VP
                    Compl
                      teacher
                        V
                          DP
                            to bring cookies
                              asked
                                Det
                                  NP
                                    [[BILLIE]F,1 ’s mother]~1,1
```

Here the annotation ‘~,2’ tells us that the focus on Billie has to be converted into an alternative set for Billie’s mother. It is this set, which is then passed on to provide the basis for interpreting only along the lines of Rooth’s definition.
The ‘Billie’s mother’ cases must be sharply distinguished from a phenomenon that may look similar at first sight. Consider the examples in (32)

(32)  a. John only_1 tidied up [the LIVING ROOM]_1.
     He didn’t tidy up the study.
   b. John only_1 tidied up [the LIVING ROOM]_1.
     He didn’t do the dishes.

In (32.a) the alternatives to the VP that is the sister of only may be assumed to be properties of the form ‘λw.λx.tidy-up’_w(x,d)’, where d is some alternative to the living room. But in (32.b) this is not so. Here doing the dishes is apparently among the alternatives.

This phenomenon has been known for a long time, and the diagnosis is this: When the focal stress is on that part of a larger constituent that gets the default stress when the constituent is used in an information-structurally neutral way, then the constituent as a whole can be considered as focus-marked, and in that case the range of possible alternatives is wider. (In the case at hand now other tasks that the subject might have performed can count to, not only those that consist in tidying up something.)

So the usual, and correct annotation in this case is as in (33)

(33)  John only_1 [tidied up the LIVING ROOM]_1.
     He didn’t do the dishes.

(It should be noted that the second sentences in (32) also come with distinctive prosody. More about this later.)

Another problem for the present account, but also for the logical form account we will consider below, are sentences in which only associates with a DP, as in (34)

(34)  a. Only_1 [MARY]_F,1 was happy.
   b. Mary introduced only_1 [BILL]_F,1 to Sue.

Things get more complicated also when we have different focused constituents going with different operators. An example:

(35)  a. Mary only_1 introduced [BILL]_F,1 to Sue.
     She also_2 only_1 introduced [Bill]_F,1 to [ELLEN]_F,2.
   b. Mary only_1 introduced Bill to [SUE]_F,1.
     She also_2 only_1 introduced [FRED]_F,2 to [Sue/her]_F,1.

##
How is one to deal with focus-background information structure within a logical form approach like the one we have been pursuing?

Again we begin by considering the sentence

(36) Mary introduced [Bill]_F to Sue.

The preliminary representation of (36) that we aim for is that in (37).

(37)

\[
\begin{array}{cccccc}
m & b & s & C_F & y' \\
\text{Mary(m)} & \text{Bill(b)} & \text{Sue(s)} & C_F(b) & y' \neq b \\
\end{array}
\]

(alternative set restriction presupposition)

\[
\begin{array}{cccccc}
y_F & t & e \\
\text{C(y)} & t < n & e \subseteq t \\
\end{array}
\]

\( e: \text{introduce}'(m,y,s) \)

There are three things we need to clear about (37): (i) What is its semantics? (ii) How is it constructed from a syntactic structure for (36) with the necessary information-structure annotation? (iii) What is the general form of focus-induced semantic representations of which (37) is an instance and what are the general principles for constructing such representations? We will address the questions in (iii) as we answer (i) and (ii).

The focus marking of Bill in (36) is reflected in (37) by the three part division into (i) the alternative set restriction, (i) the focus frame, (ii) the focus and (iii) the alternative set restriction presupposition. In addition there is a presupposition for the alternative set restrictor predicate \( C_F \). The resolution of this presupposition makes it possible for the context to restrict the set of possible alternatives, as, for instance, in the way illustrated in (20). We have built Rooth’s restrictions on the resolution of ~ - the ordinary value must belong to the contextually restricted alternative set and, moreover, the set must contain at least one more member - into the presupposition.
(N.B. the $C_F$-presupposition often ends up as part of some larger presupposition set. In (37) this set also contains the presuppositions contributed by the three proper names of (36).)

Focus frame and focus correspond to focus value and ordinary value in Alternative Semantics. In fact, we can obtain an (ordinary value, focus value) pair by:

(i) determining the semantic values of the merge of the focus frame DRS $K_{ff}$ and the focus DRS $K_f$ (this gives the ordinary value), and

(ii) forming the set of semantic values that we obtain by assigning some admissible value to the focus variable $y_F$ and then expanding this assignment to an assignment to the entire Universe of the focus frame DRS (this gives the focus value).

(The admissible values for the focus variable $y_F$ are those which satisfy the constraint $C_F$.)

As it stands, this description of how the (ordinary value, focus value)-pair is obtained is hard to make sense of. In fact, it is incomplete as it stands and can be made precise in more than one way. The matter will be cleared up as we go along.

For now just note that one kind of (ordinary value, focus value)-pair that we can get along these lines is one which consists of a proposition as ordinary value – the proposition determined in a given intensional model $M$ by the merge DRS $K_{ff} \oplus K_f$ - and a set of propositions as focus value (the set of propositions we get by choosing an admissible value $d$ for $y_F$ and then forming the set of those worlds $w$ such that there is a verifying embedding $g$ of $K_{ff}$ in $M_w$ such that $g(y_F) = d$.

However, we observed earlier that it seems unnatural to invoke intensionality in an account of the truth conditions of sentences like ‘Mary only introduced [Bill]$_F$ to Sue’, in which the semantic contribution of focus is essential, but in which all compositional operations would appear to be extensional.

Suppose that the proper name presuppositions in (36) are accommodated and that the predicate DR is resolved (with or without accommodation) to some predicate $C_0$. This turns (37) into (38).

$$
\begin{align*}
&\begin{array}{c}
m \\
&\text{Mary(m)}
\end{array} &
\begin{array}{c}
b \\
&\text{Bill(b)}
\end{array} &
\begin{array}{c}
s \\
&\text{Sue(s)}
\end{array} &
\begin{array}{c}
C_0(b) \\
&
y'
\end{array}
\end{align*}
\begin{align*}
&\quad y' \neq b \\
&\quad C_0(y')
\end{align*}
\begin{align*}
&\begin{array}{c}
y_F \\
\end{array} &
\begin{array}{c}
t \\
\text{t < n}
\end{array} &
\begin{array}{c}
e \\
\subseteq t
\end{array} &
\begin{array}{c}
y = b \\
\end{array} &
\begin{array}{c}
> \\
\end{array}
\end{align*}
$$
(38) is free of presuppositions, but it is still not truly resolved in every respect, so long has no use has been made of its focus frame-focus structure. As (38) stands, there is no recognizable ‘point’ to the focus on Bill. Often, such a justification can be construed by relating the represented sentence in some appropriate way to the context, often in the sense of contrast. (Typically the immediately preceding or the immediately following sentence or clause, but more distant discourse material may come into this too.) We will look at examples of this shortly. But let us first have another look at the kind of sentence-internal use of focus that we have already considered. So once more our paradigm sentence (1.a).

(1.a) Mary only introduced \([\text{BILL}]_F\) to Sue.

When we build the representation for this sentence – details will be given below – we obtain, after resolution of the presuppositions, the representation in (39).

(39)

\[
\begin{array}{cccc}
m & b & s \\
\text{Mary}(m) & \text{Bill}(b) & \text{Sue}(s) & \text{C}_0(b) & y' \\
\end{array}
\]

\[
y' \neq b \\
\text{C}_0(y')
\]

\[
\text{ONLY}( < , t , e , y = b > ) \\
\text{C}_0(y) \\
\text{t < n} \quad \text{e} \subseteq \text{t}
\]

\[
e: \text{introduce'}(m,y,s)
\]

Here the ff-f division structure of (38) has been given as argument to the operator ONLY contributed by only. And now that the input to only is given in a certain representational form, we can articulate the contribution of only also in a way that exploits this form. And it is obvious how this contribution should be articulated, at least as long as we ask no more of the semantics of (1.a) than we have been doing so far. Intuitively it is plain what ONLY should do when we apply it to its input structure in (39): the result should say that the result of setting the focus variable y in the ff-DRS equal to b leads to a DRS that is true, whereas setting y to any value satisfying \(\text{C}_0\) but distinct from b yields a DRS that is false. The obvious way to express this in our DRS formalism is given in (40):
We get the DRS for (1a) by eliminating the ONLY condition from (39) and merging the result with (40). The result is (41).

\[ t \quad e \]
\[ t < n \quad e \subseteq t \]
\[ e: \text{introduce}'(m,b,s) \]

\[ y' \quad \forall \quad t' \quad e' \]
\[ C_0(y') \quad y' \neq b \quad y' \]
\[ t' < n \quad e' \subseteq t' \]
\[ e: \text{introduce}'(m,y',s) \]

We now turn to the construction of these representations. We focus on (1a). We now assume the syntactic structure in (42) in which tense is accounted for in the familiar way. And with that comes a change in the adjunction site for only. Note that the meaning of (1a) is that (i) Mary introduced Bill to Sue and (ii) the introduced no-one else to Sue. That is, the second conjunct is also within the scope of tense. To capture this fact we adjoin only to T' rather than to the upper VP. Thus our starting point for the construction of the semantic representation is the syntactic structure in (42).
As in Rooth’s Alternative Semantics the foundation for the ff-f division is laid at the point of interpreting the focus constituent \([Bill]_F\). So we begin with the representation of this node:

\[
\text{(43)} \quad [[Bill]_{DP}]_F \quad \Rightarrow \\
\begin{array}{c}
\begin{array}{c}
\text{b} \\
\text{C}_F \\
y'
\end{array}
\end{array}
\begin{array}{c}
\langle y_F, b \mid \langle \{ \rangle, \langle \rangle, \langle y = b \rangle \rangle \rangle
\end{array}
\begin{array}{c}
\text{Bill}(b) \\
\text{C}_F(b) \quad y' \neq b \\
\text{C}_F(y) \\
\text{C}_F(y')
\end{array}
\]

Note that in this representation it is the focus variable \(y\) that plays the role of referential argument for the focus marked DP \(Bill\).

Combining this constituent with the semantics of \(introduce\) amounts to argument insertion of the referential argument \(y\) into the direct object slot of the translation of the verb. This now involves merging of the (non-presuppositional DRS in the representation of the verb with the ff DRS of (42). (It is the ff-DRS where all the action takes place.) Since \(y_F\) will be needed later on, it is kept in the store with its marking as focus variable. What we get is (44).

\[
\text{(44)} \quad [[[introduce]_{VP}]_V [[Bill]_{FDP}]_{VP}} \quad \Rightarrow \\
\begin{array}{c}
\begin{array}{c}
\text{b} \\
\text{C}_F \\
y'
\end{array}
\end{array}
\begin{array}{c}
\langle e, y_F, b \mid \langle \{ \rangle, \langle \rangle, \langle y = b \rangle \rangle \rangle
\end{array}
\begin{array}{c}
\text{Bill}(b) \\
\text{C}_F(b) \quad y' \neq b \\
\text{C}_F(y) \\
\text{C}_F(y')
\end{array}
\]
The next two steps integrate the indirect object Sue and the past tense into (44). This too involves the ff-DRS (while adding another proper name presupposition for Sue):

(45) \[
\begin{align*}
&[[[\text{introduce}]_V [[\text{Bill}]_F]_{\text{DP}}]_{\text{VP}}] \ [\text{(to)} \ \text{Sue}]_{\text{DP}}] \ \text{VP}] 
&\Rightarrow \\
&\begin{array}{c} \\
&b \\
&{s} \\
&C_F \\
&y' \\
&\end{array} \not< \begin{array}{c} \\
&< e, y_F, b, s | < \\
&Bill(b) \\
&Sue(s) \\
&C_F(b) \\
&y' \neq b \\
&C_F(y') \\
&\end{array} \\
\end{align*}
\]

It is at this point that only makes its contribution. It turns the ff-f structure S of (44) into a condition of the form ‘ONLY(S)’ which then converts into a DRS like that in (40). This DRS then supplants the DRS-condition ‘ONLY(S)’ in the DRS K that contains the condition as an element of its condition set. ‘Supplanting’ means that the condition ‘ONLY(S)’ is removed from K, whereupon the DRS (40) is merged with that DRS. Since in the present case ‘ONLY(S)’ was the only constituent of K, the ‘merge’ amounts to K being replaced by the DRS (40).

We present the effect of the combining the representation of the lower T’ node with only in two stages. The first stage consists in supplying the operator ONLY, which we take only to contribute to configurations of the kind exemplified by (1a), with its argument. This argument should be the ff-f division that is part of the representation of the lower T'. But there is a complication. (In our discussion of the construction of the semantic representations of only-sentences we could finesse this problem, but in a sense it was there all along.) The problem is this. The effect of ONLY is in essence a form of quantification: it asserts of the ff-DRS that ts instance to the actual referent b is true whereas all its other instances within the alternative set are false. This requires quantification not only over the elements that are represented by discourse referents ‘declared within’ the ff-DRS (i.e. those which occur either in the universe of the DRS itself or in the universe of one of its sub-DRSs) but also the event discourse referent e that in the T’ representation is still a member of the store. So the combination of the lower T’ representation with only requires that we transfer e from the store to the universe of the ff-DRS. (This giving in to the needs of the moment may look a bit like a hack. In fact, this is an instance of a more general pattern, which we also encounter with other quantificational adverbs: In an architecture like the one we are using here they will often be combined with the representation that serves as their scope but which contains one or more of the entities over which the adverb quantifies in store at the point when the quantifying expression makes its (quantificational) impact. In such cases application of the quantifier must always carry with it the transfer of the relevant discourse referents to the universe of the DRS on which the quantifier operates. What we need is a more general account of such kinds of quantification,
which on the one hand characterizes the expressions that give rise to this complication and on
the other states in general terms which discourse referents from the stores of the
representations with which such expressions combine are subject to the store-to-DRS-
universe transfer principle.

It might be argued that the same problem also arise for the focus variable $y_F$, which in the
semantic of ONLY adopted here is the discourse referent that is the direct target of
quantificational binding by the operator. However, we prefer to keep $y_F$ in store at this
preparatory stage to the execution of ONLY because it is directly involved in the operations
that execution of ONLY involves. (This too reflects a more general policy we have been
following. For instance, we have accounted for the semantic contribution made by a
quantifying determiner like every by assuming that it selects the referential argument of the
DP representation that is one of its two operands as the one that is to serve as its direct
bindee.)

The result of transferring $e$ from the store to the universe of the ff-DRS and making the result
to the argument of ONLY is given in (46).

(46) (semantic representation of upper T’-node in (42) before execution of ONLY)

\[
<y_F, b, s | <\{\text{Bill}(b), \text{Sue}(s), C_F(b), y' \neq b, C_F(y')\}, \text{ONLY(<}<C_F(y'), t < n, e \subseteq t, e: \text{introd'}(x_1,y,s)\rangle \rangle>
\]

Execution of the ONLY operation now involves (i) instantiating the focus variable in the ff-
DRS to its ‘ordinary value’ b (as specified by the f-component of the ff-f division that serves
as ONLY’s input) and (ii) forming a universally quantifying duplex condition to the effect that
if the focus variable in the ff-DRS is given any other value from within the alternative set,
then the result is false. The formation of this duplex condition involves making a copy of the
ff-DRS in which the ‘bound discourse referents’ are replaced by fresh ones. In addition a new
discourse referent is needed to serve as bound variable of the universal quantifier of the
duplex condition.

The result of applying these execution rules to (46) is given in (47).
Integration of the subject DP and subsequent resolution of the presuppositions leads from (47) to the DRS in (41).

Let us, for later reference, state the operations that lead from (46) to (47) once more, and in slightly more formal detail. The statement is given under (48).

(48) The operations have the effect of converting the argument of ONLY in (46) into a DRS; this DRS $K$ gets merged with the DRS $K'$ that contains the ONLY condition as a member of its condition set, after the ONLY condition itself has been removed from $K'$. The operations that lead to $K$ are these:

(i) Remove the focus variable $y_F$ from the store, and replace in the focus frame DRS $K_{ff}$ of the argument $S$ to ONLY every occurrence of $y_F$ by its 'ordinary value', which is specified by the equation in the focus component of $S$; this results in a DRS $K''$.

(ii) Form a copy $K'''$ of $K_{ff}$ by (a) replacing all the bound discourse referents of $K_{ff}$ by fresh discourse referents and (b) replacing $y_F$ everywhere by a fresh discourse referent $y''$.

(iii) Form a duplex condition which says that if $y''$ satisfies the alternative set restrictor predicate $C_F$ and is different from the focus value, then $\neg K'''$ - for the form of this duplex condition see (47) - and add this condition to the condition set of $K'''$.

The result of this last operation is the DRS $K$ we are after.
and (47) reflect the assumption that the ff-f division induced by \([Bill]_F\) is no longer needed after it has served in the interpretation of *only*. If we want to retain this focus-related information – and as we argued earlier in general that should be done—then a copy of the ff-f division in (45) should be retained as a separate member of the new non-presuppositional DRS. This requires that we also make copies of the event discourse referent e and the focus variable, which are kept in the store until further notice.

One difference between the treatment of (1a) we have just presented and its treatment in Alternative Semantics has been noted already: In the present account there is no need to appeal to intensional semantic values such as propositions or properties. Admittedly many would not see this as speaking in favor of the present treatment, since what it does is to replace an operation involving intensional semantic values by one that is purely syntactic: the rule (48) which leads from (46) to (47) is one about manipulating the form of structure that serves as the argument to ONLY. As indicated above, we could replace this syntactic operation by one like the one used in AltSem by assigning a suitable semantic value to the argument of ONLY in (46), but that would mean assigning an intensional value to it (either a pair consisting of a property and a set of properties or, equivalently, a function from individuals to pairs consisting of a proposition and a set of propositions). And then we are back to where we were. If we think of the compositionality of language as the general principle that all operations that are needed in going from the meanings of the ultimate parts of a sentence (or multi-sentence discourse or text) to the meaning of the sentence (or discourse or text) as a whole are operations on semantic values; and if we see compositionality as a desideratum for accounts of the syntax-semantics interface, then the present treatment is not even a Pyrrhic victory.

A second difference is that we do not need a different treatment depending on exactly where *only* is adjoined. Or, more accurately, we do not need to distinguish between structures in which it is adjoined to VP (or to T’ or to AspP) and structures in which it is attached above TP: the difference between an ONLY that operates on properties and an ONLY that operates on propositions need no longer be made. The matter is different, however, when *only* is adjoined to a DP, as in (49).

\[(49) \quad \text{Only [Mary]}_F \text{ won.}\]

Such cases still require a somewhat different treatment, just as they do in Alternative Semantics. The natural syntactic analysis of (49) is that in (50). To speed things up I have assumed that the lexical semantics for the verb has already been inserted and linking of the subject DP and its slot has been made explicit. (The linking index is passed up automatically form the lower to the higher DP.)

\[(50) \quad \text{S} \]
\[\text{Comp} \quad \text{TP} \]
\[\emptyset \quad \text{DP}_1 \quad \text{T’} \]
\[\text{Adv} \quad [\text{DP}_1]_F \quad \text{T} \quad \text{VP} \]
The representation for the DP *only Mary* must contain a slot for the representation that contains the argument position to which the DP *Mary* is linked. This means that there is no way in this case of getting around a higher order element in the representation for *only Mary*, a slot for the representation which in its turn contains the argument slot for *Mary*’s referential argument. (In standard type-logical frameworks for natural language semantics this would be a typical case of iterated lambda conversion, the first one involving the higher order term as argument and the second the first order term. What we need here is a more procedural analogue to this.)

The device we will be using consists of a ‘dummy DRS’ K which is supposed to contain the slot co-indexed with the represented DP. The referential argument of the DP representation is to be inserted into the linked argument position in K. So K must have such a position. We indicate this by adding a dummy argument slot $\alpha_i$ with the relevant linking index $i$, in parentheses behind K. The index is to make sure that the slot will only be filled by the referential argument of the co-indexed argument phrase.

There are two further complications replicas of which we have already encountered when constructing the representation for (1a). The first complication is that the representation of *only Mary* has two places where the relevant part from the sister representation will have to be inserted and since one of these places – the one in the nuclear scope of the duplex condition - is within the logical scope of the other, we should not insert into that place the (relevant part from the) sister node representation itself, but some copy of it in which the bound discourse referents have been replaced by fresh ones. We indicate the need for this formation of a copy preliminary to insertion by underlining the dummy DRS occupying the logically subordinate position. (This is yet one more use of underlining, but my graphic repertoire is limited.)

The complication arises from the need to retrieve certain discourse referents from storage. This problem now comes in a slightly different form as compared from the way it manifested itself in the construction of the representation for (1a) in that the event discourse referent e that must be transferred from store to DRS universe belongs to the store of the $T'$ representation which must be slotted into the positions held by the dummy DRSs K and $K'$ in the representation for *only Mary*. So in the present case this transfer must be carried out as part of the insertion process. This requirement must be stated separately and I can see no obvious notational device that can be used to indicate it.

I trust that otherwise the notation used in the representations below makes what is involved in combining the representation for *only Mary* with the $T'$ representation sufficiently transparent.

The representation for the focused DP *Mary* is the same as that for *[Bill]* in (43). That is, we get for *[Mary]* the representation in (51).

(51)  

$$[[\text{Mary}]_F]_{DP} \Rightarrow$$

$$<y_F, m | <\{ \begin{array}{c}
\text{Mary}(m) \\
C_F(m) \\
C_F(y' \neq m) \\
C_F(y')
\end{array}>, <\ldots, y = m >> >$$
(52) gives the representation for *only Mary* before execution of ONLY and (53) after execution.

(52)

\[
< y_F, m \mid <\{\text{Mary}(m) \mid C_F(m) \land y' \neq m \mid C_F(y')\},\]

\[
\text{ONLY}(<\{\text{K}(\alpha_1)[y_F/\alpha_1]\mid y = m\},\}
\]

\[
C_F(y)
\]

(53)

\[
< m \mid <\{\text{Mary}(m) \mid C_F(m) \land y' \neq m \mid C_F(y')\},\]

\[
\text{K}(\alpha_1)[m/\alpha_1]\}
\]

\[
\forall \neg \text{K}(\alpha_1)[y''/\alpha_1]\]}

\[
C_F(y'')\}
\]

\[
y'' \neq m\]

(Again, these representations reflect the assumption that the contribution made by focus will not be needed any further. Otherwise the ff-f division triple from (51) should be retained as a separate element, as argued above in connection with (1a). And in that case this triple should be amplified as the representation construction moves up the syntactic tree, just as we have seen this in our treatment of (36).)

Note that in (53), in which the ff-f division has done its work in supporting the interpretation of *only*, the referential argument of the representation is once again the discourse referent m that represents Mary, rather than the focus variable which had temporarily dethroned m as referential argument.

Note also that in (53) the subscript \(1\) on the dummy argument slot \(\alpha\) is the linking index of the represented DP. When this representation is combined with that of the T' node, which is obtained in the by now well-known fashion and shown in (54), we obtain, in accordance with our explanation of the notation in (53), the representation in (55).

(54)

\[
<e|\]

\[
t < n \quad e \subseteq t
\]

\[
e: \text{win}(x_1)
\]
Other context-sensitive particles are the so-called additive particles: *even, also, too, as well* and some additional ones. We focus on *also* and *too*, which for present purposes are indistinguishable. We take *too* as our target, but everything we have to say about it also applies to *also*. (There may be differences in their attachment possibilities, but that doesn’t matter to what follows.)

That *too* is focus sensitive can be seen from examples like those in (56):

(56)  
a. Mary introduced Bill to [Sue]$_F$ too.  
b. Mary introduced [BILL]$_F$ to Sue too.  

But in contrast to what we found for *only* the effect that the associated focus has on the interpretation of *too* concerns the presupposition it triggers, and not the truth conditions of the sentence of which it is part.

Intuitively it is clear what the presupposition is that *too* produces in (56a) and (56b). In (56a) it is the presupposition that Mary introduced Bill to someone other than Sue and in (56b) it is that Mary introduced to Sue someone other than Bill. We can account for this difference straightforwardly when we assume that the input to *too* is a ff-f division triple of the form

\[
< m, C_F, y' >  
\]

For instance, if we assume that in both (56a) and (56b) *too* is adjoined to TP, then in the case of (56a) its input will be the triple in (57a) and for (56b) it will be (57b).

(57)  
a. \[
< m, C_F, y >  
\]

\[
\]

\[
\]

\[
\]

\[
\]

\[
\]

\[
\]

\[
\]

\[
\]

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When applied to (57a) too produces the following combination of presupposition and non-presuppositional part:

\[(58) \quad \text{a. } y' \quad t' \quad e' \quad t \quad e \quad \{ \quad y' \neq s \quad t' < n \quad e' \subseteq t' \quad \text{e': introd'}(m,b,y') \quad \text{e: introd'}(m,b,s) \quad \}
\]

On the basis of these illustrations it seems possible to state the general conversion process by means of which TOO (the operator denoted by too) converts ff-f division triples into combinations of presuppositions and non-presuppositional parts. We can state the general procedure in much the same way as we did for ONLY in (48).

\[(59) \quad \text{The operations effected by TOO when applied to an input structure}
\]

\[(o) \quad < \quad K_{ff} \quad , \quad y = \alpha \quad > \quad C_{F}(y)
\]

are:

(i) obtaining a non-presuppositonal DRS K by merging with the focus component (the DRS which, in the cases considered here, consists of the single DRS condition ‘y = \(\alpha\)’); and

(ii) obtaining the too-presupposition \(K_{prep}\) by (a) forming a ‘copy’ \(K'_{ff}\) of \(K_{ff}\), and (b) replacing y in \(K'_{ff}\) by a fresh discourse referent \(y''\) and adding the conditions ‘\(C_{F}(y'')\)’ and ‘\(y'' \neq \alpha\)’.

(By a ‘copy’ of \(K_{ff}\) we here understand, in essence, an alphabetic variant of \(K_{ff}\), i.e. a DRS we obtain when we replace all bound discourse referents in \(K_{ff}\) by fresh discourse referents. But again there is one complication: The referential argument of \(K_{ff}\) may still be in store at the point when the copy is made. In that case we also need to introduce a fresh discourse referent corresponding to this referential argument and add it to the universe of the copy \(K'_{ff}\) that is being formed.)

(iii) When (o) is part of the condition set of some larger DRS \(K'\), then \(K\) is merged with \(K'\), and \(K'_{ff}\) is added to the presupposition set of \(K'\). The focus variable
$y_F$ is no longer needed and can be removed entirely.

(As in the case of only, we may when we form the condition

\[
\text{‘TOO}( < C_F(y) , K_{ff} , y = \alpha > )',
\]

also form a copy of the ff-f division triple that TOO takes as input structure and keep this alongside the result of applying TOO, in order to retain the information that this structure contains for possible later use. We don’t do this here.)

As one illustration of how representations of sentences with too can be constructed, consider (56a). We assume the tree in (60)

(60)

\[
\begin{array}{ccc}
\text{S} & \\
\text{Comp} & \text{TP} & \\
\emptyset & \text{TP} & \text{too} \_4 \\
\text{DP}_1 & \text{T'} & \\
\text{Mary} & \text{T} & \text{VP} \\
& \text{past} & \text{VP} \\
& & [\text{DP}_3]_{F,4} \\
& & \text{V} & \text{DP}_2 & (\text{to}) \text{SUE} \\
& & & \text{introduce} & \text{Bill} \\
\end{array}
\]

The focused DP $[\text{Sue}]_{DP} \_F$ gets the same kind of representation that was assigned to $[[\text{Bill}]_{DP} \_F$ in (43):

(61) $[[\text{Sue}]_{DP} \_F$ \Rightarrow

\[
\begin{array}{ccc}
\text{S} & \text{C}_F & y' \\
\text{Sue}(s) & C_F(b) & y' \neq s & C_F(y) \\
\text{C}_F(y') & \\
\end{array}
\]

Building the representation for the lower TP of (60) from (61) and the other (focus-free) representations for the leaf nodes of (60) we arrive at the following representation for the lower TP node.

(62) $\text{s} \text{b} \text{m} \text{C}_F y' \\
\text{e, y_F, s,b,m} \Rightarrow$

\[
\begin{array}{ccc}
\text{s} & \text{b} & \text{m} & \text{C}_F & y' \\
\text{e, y_F, s,b,m} \Rightarrow & \\
\end{array}
\]
Combining this representation with too leads to the one in (63).

(63)

\[
< e, s, b, m | <\{ Sue(s), Bill(b), Mary(m), C_F(s), C_F(y'), t', e', y'', y' \neq s, C_F(y''), y'' \neq s, C_F(y'), e': \text{introd}'(m, b, y'') \},
\]

\[
t < n, e \subseteq t, e: \text{introd}'(m, b, y'')
\]

Suppose that (56a) was uttered immediately after, say, the sentence in (64)

(64) Mary introduced Bill to Diana.

Then intuitively this first sentence justifies the too-presupposition in (63). We can formally obtain this justification if we (a) accommodate the \(C_F\)-presupposition to some predicate \(C_0\) with the property that both Sue and Diana belong to its extension and (b) accommodate the reasonable assumption that Sue is different from Diana. (a) is worth special notice: the desire to use the discourse context provided by (64) imposes only a partial constraint on the resolution of \(C_F\). So, given the context as we have it, resolution of the \(C_F\)-presupposition requires an accommodation that is largely arbitrary. But the accommodated predicate is nevertheless subject to certain constraints, viz. that there are some objects that must belong to its extension.

Remark on the attachment site(s) of too.

In our treatment of (56a) we assumed that too was adjoined to TP. That has the effect that the too-presupposition shares the information provided by tense with the assertion. And that entails that verification of the presupposition requires a discourse context that entails the presupposition with that tense-based information built in. There are many examples that show in general this is not right. (65) is one of them.

(65) Mary has met the President. [Fred]_{F,1} will meet him too_{1}.
Intuitively the *too*-presupposition of the second sentence is verified by the first sentence. But that means that the tense information of the assertion made by the second sentence should not be part of the *too*-presupposition. For the first sentence tells us about an event of someone other than Fred meeting the President, but not about such an event in the future.

We can avoid inclusion of the tense information by allowing *too* to attach below T’ (e.g. by adjoining it to VP). But in (65) we then have the problem that the associated focus constituent is not within the scope of *too*. The problem, in other words, is: How can we get the subject DP to be within the scope of *too* while keeping the tense information out. As it is, I do not know of a satisfactory solution to this problem.

At this point we leave the construction of representations of sentences involving association of focus with focus-sensitive particles like *only* and *too*. Many of the empirical complexities to which we have drawn attention at an informal level have not yet been considered at the level of formal detail in which we have looked into the representation constructions for (1a) and (49), and on the basis of our experience with just these two examples it may be expected that further technical problems will need to be resolved when dealing with these further phenomena. But that is for another occasion, or several other occasions.

Instead we now have an informal look at yet some other phenomena involving focus. In particular we now wan to address the question:

(66) What is the range of different semantic and pragmatic functions that focus can serve?

Before we try to address this question first a conceptual clarification. In some of the literature on focus, especially in relation to English and similar languages in which focus is marked prosodically, and not morphologically or syntactically, it is quite unclear whether focus is to be identified in prosodic terms – a constituent is *focused* iff it has the relevant prosodic properties (viz. the relevant part of it has primary ‘focal’ pitch accent) – or in semantic or pragmatic terms. We have already seen that in cases where focus is associated with *only* the prosodic and the semantic-pragmatic criteria for focus may come apart. This happens in cases of ‘secondary focus’, in which a combination of *only* and its associated focus constituent is repeated and the second occurrence of the focus constituent is distressed.

In these notes we have been trying to keep the question of how focus is realized separate from the question what the effects are that focus background articulation has on interpretation and concerned ourselves with the second complex of questions. So we would like to pitch our inquiry after the range of different functions of focus in a form that once more brackets the question of prosodic, syntactic and/or morphological realization out of it. But if we are to characterize focus in semantico-pragmatic terms, isn’t the question what semantic or pragmatic functions focus might serve going to be circular?

Not quite. We will assume that what distinguishes a constituent as focused is that it contributes a focus frame-focus division at the level of semantic representation (or a non-trivial (ordinary value-focus value) pair in Alternative Semantics). The assumption is that such a structure is legitimate only if there is something in the sentence or discourse that makes use of it. So the quest is for the different intra- and inter-sentential semantic operations and processes that require ff-f divisions as inputs, or that can make use of them.
This way of shaping our question could still be problematic, for it need not be clear in each and every case if a certain aspect of interpretation that can be analyzed as involving ff-f structure must be analyzed as involving such structure. But in actual practice cases where one might be in doubt whether what can be analyzed using ff-f structure could perhaps also be analyzed without it appear to be rare, if they exist at all. At least we have not yet become aware of such cases as yet. Thus pursuing the question in this form seems meaningful enough.

So far we have only looked at sentence-internal uses of focus, and even as far as those are concerned we have looked only at cases of only one focus-sensitive operator, viz. only.

But even among focus-sensitive operators there is significant variety. This is one of the principal messages of Beaver and Clark’s Sense and Sensitivity, which among other things draws attention to the differences between two classes of such operators, exemplified by, respectively, only and always. only and always form a useful pair since in many cases they seem to convey the same truth conditions, as in the famous example sequence due to Rooth, and reproduced here in (67).

(67)  
  a. In St Petersburg officers always escorted [BALLERINAS]_{F}.  
  b. In St Petersburg [OFFICERS]_{F} always escorted ballerinas.  
  c. In St Petersburg officers only escorted [BALLERINAS]_{F}.  
  d. In St Petersburg [OFFICERS]_{F} only escorted ballerinas.

(56a) appears to have the truth conditions that whenever in St Petersburg an officer escorted someone, then that someone was a ballerina. (67b), in contrast asserts that whenever in St Petersburg someone escorted a ballerina, that someone was an officer. And the truth conditions of the only-sentences in (67c) and (67d) seem to be very much like these: (67c) says that the only escortings that officers were involved in in St. Petersburg were escortings of ballerinas, which comes to the same thing as our paraphrase of (67a); and (67d) says that the only escortings in St. Petersburg that involved ballerinas were escortings by officers, which comes to the same thing as our paraphrase of (67b).

These observations suggest three things: First, just as in the only-sentences in (1) that we started with the truth conditions of the sentences in (67) depend on which constituent is associated with the focus-sensitive. Second, always seems to be focus-sensitive in just the same way that only is. And, third, the semantics of these two focus-sensitive operators - always and only – happens to be such that when they associate with the same constituents in the same sentences (but for the fact that the one contains always and the other only), the truth conditions are the same.

Beaver and Clark show that none of these suggestions is in fact correct. One of their examples is the pair in (68).

(68)  
  a. Mary always beats Sue at [TENNIS]_{F}.  
  b. Mary only beats Sue at [TENNIS]_{F}.  
  c. Mary always competes with Sue at [TENNIS]_{F}.

(68b) has the meaning one would expect on the basis of what can be observed about (67c,d): tennis is the only game at which Mary beats Sue. But (68a) does not have these truth conditions. It says rather that tennis is a - or the - game at which Mary always beats Sue. This reading of (68a) indicates that in this sentence the DP tennis is not associated with always.
Rather, the focus on *tennis* – we may assume that the sentence is spoken and that *tennis* is prosodically marked in the way that is typical of focus marking in English – seems to serve a different function here – that of making tennis salient, or contrasting it with other sports: tennis is a sport in which Mary always beats Sue, as (presumably) opposed to other sports for which that is not so.

Interestingly, this effect – which confers upon (68a) a meaning that is clearly distinct form that of (68b) – disappears when the verb is changed to the one in (68c). (68c) means that whenever Mary competes with Sue, it is always at tennis; replacing *always* by *only* in (68c) doesn’t make a significant difference to the truth conditions.

The explanation of the difference between (68a) on the one hand and (68c) and (67a,b) on the other is that the verb *beat* carries a strong presupposition, you cannot beat someone (in the sense of the verb that is relevant here, unless you play against her. The reason why this difference matters is that quantificational adverbs like *always* are generally in need of a restriction to the quantification they express and there is no general linguistic principle that assigns a restrictor to them. In this regard adverbial quantifiers differ from nominal quantifiers such as *every* and *most*. For the latter the descriptive content of the noun phrase of which they are part always provides them with a restrictor for the quantification they express. That doesn’t prevent nominal quantification from often benefiting from some further implicit, contextually given restriction as well. But at least there always is the restriction provided explicit by the noun phrase itself. In comparison the restrictors of adverbial quantifiers are radically underspecified; but there are certain quite reliable strategies for determining which part of the linguistic material within the scope of the adverb is to be construed as its restrictor (rather than as part of the quantifier’s nuclear scope). ff-f structure is one reliable clue: the focus must become part of the nuclear scope, whereas the focus frame is a strong candidate for the restrictor. But it is not the only such clue. Presupposition is another: if certain presupposition triggers occur within the scope of an adverbial quantifier, then that often licenses the interpretation in which the presupposition of the trigger plays the part of quantification restrictor whereas the non-presuppositional part of the semantics of the trigger becomes part of the nuclear scope.

In (68a) it is precisely the presuppositional aspect of the verb *beat* – the fact that every predication of the form ‘x beats y’ comes with the presupposition that x and y have been competing – that is decisive. The focus on *tennis* could in principle have provided the cue that distributes the material in the scope of *always* over its restrictor and its nuclear scope - that is what happens in (68c) - but it is defeated by the presupposition of *beat*, which apparently takes priority in such cases. (What the general priority principles are which determine how we interpret sentences with quantificational adverbs and more then clue for the distribution of material between restrictor and nuclear scope is not yet well-understood and one of the state-of-the-art problems in the semantics and pragmatics of presupposition and information structure.)

These considerations apply to adverbial quantifiers, but as indicated by the contrast between (68a) and (68b), they do not apply, or at any rate not in the same way, to a focus-sensitive word like *only*. The most likely explanation is that *only* is *focus-functional* in the terminology of Beaver and Clark: it always requires focus frame-focus structure for its interpretation; alternatives like presupposition-non-presupposition structures just won’t do. That is why in (68b) it is the focus on *tennis* that enters into the interpretation of *only* in the way we have come to expect, the presence of the presupposition trigger *beat* notwithstanding.
These are some observations about differences in the ways in which ff-f structure can be used sentence-internally. But the function of focus is just as often trans-sentential as it is sentence-internal. One trans-sentential function has already been mentioned in passing: the focus structure of an answer to a wh-question must match the information structure of the question, which presents a number of similarly structured possible answers from which the answer must elect the right one or ones.

But at least as important is the function of focus to ‘mark contrast’. That focus typically has some contrastive effect seems plain and undeniable. (Perhaps it is even true that it has such an effect in all cases.) But it is not so easy to say exactly what contrast amounts to. Still, there is one aspect of contrast that is pretty obvious, and it is one that is very important for a proper understanding of how contrastive focus works. This is that if two constituents – occurring in, say, two successive sentences – can be perceived as standing in some relation of contrast to each other that must be because they are said to differ in some significant way; that is, there is something that is claimed about the one and something else, which can be perceived as contrasting with this something, that is said of the other. In other words, contrastive elements typically come in pairs (or in triples or even larger numbers, but not on their own).

Among such cases of contrast, where we have two focused constituents in two successive sentences, here are in particular those in which the contrasting things that are said about them in the successive sentences can be interpreted as standing in opposition to each other because they too contain contrasting constituents. And a special case of this is that where both the focused constituents and the contrasting constituents that mark the difference between the opposing things that are being said about the former constituents are definite noun phrases which refer to particular individuals. Example are (69a) and the famous (69b).

(69)  
a. [John]_F invited [Mary]_F and [Carl]_F invited [Susie]_F.  
b. First [John]_F called [Mary]_F a Republican and then [she]_F insulted [him]_F.

The annotation we have used in (69) suggest that the different F-marked constituents are, as far as information structure is concerned, all on a par. It has been suggested, however, that that isn’t always so: there are cases which suggest that one pair of contrasting elements (such as e.g. John and Carl in (58a)) plays a different information-theoretic role than the other. In fact, the initial informal description I gave of cases of this kind suggests some such difference too: there is ‘primary’ contrasting pair of two constituents about which different things are being said. That formulation makes it sound like the members of the first (‘primary’) pair play the part of topics, about which the speaker is making certain claims.

The suggestion of such an asymmetry has been made with particular force by Büring and (more or less simultaneously but independently) Eckhardt in connection with the prosodic contour – the so-called ‘hat contour’ - that one typically finds in the German counterparts of sentences like those in (59): Only the second prosodically marked constituents in such sentences are cases of focus, these authors claim, whereas the first constituents play the part of contrastive topics. A famous illustration of this position is Büring’s ‘pop star’ example, a version of which is given in (70).

(70)  
(B has been to a pop star concert. A has not and asks B about it.)

A: What were the pop stars wearing?
B:  [The leader]$_{CT}$ was wearing a [caftan]$_{F}$.
And [the female singer]$_{CT}$ was wearing [hot pants]$_{F}$.

In fact, the information structure of this exchange is more complex than anything we have seen so far in that there the two correlated contrasting pairs – the leader and the female singer correlated with the property of wearing a caftan and the property of wearing hot pants – but in addition the contrastive topics qualify as such because of the fact that they are parts of what can be seen as the over-all topic of B’s reply, viz. the set of pop stars that has been introduced by A’s question.

How are we going to adjudicate between (a) the view that in cases like B’s replies in (70) only the second marked constituent is a focus constituent while the first is a contrastive topic and (b) the view that both constituents are focused constituents?

It is not easy to see how to answer this question; but that ay be because it is the wrong question. In fact, what I will suggest is that both views may be correct at the same time, because the claims they are making aren’t trying to address the same issues; each is right on its own terms and in its own way.

To explain what I have in mind, let us have a closer look at the first sentential utterance of B in (70) and let us start by treating the two marked constituents in it both as focus constituents along the same lines we have been considering above. This means that when we are building the semantic representation for the sentence, then we get for the T’ node the representation shown in (71).

(71)

I take it that what ‘caftan’ refers to in the sentence is some type of garment. The term ‘^caftan’ is supposed to refer to the property of being a piece of clothing of the given kind. (So the progressive form be wearing of the verb wear is analyzed here as a relation between an individual x and a type of clothing P which holds iff x is wearing a piece of clothing of type P. These details do not matter much, but what is important is that we analyze the focus as coming with a requirement to resolve its alternative set predicate in a way that is commensurable with what the denotation of ‘^caftan’ is.

We must now combine this representation for the T’ node with the representation for the subject DP the leader. As it is we are treating this DP also as focus marked, , and thus as giving rise to a representation like that in (72). (We treat the leader here as a kind of proper name (which of course isn’t quite right), so as to avoid the complications that would arise from dealing with it as a definite description, which of course it is, with all the extra complexities that are not directly relevant here.)

(72)  [[The Leader]$_{DP}$]$_{F}$  ⇒
How do we combine (71) with (72)? That is not at all clear. One possibility, corresponding to the ‘cross product rule’ for combining two semantic values that each consist on an ordinary values and a non-trivial (i.e non-singleton) set as focus value, is to amalgamate the two ff-f divisions into a single one: We get (i) a combined restrictor, which puts the presuppositional constraints given by $C_F$ and $C'_F$ on the two corresponding focus variables $y_F$ and $z_F$; (ii) a ff representation that is the merge of the two ff representations; and (iii) a focus component that sets $y_F$ equal to `caftan and $z_F$ to l. This result is given in (73).

(73)

But this is by no means the only possibility, and in some cases it is clearly not the right one. To be more explicit, the way of combining two representations that each involve focus exemplified in (73) is fine for a case where two focused constituents form what might be described as a single discontinuous focus, which supports a certain aspect of the interpretation of the sentence of which the two constituents are both parts. An example is (74a), where the intended interpretation is that Bill and Sue were the only pair $<a,b>$ of people such that Mary introduced a to b. But for a sentence like (74b), on the interpretation which takes Bill as associated with only and Sue with also, the kind of amalgamation exemplified in (73) is not what we want. Here combining the representations of introduce Bill and (to) Sue requires nesting the ff-f division of the one inside that of the other. (We omit the non-trivial technical details.)

(74)  

a. Mary only$_1$ introduced [BILL]$_{F,1}$ to [SUE]$_{F,1}$.

b. Mary also$_2$ only$_1$ introduced [Bill]$_{F,1}$ to [SUE]$_{F,2}$.

This discussion shows that the way in which the representations of two or more focused
constituents are combined can be one source of asymmetry between them. This consideration could be applied in particular to B’s answer in (70). The way in which subject representation and T’ representation are combined in (73) leads to one set of interpretations, which may still differ from each other on account of how the presuppositions in (73) are resolved. But it is also possible to combine (71) and (72) in such a way that the ff-f division of (71) is embedded within the ff-f division of (71), and that may give rise to yet another set of possible interpretations.

The suggestion in the last paragraph that a single way of combining (71) and (72) may give rise to a set of interpretations indicates that the mode of combination need not be the only source of asymmetry between the two focus constituents. A second source might be the ways in which the alternative set presuppositions – in (73) these are the presuppositions associated with the anaphoric predicate discourse referents C_F and C’_F – are resolved.

Much of the intuition that in the first sentence of B’s reply in (70) the subject DP the leader has an information-theoretical status that is different from that of the NP caftan has to do with the fact that its referent – the leader of the pop star group in question – is a member of the local discourse topic established by A’s question (viz. the set of members of that very pop group). This links the subject DP in particular way to the context of the discourse of which its sentence is part and endows it – within this perspective – with a quite different role than the focus constituent caftan. Intuitively a full answer to A’s question is one that specifies what x was wearing for each x in the set X of pop group members and the sentences that make up Bs answer in (70) can be thought of as a part of that answer. The full answer is a function f from the members of X to the kinds of clothing they wore. B’s answer provides – assuming that what he says is true – a sub-function f’ of f. (f’ would have been all of f if the pop group had consisted just of the leader and the female lead singer.)

Büring’s own treatment of B’s replies in (70) takes this consideration one step further. He allows for the possibility that the resolution of the alternative set constraints for what he considers the focus constituents in the sentence forms instantiated by each of the two sentences of D’s reply in (70) – in the first sentence this is the constituent caftan – to be dependent on the referent of the contrastive topic constituent. For the case of (70) the effect of this possibility is not all that easy to demonstrate in unequivocal terms. But the effect of the option is clearly visible in (75).

(75)  A: Who in their families does each of your friends like best.  
      B: [Most]_F prefer [their youngest daughter]_F.  
            But [one]_F, Fred, actually prefers [his wife]_F.

In Büring’s terms [their youngest daughter]_F and [his wife]_F would be focus constituents, whereas [most]_F and [one]_F would be contrastive topics. And in this case the asymmetry is intuitively a particularly striking one, insofar as the alternative set for the focus constituent seems to vary with the individual members of the discourse topic: For each x in the set X of B’s friends the alternative set for the focus constituent is x’s family.

To sum up: The way in which interpretations for sentences with focused constituents are constructed makes room for functional asymmetries between them at two junctures; first at any point where two representations of constituents that are either focused themselves or contain focused subconstituents as proper parts; and second, at the stage of presupposition resolution, through the ways in which one resolves the alternative set constraint.
presuppositions. In particular, resolution of such a constraint to a local discourse topic, in the way that is suggested by the structure of (70), confers upon the constituent which gave rise to this presupposition a status that the phrase ‘contrastive topic’ intends to capture (and seems to capture quite well).

##

In the discussion of Büring’s (70) we have encountered two interlocking notions of topic: contrastive topics and the discourse topics which contain contrastive topics as members. But these are only two of the different notions of ‘topic’ that have currency in the literature. In fact, the different things that students of language have targeted in using the word topic cover a very wide range.

On the one hand there are those who have used ‘topic’ as a grammatical term, much akin to ‘subject’. Even as late as the first half of the 20-th century there was a tendency to use the terms ‘topic’ and ‘grammatical subject’ without sharply distinguishing between them. It wasn’t until the Chomskyan revolution that the untenability of this kind of conflating grammatical (= syntactic) notions (such as ‘subject’) and notions that have to do with meaning and use (such as ‘topic’) was properly appreciated.)

But grammatical conceptions of ‘topic’ still play a part in current theorizing (even though such accounts of topic are far beyond making naïve and clearly misleading identifications like that of ‘topic’ and ‘subject’). Such theories are about ‘sentence topics’, constituents of sentences that are distinguished by syntactic properties such as the special syntactic positions where they can be found. There is a tendency for sentence topics in this sense to also show distinctive semantic and/or pragmatic behavior – that is after all what partly motivates the term ‘topic’ even in here – but the syntactic properties play an important role as well and may even be resorted to in defining what topics (in this sense of topic) are.

Such largely syntactically motivated notions of topic are to be distinguished from the notion of ‘aboutness topic’. This is a descendant of what may have been the strongest intuition about what makes a sentence constituent its topic: it is that part of a sentence or clause that the rest of the sentence or clause is saying something about – or make some ‘comment’ about, as it is also often put. The notion of aboutness topic is part of a conception of logic and grammar that goes back to antiquity, according to which it is in the nature of making assertions that one assigns some property to some antecedently given ‘topic’ (or ‘subject’). It has been said, and probably quite rightly, that this conception may have been the primary reason why logic stagnated for more than two thousand years, basically the time from Aristotle to Frege. As in particular Russell liked to stress, one of the central problems with formal logic before Frege was that logicians ignored 2- and more-place relations. (One indication of how important the difference is between relations and properties - or, if you like, between 1-place predicates and ≥-place predicates – is that that parts of predicate logic which only has 1-place predicates - the so-called monadic predicate calculus – is decidable (a mark of logical simplicity), whereas the full predicate calculus in which there are also 2- and/or >2-place predicates, is not.)

But while the mesmerizing influence of the idea that all claims, and with them all proposition have a ‘subject-predicate’ form, in which an item given by the subject is said to have some property, has been a serious obstacle to progress in formal logic, there is no denying that the grammatical form in which information is expressed in what appear to be pretty much all natural languages is typically that of subject and predicate. (If that hadn’t been so, then there
would have been no mesmerization.) Both the popularity and the importance of the notion of aboutness topic are reflections of this dominant way in which we put things when we put them in the languages we speak.

The notion of aboutness topic, then, is important when we want to account for the way in which speakers – for better or worse – fashion what they want to express in the words of their language. But is not only at the level of the individual sentence that our fitting words to the information we want to get across is subject to canons and laws. There are also organizational principles at the level of discourse, dialogue and text. These principles may vary somewhat as a function of the kind of text or discourse involved – vary as a function of genre, as it is often put – but nevertheless there is much by way of organization that different text and discourse types share. And in the general principles that govern them topics also play an important part.

On the one hand these topics are like the topics talked about above: they are entities – persons, groups of people, places, events about which there may be quite a lot to say and which therefore are the targets of comments for many sentences or longer exchanges between two or more discourse participants. Discourse topics of this kind admit of some kind of hierarchical organization, in the sense that a global topic may be split up into two or more smaller local topics, to each of which some subpart of the text or discussion may then be devoted; and in the course of that the local topics may be split up into smaller ones in their turn, with their subparts determining yet smaller sections of the discourse or text. In this way a certain hierarchical organization can be imposed on the text or discourse with each part corresponding to a part of the original global topic of the discourse or text a whole.

On a small scale Büring discourses like (70) reveal this kind of hierarchical organization of topics. What above was called the discourse topic in our discussion of (70) – i.e. the set of groupers brought into play by A’s question – gets portioned into different parts, each of which is made into the topic of a separate sentence in an attempt to answer the question – these are the ‘contrastive topics’ that in (70) are the subjects of the successive sentences that make up the multi-sentence answer that B is producing in reply.

As a general form of discourse and text organization this may sound rather schematic; and that impression is not wrong, although one occasionally does encounter texts or discourses that can be seen as fitting this kind of characterization rather well. But there is another notion of topic that is also invoked in accounting for discourse structure and that holds more promise for an insightful description of the structure of conversations and texts. This is the notion of a topic as issue, or question. Discourses and texts are, it is assumed, often motivated by a central issue - or question, or concern – and in the pursuit of this issue the author or discourse participants will typically be led to issues or questions that derive from the original one and in that sense can be regarded as subordinate to it. In its most explicit and hard-nosed form a theory of discourse structure conceived along these lines will maintain that every sentence in a well-organized, coherent text or piece of conversation will be justified only insofar as it addresses the issue that is current at that point: the text or discourse, in other words, is characterized by a hierarchy of issues/questions, and at each point there is an obligation to deal with the issue that is current at that point.

It is clear that many things will need to be clarified if such a theory is to be more than just a shell for phrasing, more or less naturally, insights into the structure of discourse that are gained by independent means. (For one thing, an obvious and important question is how and to what extent author or discourse participants can steer the text or discourse by introducing a new issue, which they can then either address themselves or, in a conversation, present as a discussion target for the others.) But quite apart from how issues are determined in the course
of a discourse or text, the notion that at any point in a text or discourse there is something that can be seen as the issue – by the reader of the text or the participants of the conversation – has come to be seen as important and fruitful. The notion is important in particular because it appears to be a quite general property of natural language utterances that their content can be divided into a part that is ‘at issue’ – this part is, and is presented as, directly addressing the current issue – and parts that are ‘not at issue’. At-issue content and non-at-issue content are often realized in different ways and they also invite different handling in interpretation.

Investigating the differences between these two kinds of content is one of the central concerns of PEPA group (David Beaver, Craige Roberts, Mandy Simons and Judith Tonhauser) which has been active for the past three years and is increasingly commanding attention.

It should have been clear even from this brief discussion that the issue is no longer – if it ever was – that of arriving at a conclusion what is the ‘right’ notion of topic. It appears that all the notions that have been mentioned have a part to play in a comprehensive account of information structure and the structure of discourse. The challenge is to define each of these notions in transparent and operative terms and, most of all, to explain how the different notions are related and ineract.
A. The representation of the focus and its background in (2) is the triple between the inner angled brackets. We refer to such representations of focus structure as focus frame focus divisions (ff-f divisions for short). I will often represent them schematically as \(<K_0,K_1,K_2>\). The first component \(K_0\) - in (2) this is the DRS \(<y:C(y)>\) - is called the restrictor of the given ff-f division; \(K_1\) - in our example \(<e:e<n,e:intr(m,y,s)>\) - is referred to as the ff-f division's focus frame and \(K_2\) - here \(<:-y=b>\) as its focus constituent.

B. The variable \(y\), displayed in bold face, is the focus variable of the given ff-f division. It replaces the focus-marked constituent Bill of the represented sentence (1) in its semantic representation. The replacement of the focus-marked constituent by the focus variable is what produces the separation of focus constituent from focus frame. The logical type of the focus variable is always that of the extracted focus constituent. Thus, given the assumption that the NP Bill in (1) has the type of an individual, the focus variable \(y\) in (2) is an individual variable.

C. The focus constituent of an ff-f division expresses that the value for the focus variable is that which is specified by the focus marked constituent. (We will consider later the question whether this value is unique. But for the time being let us assume it is.)

D. In general the possible values of the focus variable are restricted by context. This restriction is represented by the predicate \(C\); the restrictor of the ff-f division serves to express this constraint on the values of the focus variable.

E. The reason that in (2) the discourse referents m,b,s and n and the conditions "Mary(m)", "Bill(b)", "Sue(s)" appear outside the focus frame has to do with the presuppositional status of the sentence constituents which introduce them: the definite NPs Mary, Bill, Sue and the tense of the verb (in the case of n). In (2) it has been assumed that the presuppositions these constituents introduce have already been resolved. We return to the issue of presupposition under G.

F. In this paper I give no explicit account of the process by which representations like (2) are constructed from focus-annotated syntactic sentence structures. The following recipe (formulated along the lines of the top-down construction algorithm of (Kamp & Reyle, 1993) is meant as a rough guide line:

(i) Extract the focus constituent from its position in the syntactic tree and replace it by a variable of its type.

(ii) Process the resulting syntactic tree essentially as one would have done if no such substitution had taken place. (To combine the focus variable with the representations of other constituents from the tree will require slight adjustments, but this is straightforward.) The result of this processing is the focus frame component of the representation.

(iii) The focus constituent itself is turned into a (reducible) DRS-condition by adjoining the

\[\text{N.B for the remainder of this paper it is not essential to understand the details of this recipe or to be familiar with the top-down construction algorithm which it presupposes. I should add that the recipe is easily adapted to other construction algorithms for DRT, e.g. the bottom-up algorithms of (Zeevat, 1989), (Asher, 1993), or (Van Genabith et al, 2004).}\]
focus variable as argument to the root node of that constituent and placing the condition into the condition set of the focus constituent of the ff-f division (of which this condition will be the sole constituent). The application to this reducible condition of procedures familiar from the DRT literature will then convert the focus constituent into a DRS. A comparatively trivial example is the focus constituent in (2).

(iv) Familiar DRS construction procedures will similarly lead to the focus frame DRS, after the focus variable has been inserted at the position of the focus-marked constituent within the syntactic tree.²

(iv) The restrictor is always constructed as the DRS \( \langle \alpha : C(\alpha) \rangle \), where \( \alpha \) is the focus variable and where \( C \) is a fresh predicate variable. More will be said about \( C \) in the next remark.

G. As in other devices found in natural language - quantification, abstraction, wh-question formation, to name some - the focus variable in an ff-f division is open to restrictions that are not made explicit in the sentence itself, but have to be extracted or inferred from the context. As said, the predicate variable \( C \) represents this contextual restriction. The resolution of \( C \) in context can take either an intensional or an extensional form. Often the value of \( C \) is determined as the property of being a member of a given set \( Y \cdot C \models \lambda \alpha. \alpha \in Y \) - where \( Y \) can be recovered from the context. It is common for \( Y \) to be quite small. An example is the exchange given in (3), in which (1) is uttered as B's reply to the question asked by speaker A.

(3) A: I know that Carl, Bill and Fred were in the room and I saw that Mary introduced one of them to Sue. But who was it?
B: Mary introduced [Bill]F to Sue.

In this case it is A's query which provides the relevant contextual clue. This clue enables the interpreter to associate with the focus frame of (1) a set consisting of just three propositions, the proposition that Mary introduced Carl to Sue, the proposition that she introduced Bill to Sue and the proposition that she introduced Fred to Sue.

Since the value of \( C \) has to be determined in context, it is natural to treat this requirement as a presupposition - a presupposition of an "anaphoric" kind that is akin to the anaphoric presuppositions which, following (Van Der Sandt, 1992), we associate with third person pronouns and other overtly anaphoric expressions. Seen in this light the representation in (2) is incomplete, as a representation of the presupposition is missing from it.

Before we add a representation of this presupposition to the representation of (1), let me recall one of the central contentions of (Rooth, 1992): Each ff-f division comes with a pair of presuppositional constraints on its alternative set - the set is presupposed (i) to contain the

²I am ignoring a complication here, which has to do with the scope of a given focus marking. Often the material that goes into the focus frame and the focus constituent of a ff-f division is not all but only part of the material that makes up the sentence. (In (Rooth, 1992) and much of the subsequent literature, scope is marked by a tilda.) Since the scope question is not critical to any of the points in this paper I will make the simplifying assumption that the scopes of ff-f divisions always include all sentence material. (This does not exclude the possibility that some material lands outside the ff-f division because of presupposition. See G below for discussion.)
focus value as one of its members; and (ii) to contain at least one other element besides. Within our representational approach this thesis can be cast into the following form:

(4) The value of the predicate variable C has to be determined in such a way that

(i) it contains the value for the focus variable that is determined by the focus constituent; and
(ii) it contains at least one other element.

A fully general formulation of these constraints is a somewhat delicate matter. However, for the cases which will be discussed here we can make do with a formulation which is fairly straightforward. We illustrate it by example: In the case of (2), where the focus constituent consists solely of the condition is "y = b", the two constraints can be formulated as (i) C(b); and (ii) \((\exists \zeta)(C(\zeta) \& \zeta \neq b)\).

We incorporate the constraints of (4) into the presupposition on C. In (5), which includes this presupposition, I have also represented the contributions made by the proper names Mary, Bill and Susan and finite tense explicitly as presuppositions. (Presuppositions are represented as in (Kamp, 2001) or (Van Genabith et al., 2004): sets of presupposition representations are adjoined to the DRS as a whole (as in (5) for the presuppositions associated with the proper names and the finite tense of (1)), or to some DRS-constituent (as is the case here for the presupposition on C, which is adjoined to a sub-DRS containing the ff-f division).

Justification of the presuppositions connected with the proper names and tense gets us back to the contributions of these constituents shown in (2).

(5)

\(<\{m: \text{Mary}(m)>, <b: \text{Bill}(b)>, <s: \text{Sue}(s)>, <n: ->}, \{<C, \zeta: C(b), \zeta \neq b, C(\zeta)>\},\n\<->: <y: C(y)>, <e: e < n, e: \text{intr}(m,y,s)>, <-, y = b>>>>

\(\text{a. John only tidied up [the LIVING ROOM]}.\)

\(^3\) I am using the Greek letter \(\zeta\) in order to leave open whether the value of this variable is an individual (an atomic element of mereological universe of things and pluralities; see Link (83)) or a set of more than one element (a non-atomic element of such a universe). The use of the disjointness symbol \(\neq\) is to allow for a similar flexibility: "\(a \neq b\)" means the same as " \(a \cap b\)" in case \(a\) and \(b\) are both individuals, "\(a \neq B\)" means the same as " \(a \cap b\)" in case \(a\) is an individual and \(B\) a set, (and analogously for a set \(A\) and an individual \(b\)), and when both \(A\) and \(B\) are sets, then "\(A \neq B\)" means that \(A\) and \(B\) are disjoint. The reason for this more general formulation will become clear as we move to other examples. See (Kamp & Reyle 1993), Ch. 4.

\(^4\) Justification either takes the form of accommodation, in which case the presupposition will actually be merged with the DRS to which it is adjoined, or it will be an entailment of the context DRS into which (11.i) gets integrated. In either case the presupposition becomes an entailment of the DRS as a whole.
He DIDN’T tidy up the STUDY.
It is on this pair that the operator contributed by only in the present instance case must be taken to operate. Since this operator must apply to pairs consisting of a property and a set of properties, rather than a pair consisting of a proposition and a set of propositions, the operator must now be a different one. We denote it as .
More explicitly, the syntactic structure for (1.a), with lexical insertion for *introduce*, is assumed to be that in (2.a), in which the constituent that receives focus – the stressed DP *BILL* – is ‘focus-marked’ with the subscript $F$. (The syntactic structures for (1.b) and (1.c) are like (2.a) except for focus marking on different constituents (the DP *Sue*, the V *introduce*).)

(2.a)

```
S
  Comp  TP
    Ø  DP₁  T'
    Mary  T  VP
      past  AdvP  VP
             only  VP  DP₃
             V  DP₂  (to) Sue
      introduce  [Bill]₉
```

A crucial part of Alternative Semantics is to determine the relevant predicates ‘Alt’ – or, more accurately, their extensions.

In the original version of AltSem these extensions are equated with the domains of the relevant types. Here the ‘relevant type’ is taken to be that of the expression that is assumed to be ‘associated’ with the focus-sensitive expression in question; in (1) this is the word *only*. And the expression that is assumed to be associated with it in (1) is, in each of the three cases, the VP.
But what could the result of this application be? As we put it above, in the case where obtain the ordinary value of the middle TP of (8) in $M$ at $w$ we applied ONLY directly on this pair.

We assume that *only* denotes an operator ONLY which operates on the semantics of its adjunction site. In (8) ONLY operates on the semantics of the lower TP, which is a constituent of type $t$.

It is intuitively clear what *only* does in relation to a pair of this kind: it asserts that of all propositions expressed by terms occurring as part of the focus value the only one that is true is the proposition expressed by the term that specifies the ordinary value. We can express this result as in (9):

\[
\text{(9) } \text{introduced'}_{M,w}(m,b,s) & \land (\forall d \in D_{e,M})( d \neq b \rightarrow \neg \text{introduced'}_{M,w}(m,d,s) )
\]

Evidently (9) is true (in $w$ in $M$) iff (1) Mary introduced Bill to Sue and (ii) Mary introduced nobody other than Bill to Sue.

But now we need to note this: In order to state in general terms what the result is of applying ONLY in a world $w$ to the semantic value of its sister, we cannot assume that it operates just on the pair of ordinary value and focus value in $w$, as they are specified in (6). For these
Introduction: Assertions and non-assertoric Speech Acts

So far we have only looked at the semantics of indicative sentences. The representations we have been constructing for such sentences identify their truth conditions. But what is the point of presenting truth conditions (represented in a certain way) by uttering an indicative sentence? We never really addressed this question explicitly, though it should have been clear even so what the typical point of such utterances is: the speaker ‘puts’ the truth conditions of the sentence she utters ‘on the table’ with the purport that they are fulfilled (i.e. that what she says is true) and usually with the intent that her audience accepts them as fulfilled.

Speech acts of this type, which present a set of truth conditions – or ‘propositional content’ – as true of the subject matter that the speech act targets, are called ‘assertions’. Assertions may vary in how forcefully they are made, i.e. how much confidence the speaker manifests in their being true and how much she urges their content on her audience. But otherwise they are all of a kind.

However, there are many more things that we can do with language than make assertions; and there are other sentences types – types of sentences that do not have the forms of indicative sentences - that are earmarked for uses that are not assertions. English (like many other European languages) has three types of sentences – three sentence ‘moods’, indicative, imperative and interrogative. It is part of our basic knowledge of grammar how these types differ: Indicative sentences have the standard word order of an SOV language (which English is generally assumed to be); imperatives are sentences without overt subjects, and where the implicit subject is always the addressee (or addressees); interrogatives come in two forms: (i) that of polar interrogative sentences, in which the finite verb of the main clause precedes the subject (instead of following it, as it does in indicative sentences); (ii) the form of so-called ‘wh-interrogatives’, in which the main clause subject is preceded by some ‘wh-phrase’. (There is a range of wh-phrases: the interrogative pronouns who, what, when where, why; DPs in which the determiner position is filled by which; how on its own (as in ‘How did you do that?’) and adjectival phrases beginning with how, such as how big, how far, how hot, how tedious.

The use of imperatives and interrogatives is restricted. Imperatives can only be used in directive speech acts, especially in making recommendations, advising, directing (as when you tell somebody how to get somewhere, or in recipes, maintenance manuals, etc. which tell the reader how to carry out a certain kind of task, like preparing a certain dish or servicing an engine). (Contrary to what is often bandied about, imperatives are not very common in straight commands. Were you to tell your cleaning lady: ‘Clean the kitchen.’, that wouldn’t just sound rude, it would somehow sound strange. Adding ‘please’ – as in ‘Please, clean the kitchen.’ – improves things somewhat, but out of the blue, and in the society in which we live, the utterance is still not quite in keeping with normal expectations.)

Like imperatives, interrogatives are also quite restricted in their use. Their basic use is for asking questions.
These observations might seduce one into thinking that there is a neat correspondence between the three grammatically defined sentence ‘moods’ indicative, imperative, interrogative on the one hand and the types of speech acts that can be performed by using these modes on the other – interrogatives for questions, imperatives for certain kinds of directive speech acts and indicatives for making assertions. But this is a notorious oversimplification. As Searle was the first to see clearly and to discuss in a systematic way, the correspondence between speech act types and sentence modes is much more complicated. In particular, indicative sentences can be used for many more purposes than just the making of assertions. An utterance of an indicative sentence with a rising intonation at the end is naturally understood as a yes-no question rather than an assertion. And – the central discovery of Austin – indicative sentences whose main verbs are of a special ‘performative’ sort are, when the verb is used in the first person present tense, typically used to perform speech acts that correspond to the meanings of those verbs – to be precise: speech acts that these verbs, when used with a different person or tense, are used to describe. And many of these verbs do not describe assertions; examples are verbs such as promise, recommend, suggest, command.

And, finally, there is the phenomenon of indirect speech acts. (This phenomenon was first discussed in systematic way by Searle.) ‘Could you pass the salt’ is normally understood as a request for the salt cellar on the table, and not as an inquiry whether the addressee has the ability to pass the salt cellar; ‘It is rather drafty here.’ can be understood as the request to the person who is sitting next to the open window to close it; and so on.

Two of the central challenges for Speech Act Theory are:

(i) to explain the possibility of performing different types of speech acts with performative verbs on the basis of a suitable lexical semantics for those verbs and

(ii) to account for the performance of indirect speech acts with certain types of sentences on the basis of (a) the assumption that these sentences are destined for making certain types of speech acts directly and (b) that from the initial assumption that a given sentence has been used to make a direct speech act of a type for which it is earmarked it can sometimes be inferred that the speech act the speaker must have intended to make must be a different one.

The correlations between sentence modes and speech act types won’t be of any further consequence in what follows here. What does matter is that the grammatical mode of a sentence makes no difference to its propositional content. The mode is only an indication – if in general not an unequivocal one – of the kind of speech act in which that propositional content is used. For instance, the sentences in (1) all have the same propositional content – the content that the addressee will come to the speaker’s party at some time following the utterance time – while utterances of the three sentences will typically be understood as performances of different kinds of speech acts.

(1) a. You will come to my party
    b. Will you come to my party
    c. Come to my party

This observation supports the following schematic analysis of the range of propositional speech acts that can be made in a language like English. Speech acts can be classified along two orthogonal dimensions: (i) their propositional content and (ii) their speech act type. This means that a speech act can be represented schematically as a pair \(<\text{SAT}, p>\), where \(p\) is the
proposition that makes up its propositional content and SAT denotes the type of speech act it is. Thus the three sentences in (1) can be used to make (at least) three different types of speech act, all with the same propositional content and with the respective SATs ‘ASS’ (for Assertion), ‘QUE’ (for asking a question, or ‘Querying’) and DIR (for ‘Directive’, a family of speech act types that is usually subdivided into recommendations, requests, commands and, according to some classification schemes, some additional ones).

This thesis can be traced back to Frege. It has proved useful as a first working hypothesis within pragmatics, even if it is difficult to determine what repertoire of distinct speech act types a systematic account of speech acts should settle for – this question has important ramifications because of its implications for the two challenges mentioned above – a systematic account of performative speech acts and speech act verbs and an account of the nature of indirect speech acts. (Unless more is said about those accounts it is difficult to bring these ramifications into proper focus, and I won’t try to do this.) Agreement on what is the best choice of SATs has yet to be achieved.

**Questions**

Whatever the merits of such a 2-dimensional analysis of speech acts, it won’t do for questions. The reason for this is simple. As noted, there are not only questions with a propositional content – the so-called ‘yes-no’ questions, or ‘polar’ questions, such as ‘Is Mary in Paris right now?’, but also so-called *wh*-questions. Many questions of this latter are naturally understood as requests for a specification of the satisfiers of some predicate. For example, the question ‘Who is coming to dinner’ is a request for the satisfiers of the predicate $\lambda x. x$ is coming to dinner and ‘Where have you hidden the Easter eggs?’ as a request for the satisfiers of the predicate $\lambda p. p$ is a place where Easter eggs are hidden. It is clear from this that *wh*-questions involve some kind of propositional content too – viz. the propositions that one obtains by putting different arguments in the slot held by the *wh*-word or -phrase - but this is not a ‘propositional content’ that can be captured in the form of a single proposition $p$.

Usually the number of possible answers to a *wh*-question between which the answerer must choose isn’t just two, but some larger number. Often the number is much larger than two, and there is no upper bound to it.

There are also *wh*-questions that are not so easily understood as a request for the satisfiers of some well-defined predicate. One example of this are *why*-questions. According to J. S. Peirce (most widely known as the founder of Pragmatism) answers to such questions involve ‘abduction to the best possible explanation’. Peirce assumed that abduction is a special form of reasoning which forms an essential part of scientific methodology. It is a form of reasoning that, given a particular proposition (a possible fact or set of facts, certain scientific phenomena or experimental data) as premise, yields as ‘conclusion’ the best explanation for the truth of that proposition. What is to be understood by ‘best explanation’ needs further spelling out, as do questions concerning the constraints under which the ‘best explanation’ selection must be made (constraints that may be seen as ancillary premises of the given abductive argument). It has proved extremely difficult Making these various aspects of abduction precise. And a large part of that difficulty is that it is so hard to determine what a potential explanation of the ‘premise proposition’ could be like. Evidently there is no way of reading off the predicate ‘is an explanation of the given explanandum from the ways in which explananda are typically presented. And that is true in particular of the explananda presented by *why*-questions. What for instance are the extensions of the explanation predicates connected with a question like ‘Why doesn’t the motor start?’ or ‘Why is Mary late?’, i.e. the predicate ‘is an explanation of
the fact that the motor doesn’t start’ or the predicate ‘is an explanation of the fact that Mary is late’?

There is something fundamentally right about this, even if it has proved very difficult to give satisfactory accounts of what kind of inference abduction precisely is. (It would appear that there are many different inference strategies we pursue in different contexts all of which have some basic features of abduction; but it is unclear how much these have in common with each other, when one comes down to the details.) But whatever the explication, or explications, of abduction may be, it seems clear that it never comes down to selecting the intended outcome from a predefined and well-defined set.

_why_-questions are not the only _wh_-questions which do not determine a set of possible satisfiers of the argument identified by the _wh_-word or -phrase that can be read off the _wh_-question in an automatic and unequivocal way. Groenendijk and Stokhof refer to all such questions ‘open questions’ (The example of an open question they suggest is ‘What are questions?’.) Coming up with an answer to an open question must begin with a reflection on what could qualify as a satisfactory answer, before proceeding to finding out which of the possibly satisfactory answers is or are true. Groenendijk and Stokhof contrast open questions with what they call ‘informative questions’. An informative _wh_-question supplies a well-defined predicate and with that a well-defined set of possible answers: each complete answer is the specification of the set of those individuals that satisfy the predicate. It is on informative questions that formal accounts of the meaning (semantics and pragmatics) of questions have mostly concentrated. These will also be the exclusive target of our considerations here.

Even among the _who_- and _which_-questions we find instances that do not straightforwardly qualify as informative questions. Invariably informative are only the yes-no question and so-called ‘alternative’ questions. Examples of alternative questions are the questions in (2).

(2)  
a. Is Mary at home or (is she) at work?  
b. Do you want coffee or (do you want) tea?

Such questions have a built-in expectation that one of their disjuncts is true and thus qualifies as the true answer to them. In fact, this expectation has the status of a presupposition, to the effect that the disjunction of the alternatives offered by the alternative question is true. If the addressee of an alternative question knows that this presupposition is not fulfilled, then he will perceive the question as infelicitous. For instance, when you are asked (2.b) and you don’t want either coffee or tea and say as much in reply, that does have the feel – or at any rate this is the averred reaction of most speakers – that you are thereby implying that the situation (in this case regarding your wants and desires) isn’t what the speaker was apparently taking it to be (viz that you wanted one or the other).

Most commonly alternative questions come as disjunctions of two alternatives. But that is no restriction. Instead of (2.a) one might also ask ‘Is Mary at home or (is she) at work or is she at the gym?’). In fact there is no limit on the number of disjuncts, any more than there is an upper bound to the number of disjuncts in disjunctive indicative sentences.

Yes-no questions can be considered a special case of alternative questions, in that they can be seen as offering the alternative between the proposition they express and its negation. Thus, (3.a) and (3.b) are for all practical purposes equivalent. Certainly a true answer to the one is a true answer to the other.
(3)   a. Is Mary at home?
       b. Is Mary at home or (is she) not?

It is therefore possible to treat yes-no questions as a special case of alternative questions and that is what we will do.

Note that since one of p and \( \neg p \) will always be true, the presupposition that attaches to alternative questions in general will automatically satisfied when an alternative question is a yes-no question in disguise. Thus yes-no questions are de facto free of any presuppositions.

We already saw that wh-questions prevent a general treatment of questions along the Fregean lines according to which every speech act can analyzed as a pair of the form \(<\text{QUE}, p>\), where \text{QUE} is the speech act type of asking questions and \( p \) is a proposition. For wh-questions present not a single proposition but rather a predicate that can yield any number of different propositions through instantiation by different individuals. Furthermore, something like this is true for alternative questions as well. An alternative question offers two or more mutually exclusive propositions, with the presupposition that one of them must be true and the request to indicate which one of them is the true one. (Only yes-no questions can get by on the assumption that a single proposition is involved because there the choice is between the presented proposition and its negation; and the negation of a proposition is fully determined by that proposition.)

**Formalization**

Ever since work by Hamblin in the sixties there has been a de facto agreement among linguists who have worked on the semantics of questions that the semantics of question must be analyzed in terms of the question-answer relation. As Groenendijk and Stokhof summarize Hamblin’s basic theses (Their ‘Questions’, Section 4.1):

(i) An answer to a question is a sentence, or statement.

(ii) The possible answers to a question form an exhaustive set of mutually exclusive possibilities.

(iii) To know the meaning of a question is to know what counts as an answer to that question.

We will assume, then, that the semantics of informative questions is to be given in terms of what we make of the question-answer relation. Or, to put this in different words, the meaning of each particular question is to be cached out in terms of the set of possible answers to it.

That still leaves us with a number of options, but the difference between these show up primarily in relation to wh-questions. For alternative questions there isn’t much give and take between different implementations of the ‘Hamblin approach’ (not at any rate when we consider existing proposals): the question explicitly presents a set of two or more alternative propositions, and these are the possible answers.

A. Alternative Questions
Before we turn to \(wh\)-questions, first something about the representation of questions within the framework we have been using. For alternative questions this matter is quite straightforward, but we need a notational convention.

Since an alternative question takes the form of a kind of disjunction between the propositions it offers as its possible answers, a semantic representation of the question must include semantic representations of those alternative answers. As far as these representations are concerned we can rely on our DRS construction algorithm for indicative sentences (to the extent that we have developed it). This will give us DRSs \(K_1, \ldots, K_n\) (with \(n \geq 2\)) for each of the disjuncts. But how should these be combined into a representation of the question as a whole?

Here is my proposal: We mark the representation for the question as a whole – a DRS, but involving the notation explained below – with a question mark, to indicate that it is the semantic representation of a question. Moreover, we indicate that the representations \(K_i\) are alternatives by using the alternative connective ‘\(?/\)’. The ‘interrogative disjunction symbol’ ‘\(?/\)’ differs from ordinary disjunction \(\lor\) in a way that is reminiscent of the difference between the ‘ambiguity disjunction sign’ ‘\(!/\)’ and \(\lor\). ‘\(!/\)’-disjunctions are used to represent ambiguities in preliminary representations. To turn a preliminary representation containing a the ‘\(!/\)’-disjunction into a non-preliminary one, one of its two or more disjuncts has to be selected and the others discarded. In the case of a ‘\(?/\)’-disjunction, selection of one of the disjuncts is not part of the transition from preliminary to final representation. Instead, it serves as an indication that answering an alternative question with a non-preliminary representation as in (6) takes the form of selecting one of the ‘\(?/\)’-disjuncts.

The representation, then, of an \(n\)-termed alternative question will be as in (4):

\[
? \quad K_1 \ ?/ \ \ldots \ ?/ \ K_n
\]

As noted, alternative questions come with the presupposition that one of the ‘\(!/\)’-disjuncts is true. That is, the presupposition that comes with the alternative question representation in (4) is that the ordinary disjunction \(K_1 \lor \ldots \lor K_n\) is true. In addition there appears to be a presupposition to the effect that the disjuncts are mutually exclusive. Together these presuppositions amount to the exclusive disjunction of the disjuncts. Since this presupposition is invariably associated with alternative questions, we can afford to refrain from representing it explicitly; whether it is an explicit part of the representation or not, it is part of what is represented. I will take this liberty, and will not include representations of these exclusive disjunction presuppositions as explicit parts of the representations of alternative questions.

The semantics of representations like (4) must give us, in some form, the propositions expressed by \(K_1, \ldots, K_n\). Given an intensional model \(M\) this can be done in an obvious way: for any given time \(t\) (the utterance time of the represented question) the meaning of the question \(? \ K_1 \ ?/ \ \ldots \ ?/ \ K_n\) relative to \(M\) (uttered at time \(t\)) is the set of propositions \(\{[[K_1]]_{M, t}, \ldots, [[K_n]]_{M, t}\}\). Providing a full answer to the question amounts to selecting one of the \(K_i\).
Informative *wh*-questions – and more particularly those in which the *wh*-phrase is *who, what* or a DP beginning with *which*, which are the *wh*-questions on which we will focus – present a more complicated picture. First a matter that we already touched upon, but discussion of which we decided to defer: the form of a *wh*-question doesn’t in general fully determine the set of its possible answers because of the fact that the domain of entities that fall within the range of the interrogative phrase is often affected by context. In this respect *wh*-phrases are much like quantifying DPs and definite descriptions: the descriptive content that is presented explicitly by the phrase is reinforced by some additional predicate recoverable from context. I assume that the mechanisms involved – that of making the possibility of such additional domain restrictions possible and the mechanism or mechanisms involved in contextual recovery if and when it is needed – are the same in all these cases; and I will therefore adopt the device of an anaphoric ‘C’-presupposition, which we introduced in dealing with definite descriptions, also in connection with *wh*-questions.

If it is assumed that propositions $[[K_i]]_{M,t}$ are mutually exclusive, then in any situation in which the disjunctive presupposition is satisfied there will be exactly one true answer among the propositions $[[K_1]]_{M,t}, \ldots, [[K_n]]_{M,t}$. In this sense, the ‘right’ answer to such a question is always uniquely determined. But as Groenendijk and Stokhof discuss at some length, this is not the only way in which ‘right answer to an alternative question’ can be defined.

On the one hand there is the matter of how the answer should be worded. There are always all sorts of equivalent ways in which a ‘proposition’ (i.e. a set of possible worlds) can be expressed in English. But the words in which the answerer expresses his answer ought to be chosen in such a way that they can be straightforwardly understood as selecting some particular one among the alternative propositions that the question presents. The simplest and most direct way to achieve this, of course, is to use the very words that the asker herself used to present the alternative that the answerer selects. But it would not be right to insist that the answer should be given in this particular form. A somewhat weaker requirement is that the words used in the answer that is represented by the disjunct $K_i$ in the representation of the question should in their turn yield $K_i$ as semantic representation (i.e. yield $K_i$ when the representation construction procedure is applied to them). This weaker requirement will still rule out a very large number of possible ways in which the proposition $[[K_i]]_{M,t}$ could in principle be expressed. Even weaker requirements on the adequacy of answer formulation could be considered, to the effect that the equivalence between the selected disjunct $K_i$ of the question representation and the representation $K'_i$ of the answer can be easily recognized, in some suitable sense of ‘easy’. But we will not explore these possibilities further.

Besides answers that coincide exactly with one of the $[[K_i]]_{M,t}$ in propositional content there are also replies that stand in some different semantic relation to the meaning of a given alternative question. The ultimate purpose of an alternative question is to get the addressee to provide the means for selecting the right alternative, and there may be all sorts of ways in which the recipient of such a question may provide information that enables the asker to identify that alternative. The direct way, considered above, is to simply express that very proposition, and preferably in the same words that were used by the asker. But in addition to this there can also be various indirect ways of achieving this. It may be that the answerer’s information only enables him to give a partial answer to the question, i.e. one that is compatible with two or more of the question’s alternatives. But in some such cases it may be true in addition that the asker herself can derive a complete answer from the information that the recipient of the question is able to supply, because she has information that he is lacking.
and which yields a unique answer when combined with what he knows. For instance, in reply to A’s question (5.a) B might answer with (5.b). If A knows that neither the butler nor the cook had access to the garden shed, then she can infer from (5.b) that the correct answer is given by the third disjunct of her question.

(5)   a.   A: Did the cook murder Lady Persephone, or did the butler do it, or was it the gardener?
      b.   B: The murderer must have had access to the garden shed.

On the one hand the answer in (5.b) is an example of an answer that, when taken on its own, provides too little information for a complete answer. But on the other hand it also provides more information than is strictly required. For when fully expanded (5.b) means something like ‘Whoever murdered Lady Persephone had access to the garden shed.’ A’s question (5.a) says nothing about what conditions the person who murdered Lady Persephone must have satisfied, and in particular it says nothing about the garden shed. But if the case is as imagined, then of course this information about access to the garden shed is essential to the deployment of A’s own information about it.

This example suggests the following refinements to what it is for a proposition to be a complete answer to an alternative question. For an alternative question Q of the form (4) (and posed at t) the possible complete answers to it are the propositions \( [[K_i]]_{M,t} \). Closely related to this relation of a reply being a complete answer to Q there is also the relation of a reply entailing a complete answer to Q. Replies that entail a complete answer to Q may be replies that are a complete answer to Q in that they are identical with one of the disjunct propositions \( [[K_i]]_{M,t} \), but they may also be strictly stronger than the \( [[K_i]]_{M,t} \), containing more information, than is required of a reply that is a complete answer.

In the situation we were assuming for the exchange in (5) the excess information in the answer served a purpose in that without it A would not have been able to infer a complete answer. But it is also possible that excess information in an answer to a question may serve no real purpose and only divert attention from the issue that the question raises. When B answers A’s question (5.a) by giving the reply in (6), then the answer – as an answer to (5.a) – is odd, unless the fact that Sir William is still alive can be understood as standing in some relevant rhetorical relation to the answer’s first conjunct (which constitutes a complete answer by itself).

(6)   B:    She was murdered by the cook and Sir William is still alive.

In fact, the attempt to make sense of (6) as an answer to (5.a) the interpreter would be trying to find some such connection between the first and the second conjunct of (6): Maybe the fact that Sir William is still alive is relevant insofar as it suggests that the cook did not achieve her goal by poisoning the food that was served to, and eaten by, both her employers. So she must have used some different means, e.g. by poisoning Lady Persephone’s bed time toddy.

In the actual practice of answering questions extra information, which goes beyond what the question asks for when taken strictly and literally, is often not only welcome, but expected. Classical examples are questions like (7) when asked at a ticket counter or information booth at a railway station.

(7)   Is there a direct train from here to Bamberg?
The natural way to give a positive answer to such a question is not to simply say ‘yes’ and to wait for the asker’s next move, but to supply additional information about the departure and arrival times of direct trains to Bamberg, e.g. when the next direct train to Bamberg is going to leave, and from which platform. The question can of course also be answered with a simple ‘yes’, but that would normally be just an opening to the next part of the conversation, in which the person who is requesting information goes on to ask further questions that the answerer can anticipate on the basis of the first question.

When such cooperative answers to questions, which do not only give the information that has been requested explicitly but also information of which it can be anticipated that it will be wanted or should come in useful, are appropriate is a non-trivial problem. It is a prominent issue in that branch of Artificial Intelligence which is concerned with the development of automated Question Answering Systems, in which the system takes over the part of the person in the information booth. When such systems fail to provide cooperative answers in situations where the user expects a cooperative answer the user can easily get frustrated. Much effort is therefore spent on making systems capable of recognizing what information the user will expect to get beyond what his question explicitly requests and to answer his questions in an optimally cooperative way.

These various considerations go to show that formal relations between the propositional contents of questions and answers can provide no more than a skeleton for more refined analyses of question-answer relations, in which pragmatic factors, such as the inferable concerns of those who ask questions are taken into account as well. Still, such a formal skeleton can be useful nevertheless, if only because it gives a first, simple picture of what the main formal distinctions are. The following definitions are slight adaptations of definitions from Groenendijk & Stokhof’s HLL article ‘Questions’:

**Def. 1** Let $M$ be an intensional model. Let $Q$ be the utterance of a question of the form (4), made in a world $w$ of $M$ at a time $t$ of the time structure of $M$ and let $p$ be a proposition relative to $M$. Then:

a. $p$ is a complete answer to $Q$ with respect to $M$ and $t$ iff $p$ is identical to one of the propositions $[K_1]_{M,t}$, ..., $[K_n]_{M,t}$.

b. $p$ entails a complete answer to $Q$ with respect to $M$ and $t$ iff $p$ entails one of the propositions $[K_1]_{M,t}$, ..., $[K_n]_{M,t}$.

c. $p$ is a partial answer to $Q$ with respect to $M$ and $t$ iff $p$ is incompatible with at least one of the propositions $[K_1]_{M,t}$, ..., $[K_n]_{M,t}$.

d. Suppose that $q$ is some proposition. Then

$p$ entails a complete answer to $Q$ relative to $q$ with respect to $M$ and $t$ iff the conjunction $p \& q$ entails one of the propositions $[K_1]_{M,t}$, ..., $[K_n]_{M,t}$.

N.B.1 The interesting instances of (Def.1.d) are of course those in which $q$ doesn’t already entail a complete answer to the question all by itself. As illustrated in our discussion of (5), we think of $q$ primarily as information that is independently available to the asker. If $q$ is known to the asker and it already provides a complete answer to the question she asks, then of course there would have been no need for her to ask $Q$ in the first place.
N.B.2 The notions defined in (Def.1.c) and (Def.1.d) are logically independent. In particular
p can entail a complete answer to Q relative to q without being a partial answer to Q. The
answer in (5.b) is a case in point. It is not a partial answer to (5.a) in the sense of (Def.1.c),
even though it does entail a complete answer when conjoined with A’s information about who
had access to the garden shed. But of course, it is also possible that a reply that entails a
complete answer to a question in conjunction with some further information also constitutes a
partial answer when taken on its own. An example is the two-sentence answer to (5.a) given
in (8).

(8) It wasn’t the cook. And furthermore, the murderer must have had access to the garden
shed.

(8) is a partial answer to (5.a) in that it excludes the third disjunct all by itself. And it entails a
complete answer in conjunction with A’s information about who had access to the garden
shed. In fact, just the knowledge that the butler had no access to the shed will be enough to
infer the complete answer that the answer is the one remaining option, viz. that it was the
gardener.

So much for alternative questions. We now turn to the more intriguing subject of \textit{wh}-
questions.

\textit{Wh}-Questions

Once again it will be useful to start with the matter of logical form. The central demand on the
logical form of a simple \textit{wh}-question, such as (9.a) or (9.b), is that it can be interpreted as a
specification of the set of complete answers to the question.

(9) a. Who came to the party?
   b. Which faculty members came to the party?

We already noted that what counts as a complete answer to these and other \textit{wh}-questions
depends on the intended ‘domain’: some set D such that the question counts as having been
answered completely when and only when it has been specified for each element d of D
whether d satisfies the predicate specified by the question. (e.g. in the case of (9.a) which d in
D came to the party and which d in D didn’t). We also noted that the addressee should be in a
position to identify D, possibly with help from the context in which the question is addressed
to him, and that the mechanisms involved in the context-based recovery of D appear to be the
same as those involved in the recovery of domain restrictions on nominal quantification and
on the presuppositions generated by definite descriptions; and finally, let us recall the decision
I announced at that point that we would employ the same formal device to represent the need
for contextual recovery that we have been making use of already in our treatment of definite
descriptions.

All this is premised on the assumption that the semantic contribution made by the \textit{wh}-phrase
includes a variable (or discourse referent, in our framework) that serves as its referential
argument. In this respect \textit{wh}-phrases are like other DPs: like other DPs they contribute to the
representations of the interrogative expressions that contain them as constituents a discourse
referent that acts as their referential argument and which is inserted in the relevant argument
slot to which the \textit{wh}-phrase is linked as argument phrase. The only difference with other types
of DPs that play the role of argument phrases is that \textit{wh}-phrases undergo syntactic movement, so that the link to their argument slots is differently in the surface syntax. (In this last respect, of course, argument linking of \textit{wh}-phrases in questions is just like argument linking for relative pronouns in relative clauses.)

I have been speaking of ‘\textit{wh}-phrases’ in order to include phrases like \textit{which faculty members} in (9.b). Such phrases show obvious syntactic similarity with definite and indefinite descriptions, as well as with quantifying phrases such as \textit{most faculty members} and \textit{every faculty member}; and we shall follow the obvious suggestion implicit in these comparisons in that we will assume that the \textit{wh}-word \textit{which} that occurs in such \textit{wh}-phrases plays the part of Determiner, with an NP as syntactic sister. And as with other complex DPs, the NP of a \textit{wh}-phrase can be just a single noun, but it can also be a more complex phrase, such as e.g. \textit{which faculty members who had said that they would be coming}. \textit{wh}-phrases consisting of a single \textit{wh}-word, such as \textit{who} or \textit{what}, can, I will assume, be analyzed syntactically as rudimentary DPs, like the personal pronouns \textit{he}, \textit{she}, \textit{it}, \textit{they}. (The commonly used term ‘interrogative pronoun’ for expressions like \textit{who} or \textit{what} suggests some such analogy between such pronouns and personal pronouns.) For the one-word DPs \textit{who} and \textit{what} I will assume that the Det node acts as host of a semantic feature that is reflected by the ‘\textit{wh}’-morphology of \textit{wh}-phrases and that that feature is responsible for the semantic structure of a \textit{wh}-question, as the combination of a predicate and a queried argument position in it. In this semantic respect the Det nodes of simple \textit{wh}-phrases are like those of complex \textit{wh}-phrases, in which the Det position is assumed to host the \textit{wh}-word \textit{which} as a whole and where this word carries the same semantic information as the feature.

Complex \textit{wh}-phrases pose a problem about which I will not have much to say, but that should at least be mentioned. This is the difference between singular and plural phrases, e.g. between \textit{which faculty member} and \textit{which faculty members}. The problem is closely related to one that is often brought up in connection with \textit{who}: Do \textit{who}-questions come with an existence presupposition, to the effect that there is something that instantiates the (simple or complex) predicate for which \textit{who} is an argument phrase? (I’ll refer to this predicate from now on as the ‘queried predicate’.) For instance, does the question in (10.a) come with the presupposition that someone solved the fifth problem on the test (see (10.b))?

(10) a. Who found the solution to the fifth problem on the test?  
b. Someone found the solution to the fifth problem on the test.

Groenendijk and Stokhof argue convincingly that in general \textit{who}-questions do not carry such an existence presupposition. This can be argued at the hand of examples like (11) – think of A as the one who is teaching a particular class and of B as her TA, who has gone over the results of one of the tests in the class. If A’s question had carried the presupposition that at least one person who took the test had found the solution to Problem 5, then B’s reply in (11.b) would have to be construed as a kind of rejection of the question rather than as a straightforward answer to it. And that isn’t the way B’s answer ‘feels’. Moreover, and perhaps more conclusively, if (11.a) did carry an existence presupposition, then A’s reaction in (11.c) would have to be construed as a kind of reneging on the question she had just asked. But that seems extremely implausible, given that the state of mind that A reveals in (11.c) must have been present when she formulated her question and thus before she got the information conveyed by (11.b). If (11.a) had an existence presupposition connected with it by virtue of its form, then A’s reaction could only be construed as an admission that she just had performed a speech act that she knew to be infelicitous. But the exchange in (11) sounds perfectly natural and doesn’t suggest in any way that A acknowledges in (11.c) that in asking (11.a) she
knowingly violated a rule of proper language use.

(11)  
a.  A: Who found the solution to the fifth problem?  
b.  B: Nobody  
c.  A: That is just what I had expected.

The choice between singular and plural complex \textit{wh}-phrases raises similar issues. For one thing, the matter of existence presuppositions can be raised for both, and in addition it may be asked whether the grammatical number of such phrases could be responsible for additional presuppositional constraints. The answers to these questions are not all that clear. From what I have been able to gather, the choice between plural and singular is governed in part by the speaker’s knowledge or assumptions about the number of possible satisfiers of the queried predicate: if it is known or assumed that the number is greater than one, then the proper choice is the plural, if the number is known or assumed to be one, the choice ought to be the singular. But it seems that when the speaker has no definite idea about the number of satisfiers, the plural is the more natural choice – the plural is the ‘semantically neutral’ choice, (as it also seems to be in connection with many other constructions in English).

These conjectures entail that the use of a singular complex \textit{wh}-phrase comes with a presupposition of ‘singularity’ – i.e. that the queried predicate has only one satisfier. This difference seems to me to get support from examples like the pair in (12).

(12)  
a. Which student of yours was chosen to participate in the competition?  
b. Which students of yours were chosen to participate in the competition?

Without further information (12.b) seems to be neutral with regard to the question how many students from the addressee’s class were chosen: the speaker could have chosen this form either because she assumes that the number is greater than one or because she simply has no idea about the number. In contrast, (12.a) seems to carry a strong implication that the speaker takes the number not to be greater than one.

In fact, there seems to be an even stronger implication in this case, viz. that the number is exactly one. In other words, \textit{wh}-questions with complex \textit{wh}-phrases in the singular, do seem to come with the combination of an existence and a uniqueness presupposition, much as this has been traditionally held to be the case for singular definite descriptions. The fact that \textit{who}- and \textit{what}-questions do not seem to come with such a presupposition may be an indication that \textit{who} and \textit{what} are not marked for number.

The clearest case is presented by plural \textit{wh}-phrases which contain a numeral. For instance, the \textit{wh}-phrase in (13.a) unequivocally carries the presupposition that there were two people who reached the top of Everest in 1953.

(13)  
a. Which two people reached the top of Mount Everest in 1953?  
b. Edmund Hillary and Tenzing Norgay  
c. Edmund Hillary, Tenzing Norgay and John Hunt  
d. Actually the number isn’t two but three. They were Edmund Hillary, Tenzing Norgay and John Hunt

The \textit{wh}-phrase \textit{which two people} unequivocally contributes to (13.a) the presupposition that the number of people who reached the top of Everest in 1953 is two. This can be seen for instance by considering how one should react to this question if one knew, for instance, that
the number was three, e.g. Edmund Hillary, Tenzing Norgay and John Hunt. In that case you
couldn’t answer the question simply as in (13.c), as you can answer (13.a), given the way
things are, with (13.b). Rather, one would have to say something like (13.d).

So much for existence, uniqueness and non-uniqueness presuppositions of *wh*-phrases. I will
ignore this matter in what follows. We will avoid the issue by restricting attention to *wh-
questions with simple *wh*-phrases and plural complex *wh*-phrases without numerals, neither of
which carry, according to our tentative conclusions, any such presuppositions.

From what has been said so far it follows that the representation of a *wh*-question must
involve three components, much like the representation of a nominal quantification: (i) a
representation of the restriction on the variable/discourse referent introduced by the *wh-
phrase; (ii) a representation of the queried predicate; and (iii) something that indicates that
these representations fit together in the manner of a *wh*-question. This last contribution is
made by the information attached to the Det node of the syntactic structure of the *wh*-phrase.
(i) is contributed by the highest NP node of the *wh*-phrase and (ii) by the queried predicate of
the question.

The task before us, then, is to decide how these three pieces fit together. The only really
important aspect of this task is the decision how they should fit together semantically. But
before we embark on that we first have to agree on a notational convention: How are we
going to represent *wh*-questions as composed of the components (i)-(iii)? Essential to the
question of notation is only that the ‘queried variable’, i.e. the referential argument x of the
*wh*-phrase, is combined with a symbol (or other piece of notation) which indicates that x is
bound in the sense of *wh*-questions. Given the commitment we have made with regard to the
representation of alternative questions it is natural to use the question mark again, but now as
a variable binder. That is, if x is the referential argument of the *wh*-phrase, then ‘?x’ is how we
will represent the third component of a *wh*-question representation.

The only remaining question about the form of the representation is now how the three
components are to be combined. Given what we have said about the analogy between *wh-
questions and nominal quantification, it seems natural to extend the duplex condition format
that we have been using to represent quantification. This is what we will do, with the
reminder to ourselves and others that the graphical format we choose isn’t what really matters.
All that we can and should ask of it is that it makes reading the representations easy and is as
consistent as possible with notational conventions that are already in place.

There is one remaining matter we have to settle. It has to do with the contextually resolvable
domain restriction presupposition involving the predicate variable C. When discussing
quantification we did not pay attention to contextual domain restriction. (In what we have
been doing so far the matter only came up in connection with definite descriptions.) But as we
noted once more above, domain restriction is an essential aspect of natural language
quantification, and of nominal quantifiers no less than of other forms of quantification. So the
duplex conditions we have been using to represent nominal quantification should in general
come with a domain restrictor presupposition too. The question then is exactly where this
presupposition should be adjoined: to the restrictor component of the representation or to the
duplex condition as a whole. From a semantic perspective there is little to choose between
these options because the contextual information available for resolution of the presupposition
will be the same in either case. And it isn’t immediately clear either that we can hope for
decisive guidance from the principles of representation construction. If it is assumed that the
C-presupposition is generated within the NP (or, more generally, within the sister to Det, in
case the sister is a higher projection than NP), then the C-presupposition will come as an
integral part for the representation that becomes the restrictor part of the duplex condition
generated by the quantificational information in Det. But if we assume that it is only
processing of the information in Det that gives rise to this presupposition, then both
adjunction to the restrictor representation and adjunction to the duplex condition as a whole
would seem possible and reasonable options. As things stand, I have no good argument for
where introduction of the domain restriction presupposition gets triggered (though I am
inclined to think that the determiner is responsible for this). So I don’t quite know how to
make a motivated choice for where the presupposition is adjoined. I will assume that the
adjunction is to the restrictor, while waiting for arguments that may settle this question either
way.

If this is how we make room for domain restrictions that are to be recovered from context for
the duplex conditions that represent nominal quantifications, then it is only natural to adopt
the same pro tem policy for the representation of wh-questions. With this last stipulation in
place the preliminary representations for the question in (14.a,b) are those given in (15.a,b).

(14)  a. Who came?
  b. Which students came?

(15)  a. 
      \[ \begin{array}{ccc}
          C & x & / \ \ \ \ \ \ e & t \\
          \{ & ?x & \\
          C(x) & \ / & t < n & e \subseteq t \\
          e: & \text{come}(x) & \\
      \end{array} \] 

  b. 
      \[ \begin{array}{ccc}
          C & x & / \ \ \ \ \ \ e & t \\
          \{ & ?x & \\
          \text{student'}(x) & \ / & t < n & e \subseteq t \\
          C(x) & e: & \text{come}(x) & \\
      \end{array} \] 

The representations in (15.a,b) are preliminary representations. In order to obtain final
representations from these the C-presuppositions have to be resolved. Suppose the resolution
of the C-presupposition in (15.b) takes the form of replacing the discourse referent C by an
explicit predicate (i.e. DRS or DRS condition) \( \Gamma \), which has been recovered in some way from
the context in (14.b) is used. This turns (15.b) into the representation in (16).

(16)  \[ \begin{array}{ccc}
          x & / \ \ \ \ \ \ e & t \\
          ?x & \\
          \text{student'}(x) & \ / & t < n & e \subseteq t \\
          \Gamma (x) & e: & \text{come}(x) & \\
      \end{array} \] 

\[ K_{\text{restr}} \quad K_{n,sc} \]
What is the semantics of a representation like (16)? The semantic value proposed above for an alternative question, with a representation of the form given in (4), was the set consisting of the propositions expressed by the different \?/-disjuncts of its representation. Is there a way in which this idea can be adapted to representations of \textit{wh}-questions like those in (14)? Here is one suggestion:

The semantic value of (16), relative to some model \(M\) in a world \(w\) of \(M\) at a time \(t\) of \(M\), is the set of propositions that are determined by the ‘nuclear scope DRS’ \(K_{\text{n.sc}}\) when \(x\) is assigned any value that satisfies the ‘restrictor DRS’ \(K_{\text{restr}}\).

More formally:

\[
(17) \quad [(16)]_{M,t,w_0} = \{p: p = \{w \in W: (\exists d \in \text{DR})([K_{\text{n.sc}}][d/x],M,w,t = 1)} \},
\]

where DR is the set of those individuals \(d\) from which ‘satisfy the restrictor DRS \(K_{\text{restr}}\’’.

N.B. The notation ‘\([K_{\text{n.sc}}][d/x],M,w,t = 1\)’ is to be understood as saying that \(K_{\text{n.sc}}\) has a verifying embedding \(f\) in \(M\) in \(w\) at \(t\) which maps \(x\) to \(d\) (i.e. \(f(x) = d\)).

As it stands, this characterization of \([(16)]_{M,t}\) is lacking formal precision insofar as it gives only a vague, informal description of the set DR. The reason for starting out with this partly informal characterization is that in making the definition of DR precise, we face a conceptual choice that has no equivalent in connection with alternative questions. Intuitively, DR is the extension of the restrictor predicate given by \(K_{\text{restr}}\). But there are two ways in which this intuition can be made precise, a ‘narrow scope’ way and a ‘wide scope’ way. The narrow scope way is to require the values of the existentially bound variable \(d\) to belong to the extension of \(K_{\text{restr}}\) at \(w\). The wide scope way is to fix DR as the extension of \(K_{\text{restr}}\) in the world \(w_0\) in which the represented question is uttered. The results of these two options are given in (18) and (19).

\[
(18) \quad [(16)]_{M,t,w_0} = \{p: p = \{w \in W: (\exists d)[[K_{\text{restr}}][d/x],M,w,t = 1 \land [K_{\text{n.sc}}][d/x],M,w,t = 1)} \}
\]

\[
(19) \quad [(16)]_{M,t,w_0} = \{p: p = \{w \in W: (\exists d)[[K_{\text{restr}}][d/x],M,w_0,t = 1 \land [K_{\text{n.sc}}][d/x],M,w,t = 1)} \}
\]

My own intuitions tend towards the second of these options. These intuitions find support in the semantics proposed by Groenendijk and Stokhof we will consider presently. But for now, let us just note that the semantics of (16) according to (19) depends on the world \(w_0\) in which the represented question is uttered; it is in \(w_0\) that the range of different propositions, corresponding to the different individuals that satisfy \(K_{\text{restr}}\) in \(w_0\), is determined. According to (18) the value does not depend in this way on \(w_0\), as the right hand side of (18) doesn’t mention \(w_0\). In this regard the semantic values of \textit{wh}-questions, when evaluated according to (19) are reminiscent of the propositions expressed by sentences with definite descriptions that are interpreted \textit{de re}, such as (20), on a \textit{de re} interpretation of \textit{the president}.

\[
(20) \quad \text{The president is a democrat.}
\]
On a *de re* interpretation of the *president*, the proposition expressed by (20) in a world \(w_0\) is the set consisting of those worlds \(w\) in which the individual who is the president in \(w_0\) is a democrat in \(w\). This proposition may depend on the world \(w_0\) in which the represented utterance of the question takes place, since the one who is the president in \(w_0\) need not be the same individual as the one who would have been the president in some other utterance world \(w_0'\). In this respect the *de re* interpretation of the *president* in (20) differs from its *de dicto* interpretation. On this second interpretation the proposition expressed by (20) in \(w_0\) is the set of worlds \(w\) in which the individual who is the president in \(w\) is a democrat in \(w\).

In fact, the difference between (18) and (19) could be described as that between a semantic value in which the restrictor predicate gets a *de dicto* interpretation and one in which it gets a *de re* interpretation.

There is one important difference between the semantic values for *wh*-questions exemplified by (18) and (19) and the semantic values we have adopted for alternative questions. The propositions in the set that is the semantic value of an alternative question are mutually exclusive. (That they are is one of the presuppositions that, we concluded, alternative questions carry.) For *wh*-questions this is in general not the case. If both Bill and Suzie are students who satisfy the context-determined predicate \(\Gamma\), then the proposition that Bill came and the proposition that Suzie came belong to the set defined by the right hand side of (19). But obviously these propositions are not mutually exclusive. It is perfectly possible that both Bill and Suzie came. In fact, a complete answer to the question will have to indicate for each student \(x\) that satisfies \(\Gamma\) whether \(x\) came or didn’t come. That is, it will have to specify for each of the propositions in the set \([\{16\}]_{M,t,w_0}\) whether it is true or not. And in principle the set of true members of \([\{16\}]_{M,t,w_0}\) could be any subset of \([\{16\}]_{M,t,w_0}\) whatever. (A similar story can be told for the option exemplified by (18), but it is a little more complicated.)

What are we to make of this difference between the semantic values of alternative questions and the semantic values of *wh*-questions? An attractive feature of the values of alternative questions is that the members of the semantic value of an alternative question just are the possible complete answers to it. The values of *wh*-questions lack this feature. But how much of a loss is it? Here complete answers correspond to subsets of the semantic value of the question, rather than to single members.

There are two proposals for the semantic values of *wh*-questions that are versions of the proposal exemplified in (18) and (19). The first is that of Hamblin – the father of the semantic theory of questions. In fact it is this very proposal, and so we will refer to it from now on as the ‘Hamblin semantics for *wh*-questions’. The other was proposed by Karttunen. It is to the effect that the semantic value of a *wh*-question in world \(w_0\) is the set of those propositions in the Hamblin semantic value that are true in \(w_0\). Formally, and again exemplified for the representation in (16):

\[
(21)
K_{\{16\}}\{w\} \rightarrow \{p : p = \{w \in W : (\exists d)([K_{\text{restr}}[d/x],M,w_0,t=1 & [K_{\text{n.sc}}[d/x],M,w,t=1]) \& w_0 \in p\}\}
\]

It is obvious that the Karttunen-value for a *wh*-question can be obtained from its Hamblin-value. The converse is not obvious (and has been claimed to be impossible (?)). But we need
not linger over this, since the semantics of Groenendijk and Stokhof, to which we now turn, seems to have all the advantages of either of these proposals, and arguably more.

The basic idea underlying the question semantics of Groenendijk and Stokhof is that a question (whether alternative questions or \(wh\)-questions) partitions the relevant part of a given information space into a set of disjoint possibilities, or ‘cells’, each of which defines a complete answer to it. So the task of the one to whom the question is addressed is to pick the cell that defines the true complete answer. This is a semantics that applies equally and uniformly to alternative questions and \(wh\)-questions alike.

First let us have, once again, a look at alternative questions. Again, let \(M\) be an intensional model and assume that (4) is the representation of an alternative question asked at time \(t\) in the world \(w_0\) of \(M\). Let \(W'\) be the subset of \(W\) which consists of all those worlds in which the presupposition of (4) holds, i.e. in which exactly one of the propositions \([K_i]_{M,w_0,t}\) is true. Then obviously the propositions \([K_1]_{M,w_0,t}\ldots[K_n]_{M,w_0,t}\) constitute a partition of \(W'\). And each of the cells \([K_i]_{M,w_0,t}\) of this partition is one of the possible complete answers to the question. Nothing new so far.

Second, \(wh\)-questions. Again we take representation (16) of (14.b) as our example. From the present perspective it is only the \(de re\) treatment of the restrictor set – as in (19) as opposed to (18) – which makes sense. So let \(DR\) be the set \(\{d \in D_M : [K_{\text{restr}}][d/x],_{M,w_0,t}= 1\}\). The partition of \(W\) we are interesting here is induced by the following equivalence relation \(R\) between worlds:

\[
w R w' \iff \text{speaking intuitively – the true complete answer to the question in } w \text{ is the same as the true complete answer in } w'.
\]

Given what we said about true complete answers above, the formal (and non-circular) definition of \(R\) is as in (22).

\[
(\forall w,w' \in W)(w R w' \iff (\forall d \in DR)(([K_{\text{n.sc}}][d/x],_{M,w,t}= [K_{\text{n.sc}}][d/x],_{M,w',t})))
\]

When \(w\) and \(w'\) belong to the same cell of the partition induced by \(R\), then for all \(d \in DR\), the proposition \([K_{\text{n.sc}}][d/x],_{M,t}\) is true in \(w\) if and only if it is true in \(w'\) and for each cell \([w]_R\) of this partition there is a unique subset \(D_w\) of \(DR\) which consists of all and only those members \(d\) of \(DR\) for which the proposition \([K_{\text{n.sc}}][d/x],_{M,t}\) is true throughout \([w]_R\). Note well that not all subsets of \(DR\) are necessarily realized in this way – which of them are depends on properties of the model.

Since the cells of the partition are mutually exclusive and jointly exhaustive, they are the propositions that may be regarded as the possible complete answers to the given question. As we have just seen, there is for each such cell \([w]_R\) a subset \(D_w\) of \(DR\) consisting of all those individuals \(d\) for which the answer in \(w\) (and in all the other worlds in \([w]_R\)) to the question ‘Did \(d\) come?’ is ‘yes’. In particular, the correct and complete answer in the actual world \(w_0\) is given by the set \(D_{w_0}\).
(What follows is very sketchy and more a enumeration of further issues than anything else.)

**The Logic of questions and answers.**

Much of the early work on questions – meaning roughly forty to fifty years ago – was driven by an interest in their ‘logic’. Studies of ‘erotetic logic’ (= the ‘logic if questions’) from those days are marred by conceptions of what a logic of questions might be that were simple-minded or wrong-headed (or both). On this point too, the dissertation of Groenendijk and Stokhof (which also presents their partition semantics) was a landmark. In fact, as so often with the ‘logics’ of various kinds of concepts and expressions from natural language for which classical predicate logic is not the right tool of analysis, it was not until a precise formal semantics had been developed for those concepts and expressions that a clearer understanding could emerge of what a logic of questions (and answers) could be.

As Hamblin may have been the first to see clearly, it is the question-answer relation that should be the right point of departure not only for the semantics but also for a ‘logic’ of questions. In fact, most or all of the notions that are important to erotetic logic as that subject is now widely understood are based on what Groenendijk and Stokhof take as their basic notion – that of a statement being complete answer to a question. One of these notions is a relation between questions – that of one question Q1 being ‘stronger’ than another question Q2. Q1 is at least as strong as Q2 iff every complete answer to Q1 entails a complete answer to Q2. (Here the relation ‘entails’ refers to some given notion of entailment between statements: It is usually assumed that is the notion of logical consequence, defined in the usually way in terms of a model-theoretic semantics for the (statements of the) language in which both questions and answers are assumed to be framed.) It is not hard to see that this entailment relation holds between two questions Q1 and Q2 iff for arbitrary M, w and t the semantic value of Q1 in M at w at t is a refinement of the semantic value of Q2 in M at w at t. (A partition P1 of a given set X is a refinement of a partition P2 of X iff every cell of P1 is included in some cell of P2.)

Much of the interest of the logic of questions for linguistics derives from the way in which question can be embedded within larger expressions. Embedding can take a number of different forms. The main distinction between these different forms is whether the result of embedding is necessarily an interrogative or whether it can be also be a sentence of some other mode (in particular, whether it can be an indicative sentence). Examples of the former type are conditionalized questions, like that in (23.a), conjunctions of questions as in (23.b,c) and dependent questions, as in (23.d,e). Examples of the latter type are the questions in (24).

(23) a. In case the meeting did take place, how many people were there?
   b. Who was invited to the party and who accepted?
   c. Was Mary invited, and, if so, did she come?
   d. What was everyone wearing?
   e. Which topics have you chosen for your final term paper?
   (said by the teacher to the students in her class)
   f. Which books did you buy? Or, if you didn’t buy any books, what else did you buy?

(24) a. Bill will know whether Mary will come.
   b. Tell me who will come tomorrow.
   c. Who will come depends on who will be invited.
(Alternative questions are sometimes classified as involving embedding, viz. under disjunction. For the single sentence disjunctive questions to which we restricted our attention in our discussion of alternative questions earlier on this is not particularly helpful from a semantic perspective, at least not for one who adopts the general strategy we have adopted, according to which alternative questions are the more basic form and yes-no questions a special, quasi-elliptical subspecies. On such an approach the or’s that occur in alternative questions are just among the special grammatical devices that a language like English has for forming interrogatives. However, there are also examples like that in (23.f), which require an analysis that differs at least in some respect from what has been proposed for alternative questions earlier. This is obvious in particular when, as in (23.f), the second sentence has the form of a conditional question.)

The logical questions that arise in connection with the embeddings of the second kind (illustrated by the examples in (24)) are closely intertwined with the semantics and logic of the embedding verbs. For instance, sentences like (24.a) are just as important for the logic of ‘know’ – and thus for epistemic logic – as they are for the logic of questions. One of the recurring themes in the logic of knowledge is the relation between ‘know that’ and ‘know whether’; the latter involves complements that are embedded questions, the former complements that are embedded indicatives. But more important than a logical analysis of ‘knowing whether’ is an analysis of ‘knowing who’. The first observation here is what type of relation is expressed by ‘know wh-’ and ‘know whether’. In view of what we have been saying about the meaning of questions this should now be obvious: these word combinations express a relation between agents and sets of propositions. And this relation obtains between an agent A and a set of mutually exclusive propositions P (in a world w at a time t) iff A knows (in w at t) which one of the propositions in P is the true one (in w). And that means that of the particular proposition p which A’s knowledge selects from P, A must now that p is true (in w).

But this amounts to no more than a reduction of ‘knowing who’ and ‘knowing whether’ to ‘knowing that’. So the real problem, you might say, is to formulate the logic of knowing that; and that is a problem that has bugged epistemologists and logicians since time immemorial; even some of the most fundamental questions connected with it – such as whether ‘know that p’ entails ‘know that know that p’ – are still hotly debated today.

Other attitudinal question embedding verbs, such as wonder or doubt, raise similar questions. The difference between these verbs and know is that they have had much less attention. (They are not central to a branch of philosophy in the way that know is central to epistemology.) Moreover, they differ from know with regard to how ‘V wh-’ relates to ‘V that’. In fact, ‘wonder that’, if grammatical at all, is used only marginally and sounds somewhat stilted or archaic. And while doubt can be used in combination with whether, it cannot be used in combination with who: furthermore, ‘doubt whether p’ means much the same as ‘doubt that p’; and ‘doubt whether p or q’ cannot be used in the sense of hesitating between which of p and q is true.

These scattered remarks indicate that question-embedding attitude verbs may differ from each other significantly in their ‘grammar’ – in how their uses with ‘whether’ and ‘who’ differ from uses with other complementizers (if any) and in what a first, informal, semantic explication of their meaning as question-embedding verbs might be like. But the hard logical work can start only after these initial clarifications, and in most cases that work is still largely outstanding.
Much the same is true for question-embedding verbs that are not attitude verbs, such as speech act verbs tell and ask. Here too we find ourselves on the borderline between ‘logic’ and lexical semantics of individual words – or, better perhaps, somewhere near that borderline; how near depends on which words, or how much of the semantics of those words, we consider as relevant to ‘logic’. But perhaps this question should no be taken to seriously. It harks back to a classical distinction between ‘logical’ and ‘non-logical’ truths that is arguably illusory. Which truths and arguments we are to consider as ‘logical truths’ and ‘logically valid’ arguments and which as propositions that are true and arguments that are valid ‘because of’ (logic and) the meanings of words occurring in them’ is an issue that involves much more than was thought relevant in earlier days. For one thing a sorting of the words of a language into its ‘logical constants’ and its ‘non-logical constats’ cannot be the whole story because there are words and morphemes with a semantics of which some part is arguably part of logic – i.e. as contributing to logical truth and logical validity – while other parts of it are not. The tenses of the verb are notorious examples of morphemes that raise such questions, and the same thing is true of certain temporal adverbs and conjunctions, such as since or before.

Attitudinal verbs and speech act verbs (whether question embedding or not) – raise many of the same questions.

As regards the grammar and logic of question-embedding verbs, there is one such verb among the ones we have mentioned and that can serve as paradigm for some of the problems described above. This is the verb depend, as it occurs in sentences like ‘Who will come depends on who has been invited.’ or ‘Whether Jane will come depends on whether she has been invited.’ or ‘Whether Jane will come depends on who has invited her.’ In all such sentences depend expresses a relation between two question meanings, i.e. between two sets of propositions. In our framework: The semantic representation of such a sentence should be of the following form:

\[ s: \text{depend}'(K_1,K_2) \]

where \( K_1 \) and \( K_2 \) are representations of questions.

But, again, this is no more than a preparation to the real work we have to do in determining the semantics of depend. In our framework this takes the form of determining the verification conditions for DRS conditions of the form (*) (which should be part of the lexical entry for depend).

What should these verification conditions be? That is not so easy to say. One problem is that ‘depend’ is ambivalent between a sense in which it means ‘depends only’ – e.g. ‘whether p depends on whether q’ means that p depends on q and on nothing else – and a sense according to which the second argument is relevant to the first argument, but isn’t necessarily the only thing that is relevant – i.e. which p in the set P identified by the first argument of depend is true in w may depend in part on which q in the set Q identified by depend’s second argument is true, but on other things as well. I suspect that it is this second, negative, sense in which we use depend most often. I use the word ‘negative’ because in this use of depend it is really ‘does not depend’ that is the semantically basic notion: P does not depend on Q if the question which of the propositions in P is true is independent of which of the propositions in Q is true. The difficulty with this second notion is that it is essentially intensional, and in an uncommonly intractable way. For suppose again that the sets of propositions identified by the first and second arguments of depend are P and Q and further that the true propositions from these sets in the actual world \( w_0 \) are p and q respectively. If which proposition in P is true does not depend on which proposition in Q is true, then that intuitively means that even if
some other proposition q’ from Q would have been true instead of the proposition q that is true in w₀, it would still have been the case that p had been true.

But what is the semantics of this subjunctive conditional? Clearly this is the kind of conditional that cannot be analyzed as a strict conditional. For in all interesting cases the sets P and Q consist of contingent propositions. And if p is contingent, then there are possible worlds in which p is false. So the conditional cannot mean that p is true in every possible world in which one of the propositions in Q is true. For if the presupposition associated with the embedded question that is the second argument of depend is satisfied – and we may assume in the present context that it is – then the set of possible worlds in which one of the propositions in Q is true is the set of all possible worlds. So if the conditional was analyzed as a strict conditional, then p could not be contingent.

What we need, therefore, is some kind of analysis in the spirit of Lewis, according to which a conditional is true in a world w so long as its consequent is true in all the relevant worlds w’ that are ‘close enough’ to w, in some suitable sense of ‘close enough’. But what are we to understand by ‘close enough’ here. Lewis’s analysis is more specific in that it defines a conditional as true in w iff its consequent is true in all the closest worlds w’ to w in which its antecedent is true. The problems with finding an adequate characterization of the right relative closeness relation between worlds – the 3-place relation that holds between worlds w’, w” and w iff w’ is at least as close to w as w” is – are well-known and have been discussed extensively in the philosophical literature. But the problem presented by the conditional under consideration is even more serious than that. It is not just that it is hard to determine what should be understood by ‘at least as close as’; the further problem is that the antecedent of the conditional at issue doesn’t pose any meaningful constraints on the possible worlds in which the consequent should be true. For by our assumption the antecedent is true in all worlds. Indeed, if we were to assume that the world w is closer to itself than any other world – an assumption often made in possible world semantics – the conditions for the conditional would collapse into those of the material conditional and our analysis of independence would reduce to triviality: P is independent from Q iff the proposition p from P that is true in w is true in w.

The analysis of independence, and with that of the second, weaker sense in which depend is often used, is thus a non-trivial problem that (to my knowledge) I still waiting for a conclusive treatment. (Quite possibly the necessary tools for a solution can be found in the work of Pearl, Spirtes and others, which involve sophisticated accounts of the interactions between causation and probability. But that is a very different line of work from anything broached in this course.) On the other hand the strong sense of depend, according to which the question which proposition in P is true solely depends on which proposition in Q is true, can be formalized quite straightforwardly. Suppose that the extension of depend in this strong sense (in a world w of an intensional model M) consists of a set of triples < s,P,Q > where P and Q are sets of propositions and s is the state of P depending on Q. Then for each such triple in the extension there must be a function f_P,Q from Q into P such that for every world w, if the proposition q in Q is true in w, then so is the proposition f_P,Q(q).

These remarks have done no more than give a flavor of the kinds of investigations that are needed as part of a precise articulation of the semantics and logic of embedded questions. A very different line of work is the logic of assertions and questions – a generalization of the ‘logic of questions and answers’ – that is currently being developed by ‘Jeroen Groenendijk and his associates (‘Inquisitive Logic’, in the terminology chosen by Groenendijk). For information see the Inquisitive Logic website: http://www.springerlink.com/content/0l26v16t28660515/.)
Answers to questions that do not involve complete sentences

Answers to questions often take the form of expressions that are not full sentences. The most obvious examples of this are the answers ‘yes’ and ‘no’ to ‘yes-no’ questions. As answers to a given ‘yes-no’ question Q these single words have the force of statements, with ‘yes’ equivalent to Q and ‘no’ to ‘not-Q’. (The rules for answering a ‘yes-no’ question that is itself negated are often more complicated and individual languages notoriously vary in how they handle answers to such questions. For instance, French has ‘si’ and German ‘doch’ to answer a ‘yes-no’ question of the form ‘not-Q’ in case the answer is Q.)

Answers to wh-questions also often, and preferentially, take the form of expressions that are not complete sentences. In particular, it is common for the answers to who-, what- and which ..-questions to be DPs. What is more, when the answer to such a question does take the form of a full sentence, it is subject to quite strict prosodic constraints, with focal stress on the constituent that corresponds to the wh-phrase of the question, and correspondingly reduced stress on the reminder of the clause, as befits the background to a focus.

Embedded identity questions and concealed questions.

Questions in which a wh-phrase precedes the copula ‘be’, as in (25), are a topic in their own right.

(25)  a. Who was Nebukadnesar?
b. Who the hell is Britney Spears?
c. Who the hell are you?
d. Who are the people behind this operation?
e. What is an axolotl?

Such questions also occur as embedded questions:

(26)  a. I don’t know what an axolotl is.
b. Can you tell me who Nebukadnesar was?
c. Can you tell me who was Nebukadnesar?
d. Would you be kind enough to tell me who you are?
e. (#) Would you be kind enough to tell me who is you?
f. * Would you be kind enough to tell me who are you?
g. Nobody has found out who are the people behind this operation.
h. Nobody has found out who the people behind this operation (really) are.

The pair (26.b.c) and the triple (26.d,e,f) show a distinction that is lost from sight in direct questions – that between an analysis according to which the wh-phrase has been extracted from the subject position and one according to which it has been extracted from the position of the complement to the copula be. In (26.b) and (26.d) we have extraction from the complement position, in (26.c) the wh-extraction is from the subject position. (26.e) and (26.f) indicate that the word order of the embedded questions in (26) is decisive evidence for the source location of the extraction. When the verb is in final position extraction has been form its complement; when it is in pre-final position, the extraction is from its subject position. This is why (26.f) is simply ungrammatical: the extracted wh-phrase who is morphologically third person, so the verb, which must agree in person with the subject, should
be in the third person as well. As the verb is not in the third person singular, this renders the sentence ungrammatical for morpho-syntactic reasons. (26.e) does not disqualify on these grounds, as here the verb does agree with the (extracted) subject. But the sentence is nevertheless odd, or at least it is likely to strike us as such, if offered without context; there is something semantically incoherent about it.

(Arguably (26.f) also has an analysis on which the pronoun *you* is a plural. In that case the sentence would not be ruled out on morpho-syntactic grounds, but would be odd for the same reasons as (26.e). Furthermore, it may well be that even on an analysis of *you* as singular (26.f) is marginally acceptable, viz. by construing the complement of *tell* as a case of quasi-direct discourse, in which it displays the same word order as an unembedded question. On such an analysis the (quasi-)embedded clause will in general be ambiguous in the same way as unembedded questions; in the case of (26.f) morphology rules out one of the analyses between which it would be ambiguous, leaving only the analysis which makes it equivalent to (26.d). I will ignore these possibilities in the discussion that follows.)

The ambiguity of direct and indirect identity questions that is revealed by the embedded forms is important because the different analyses imply a different semantics. When the structure of the question is that of an extraction from the complement position, then the subject term serves to identify the entity for which some kind of identification is sought. On such an analysis identity questions become quite similar to questions that do not have the form of an identity question. For instance, (26.d) could be asked with the same purpose in mind as (27.a), or alternatively as (27.b), and so on.

(27)  
a. Would you be kind enough to tell me what you are called?
b. Would you be kind enough to tell me which company has sent you?

Identity questions involving complement extraction are special as compared to other questions that involve extraction from some other position than the subject in that they ask for a unique identification of the subject (rather than the specification of some property the kind of which may be indicated more or less precisely in the question, but that need not be uniquely identifying). But they share with other interrogatives involving non-subject extraction the feature that the subject serves as initial identification – by the speaker – of the entity about which further information is requested. The only difference is that in the case of such identity questions the request is for identifying information.

It is in the nature of asking questions that when asking for the identification of an entity that one has just identified oneself in order to make clear whom it is that one wants identifying information about, the identification one is after must be different from the one one has just been using oneself. Answering the question ‘Who was Nebukadnesar?’ with the word ‘Nebukadnesar’ (or the words ‘He was Nebukadnesar.’) cannot be wrong so long as the question itself was well-formed in that ‘Nebukadnesar’ has a referent that is uniquely determined in the context in which the question is being asked. But by that very token it cannot be of any use to the person who asks the question. The asker must be wanting something else. But how does one tell what it is that she wants.

A large part of the answer to this question, I believe, has to do with the fact that pretty much all of us go through life with large ‘libraries’ of entity representations (ERs). Each (non-defective) ER stands for some particular referent, sometimes on purely descriptive grounds (i.e. the ER is based on descriptive information that identifies the referent uniquely), and sometime because of the way in which the ER is causally connected with its referent (e.g.
because the ER was formed as part of directly perceiving the referent); and sometimes on a combination of descriptive information and a causal relationship. And since ERs can be formed in response to information input of various kinds and from various sources, it is quite possible that we have more than ER for the same referent without realizing this; and in such cases the information that two of our ERs do in fact represent the same referent can be new and valuable.

Being told that two ERs ER1 and ER2 do represent the same referent will be especially valuable if the information associated with ER1 is quite different from ER1, and especially when it links its referent to a very different compartment of the agent’s knowledge of the world (and access to such knowledge) from the information associated with ER2. This is true for instance when one of your ERs, ER1, is based on current perception – e.g. on perception of the person you are facing, or the street you are in – whereas your other ER, ER2, represents this same person or street on the basis of earlier knowledge or experience – e.g. as the person of whom you have read a number of articles or that you have heard about in some other context, or the street that appears somewhere on a map that you may be carrying with you. Furthermore, in many such cases ER2 will have a name attached to it, such as ‘Judea Pearl’ or ‘Fifth Avenue’. Being informed in situations like these that the referent of ER1 is the same as that of ER2 enables you to ‘recognize’ the referent of ER1 – i.e. the person before you or the street you are in – as the referent of an ER you are already had, and this makes it possible for you to connect various kinds of information associated with ER2 with the referent of ER1 (by adding it to ER1).

Not only are we often in a predicament of this sort – we have two or more ERs for the same entity without knowing that they represent the same entity – it is often the case that we are aware that we must be in such a predicament, and, more specifically, that among our older ERs there must be one that is coreferential with one we have formed just now (or at least more recently). In such cases we will often be impelled to ask identity questions under discussion (i.e. question involving wh-extraction from the copula complement position). The DP we use to refer to the referent of an entity representation ER1 that we would like to identify with some other entity representation will as a rule indicate to the addressee what the nature of ER1 is; and furthermore, the situation in which the question is being asked may also indicate to him what kind of further identification we want to get. If he can supply that information, then he will typically do that in the form of a DP whose form enables us to make the link with some other ER we already have, or, alternatively, to introduce a new ER which represents the information supplied by the DP, which can then be unified with ER1 in the same way in which that can be done with an ER that was already in place. (N.B. The answer could also be given in the form of some expression other than a DP, and sometimes it will be; what matters is that it should produce the same informational effect that can be produced by the right choice of DP.)

##

Identity questions of the form just discussed should be sharply distinguished from those in which the wh-extraction is from the subject position. Questions of this latter kind form a subclass of those in which the copula combines with any kind of complement, including complements which need not be uniquely identifying. Some examples of direct questions of this type are given in (28) and corresponding indirect questions in (29).

(28)  a. Who is the winner?
   b. Who is (the) winner of a medal?
c. Who (of you) is a first year student?
d. Who (of us) is over 65?
e. Who (of you) is familiar with the basics of first order logic?

(29) a. Can you tell me who is the winner?
b. Can you tell me who is (the) winner of a medal?
c. Can you tell me who (of you) is a first year student?
d. Can you tell me who is over 65?
e. Can you tell me who (of you) is familiar with the basics of first order logic?

There is an important asymmetry between these questions and the ones discussed above which has to do with the strong tendency for the grammatical subject of a sentence to play the part of a topic. The role of topic is of special importance in wh-questions. The topic of such a question is that about which the question requests information. This role must be distinguished from the role that the wh-phrase of a wh-question plays qua wh-phrase. This latter role is usually identified as that of a focus, in the sense in which ‘focus’ has been understood in the formal semantics literature starting with (Rooth, 1985). The identification of wh-phrases as foci is consistent with many observations about the behavior of wh-questions and their answers, such as constraints on the prosody of full sentence answers to such questions and the possibility of term answers. When wh-extraction is from a position other than the grammatical subject – as in the identity questions discussed earlier, where extraction was from the copula complement – then there is no tension between the role of topic and the role of focus: the subject DP serves to identify who or what the question is about, and the wh-phrase identifies what the missing bit of information is that the answer should supply. But with wh-questions in which wh-extraction is from the subject position there is a kind of tension, in that the same constituent now has to play both roles at the same time.

That this is possible at all has to do with the complexity of the notion of ‘topic’, which manifests itself among other things in the existence of so-called ‘contrastive topics’. The examples of this that I am thinking of were first discussed by Büring, in relation to question answer sequences like that in (29).

(29) (Scenario: B has just been to a pop concert that A wanted to go to as well but couldn’t go to in the end.)

A: What did the pop stars wear?
B: The leader was wearing a kaftan.
The drummer was wearing hardly anything at all.
…

In this partial display of B’s reply the phrases the leader and the drummer are contrastive topics in the following sense: A’s question presents the pop stars as its topic. It is about this topic that A requests a certain kind of information, viz. what was worn on the given occasion. If all the pop stars had been wearing the same thing – e.g. they had all been wearing kaftans – then the answer could have been simply that: ‘They were wearing kaftans.’, or simply ‘Kaftans’. But if they were not all wearing the same thing, then the answer has to be broken up into a sequence of separate answers, one for each individual or subgroup that had an outfit setting it aside from the others. The subjects of these successive answers that together make up the complete answer to the question are ‘contrastive topics’ – in the sense that on the one hand they refer to parts of the question topic (the pop stars) while on the other they contrast with each other. It should be noted that in their capacity of contrastive topics such phrases
behave much like phrases that in other contexts would be referred to as ‘(contrastive) foci’.

A *wh*-phrase that is extracted from subject position tends to be like the contrastive topics just described in that it too wants to be understood as implying some over-all topic (comparable to the role the pop stars play in the example above) while at the same time playing the focus-like role that is the wont of a *wh*-phrase. When the subject is now present in the sentence only in the form of a *wh*-word, then the topic must be reconstructed from the context. But sometimes the topic is made explicit by an *of*-PP such as ‘of you’, ‘of us’ and the like. (28) and (29) present some alternatives of this form, and indeed, it seems that such complex *wh*-phrases with subordinate PPs sound very natural in the contexts presented by these questions.

In short, when a speaker asks a *wh*-question involving *wh*-extraction from subject, she will typically have a topic set in mind (which she may make explicit in her question, but often won’t) and the answer which she is requesting must specify which members of this set satisfy the predicate of the question.

When the predicate of the question is of the form ‘is T’, where T is some uniquely referring term, then the question can be useful only if the way in which T identifies its referent is different from the way in which the speaker identifies the topic set and its members. For suppose that ‘T’ identifies its referent in the same way that the speaker identifies the members of the topic set as that set is presented by her. Then the information that some particular member of that set satisfies the predicate ‘is T’ must already been known to her and so she must know the answer to her question already and her question will be pointless.

Telling illustrations of these coherence constraints can be found in recent work by Daphna Heller and Lynsey Wolter. Heller and Wolter consider identity questions that are asked, in varying contexts, about a Dutch piano trio (the Storioni trio). Some of these contexts involve a picture of the trio in which the instrument of each player is recognizable – the string players are each shown with their instrument, which identifies the third person in the picture as the pianist (whose instrument is presumably too bulky to hold). Other contexts involve a picture in which the players are shown without instruments, so that for someone who doesn’t already know them it is impossible to tell who plays what from the picture alone. The different examples Heller and Wolter discuss – examples of both identity questions involving subject extraction and identity questions involving complement extraction, which are being asked in contexts that vary in the way indicated – show persuasively that subject extraction questions differ from complement extraction questions in the way our analysis sketch suggests. When it is clear from the context of the question how the person A who is asking it is identifying the members of her topic set, then a subject extraction question sounds wrong when the term ‘T’ of the predicate identifies its referent in a way in which A must be assumed to have already identified the relevant topic set member. For instance, it would be very odd for A, looking together with B at the picture of the Storioni trio in which the string players are shown with their instruments, to ask: ‘Who do you think is the violin player?’. Clearly she knows the answer to that question already. In such a situation the corresponding complement extraction question – ‘Who do you think the violin player is?’ – is acceptable, because here the choice of how to specify the answer to the question – i.e. the way in which B presents the referent of the subject DP of the question – is up to him. If he knows, or can guess, how the speaker is identifying this referent – and as we saw, the form of the subject DP of the question will usually give a good idea of how this referent is identified by the speaker –, then it is part of his task to come up with a different presentation of the referent, which will be informative to A in the way we described, and that ideally should give her the information she wants. Thus in
the very same situation (of the picture in which the strong players hold their instruments) it is all right for A to ask: ‘Who do you think the violin player is?’ In this question the subject phrase the violinist serves not only to indicate what the topic of A’s question is, but also as an indicator of how A is identifying this topic. B, having both identified the topic and understood how A is identifying it, has to find another identification of the topic which will give A the information she is looking for – for instance by specifying the person’s name, or other information that could identify him uniquely in terms that are meaningful to A, for instance that he is concert master of the Brabants Orkest.

To summarize and repeat: when an identity question involves complement extraction, then A can in principle present the topic of her question in whatever way she likes; and it is then the task of the addressee to come up with some other characterization of that topic which will be useful to her. With subject extraction questions the matter is different. Such questions come with an (often implicit) indication of a certain topic set and of a certain way in which that set and its members are identified by the person A who asks it. The task of the addressee in this case is to select that member of the topic set which satisfies the predicate of the question; and in order for the answer to be natural and effective it should specify that member in the very terms in which A identifies the members of her topic set. Identity questions involving subject extraction leave B no real choice on this point; he just has to select the right member of the set. But that means that the predicate of the question has to be of the right sort; it has to be such that when B identifies its satisfier in the terms in which A identifies the members of her topic set, that will provide A with new information. If no new information will be forthcoming in this way, then the question misfires; and the blame for that lies with A.

(Note in this connection that the subject extraction question ‘Who do you think is the violin player?’, which is bizarre when A and B are looking at the picture which portrays the string players with their instruments, is fine when they are looking at the picture in which no instruments are shown. This time the request is for an identification that one of the members of the topic set – the set of the three people shown in the picture – who is the trio’s violinist; and the identification of this member should be in terms in which A can identify the members of her topic set, e.g. via a description such as the one to the right, or the one with the balding head – any description will do that sets the given person in the picture recognizably apart from the other two.)

##

The problem what can constitute a useful answer to an identity question is closely related to the age-old problem of what can make an identity statement both true and informative at the same time. For someone who knows about Hesperus and hears a reference to Phosphorus for the first time, (30.b) may be just the right answer to (30.a). And even if it won’t be the final word in the matter, the last sentence of (31.b) could be a useful answer to (31.a) if A has not so far connected the murder of Jones in any way with the murder of Smith.

(30)  a.  A:  Who or what is Phosphorus?
       b.  B:  Phosphorus is the same thing as Hesperus.

(31)  a.  A:  But who is the murderer of Jones?
       b.  B:  Well, I don’t quite know either. But one thing is for sure: The murderer of Jones is the very same as the murderer of Smith.

This then is at least part of the explanation of why identity statements can be useful if the
terms \( \alpha \) and \( \beta \) which flank the expression of the identity relation not only refer to the same thing, but are connected with two different (i.e. not yet unified) ERs for that thing in the mind of the questioner. But, of course, new information about an entity for which the recipient has just one ER can be useful as well, insofar as it will enable the recipient to reevaluate information about the referent he already had, or put that information to a new use.

There is much that has been written about identity sentences, interrogative as well as indicative, and a careful survey of the existing literature will have to be done before more can be said about such sentences than I have done.

**Concealed questions**

A closely related topic that has had, and still is getting, a good deal of attention from linguists are concealed questions. Concealed questions involve uses of question-embedding verbs - verbs that take embedded questions as complements, as in (30) – with DPs as direct arguments, but where this DP is to be interpreted as standing for an embedded question of which it is the grammatical subject. Examples of concealed questions are the sentences in (31).

(30)  
\begin{itemize}
  \item a. Only John knows whether Mary is in Paris.
  \item b. Tell me who is coming.
\end{itemize}

(31)  
\begin{itemize}
  \item a. Tell me your address.
  \item b. Do they know her telephone number?
  \item c. She didn’t tell him her name.
\end{itemize}

(31.a) can be paraphrased as ‘Tell me what your address is?’, (31.b) as ‘Do they know what her telephone number is?’ and (31.c) as ‘She didn’t tell him what her name was.’. And these paraphrases bring out how utterances of the sentences in (31) relate to utterances that have the overt form of a question. (31.a) is another way of requesting an answer to the question ‘What is your address?’. (31.b) is a question whose content is whether the individuals referred to by ‘they’ know the answer to the question ‘What is her telephone number?’. And (31.c) states that the referent of ‘she’ refrained from answering the question ‘What is your address?’ which the referent of ‘him’ did ask or might have asked. One problem that the sentences in (31) share with their paraphrases is the one we have already spotted: it is difficult to say exactly what makes an answer to such a question a meaningful one, as opposed to an answer that is merely formally correct. But they also pose additional problems, which have to do with the constraints that the concealed question construction is subject to. For instance, I can, in the right context, use the first sentence in (32.a) as a preamble to the second sentence. But the corresponding concealed question construction in (32.b) cannot be interpreted in this way.

(32)  
\begin{itemize}
  \item a. She even knew what 496 was! As soon as I asked her, she said ‘Oh, that is the third perfect number. It is 16 times 31, or \( 2^4 \times 2^5 \times 2^{-1} \), with \( 2^5 - 1 \) a prime number.’
  \item b. She even knew 496! As soon as I asked her she said ‘Oh, that is the third perfect number. It is 16 times 31, or \( 2^4 \times 2^5 \times 2^{-1} \), with \( 2^5 - 1 \) a prime number.
\end{itemize}
Of course ‘She even knew 496.’ is a perfectly good sentence. But it cannot be understood in a way that can be paraphrased by the first sentence of (32.a). In this regard ‘She even knew 496!’ is clearly different from ‘She even knew the third perfect number’, which can be understood as a concealed question. In general the direct objects of concealed question sentences are definite descriptions, often ones that we understand as denoting the value of a certain function for a given argument (such as ‘x’s address’, ‘x’s telephone number’ and so on). But not all such descriptions work equally well. ‘We now know his mother!’ can perhaps mean ‘We now know who his mother is?’ (e.g. in the course of a police investigation). But it seems that this reading is available only in contexts that strongly favor it. For more on concealed questions see in particular the work of Maribel Romero.