Eberhard-Karls Universität Tübingen
Englisches Seminar: Haupt-/Oberseminar

The Semantics of Tense and Modality

Part 1: Modality

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Contents

1 Introduction

1.1 Problems for an Extensional Semantics

There is a whole range of well-known phenomena in which the extensional semantics that we have developed so far breaks down:

Propositional Attitude Verbs

(1) a. *Molly believes that NYC is in New Jersey.*
b. *Molly believes that Mount Everest is in Alaska.*

(2) $[\![\, \textit{NYC is in New Jersey} \,]\!] = [\![\, \textit{Mount Everest is in Alaska} \,]\!] = 0$

(3) *believe*: $\langle t, \langle e, t \rangle \rangle \implies [\![\, \textit{believe} \,]\!]([\![\, \textit{NYC is in New Jersey} \,]\!]) =$
$[\![\, \textit{believe} \,]\!]([\![\, \textit{NYC is in New Jersey} \,]\!]) = [\![\, \textit{believe} \,]\!](1)$

Modals

(4) a. *Bill Clinton might be thinner than he actually is.*
b. *Bill Clinton might be Chinese.*
c. *Bill Clinton might not be identical to himself.*

(5) a. *It might be the case that Bill Clinton is Chinese.*
b. [*might* [$_{\text{VP}}$ *Bill Clinton be Chinese*]]

(6) $[\![\, \textit{Bill Clinton is Chinese} \,]\!] =$
$[\![\, \textit{Bill Clinton is thinner than he actually is} \,]\!] =$
$[\![\, \textit{Bill Clinton is not identical to himself} \,]\!]$

Intensional Adjectives

(7) a. *Kim is a potential/former lover of Bill's.*
b. *Kim is a potential/former tenant of 50 Green Street.*

(8) $[\![\, \textit{lover of Bill's} \,]\!] = [\![\, \textit{tenant of 50 Green Street} \,]\!]$

Temporal Adverbials

(9) a. *A few days ago, marigolds were blooming.*
b. *A few days ago, the United States were a monarchy.*

(10) $[\![\, \textit{Marigolds were blooming} \,]\!] = [\![\, \textit{The United States are a monarchy} \,]\!] = 0$

Examples of other intensional operators are *because, seem, likely*, and fiction, e.g. *In Sherlock Holmes, a famous detective lives at 221B Baker Street.*

1.2 Intuition: Displacement

Natural language is not limited to talking about here and now. We can shift perspective from the present, actual situation to a past, future or possible situation. There can be temporal displacement, or modal displacement, i.e. a shift in the realm of logical possibility. Examples of temporal displacement operators include *a few days ago, former*, and past tense. Examples of modal displacement operators are *believe, might, potential.*

We need a semantics for these operators. And we need to make the semantics of their arguments sensitive to a modal and temporal point of reference that can be controlled by these operators. So, the data about *former* tell us that $[\![$ *lover of Bill* $]\!]$ is not a set of people, but a function that determines, for a given time, the set people that are lovers of Bill at that time. The data with *potential* tell us that $[\![$ *lover of Bill* $]\!]$ is not a set of people but a function that tells us for a possible scenario who is a lover of Bills in that situation. In other words, you are a lover of Bills in a possible situation at a particular time. We need to make predicates relative to a time parameter and a situation/scenario parameter. The displacement operators shift these parameters from (modal) here and (temporal) now.

2 Possible Worlds

2.1 The Basic Idea

We begin with the modal parameter. This shifts us in logical space: modals are about logical possibility and necessity. Let's start with an illustration of logical possibility. Suppose we have an artificial language with one predicate P and two names A and B. A situation against which expressions in this mini-language can be evaluated consist of a set D that is not empty, and an interpretation for lexical expressions that assigns a member of D to both A and B and a subset of D to P. Imagine that $D = \{a, b\}$, $[\![A]\!] = a$ and $[\![B]\!] = b$. We have four possibilities for $[\![P]\!]$:

1. $\{\ \}$
2. $\{a\}$
3. $\{b\}$
4. $\{a, b\}$

The way we have handled things so far, each of these possibilities would represent a different model/situation. But we have now discovered that natural language can talk about the different possibilities ("models"/"situations") within one expression of the language. We would want to evaluate (the formal translations of) *A might be P* as well as *A is P* against a particular model.

Therefore, we will represent the four possible states of affairs as part of one ("intensional") model simultaneously. Intuitively, we assign to each possibility a label or index, and make the labels part of the (actual) model/ situation.

1. $w_1 : \{\ \}$
2. $w_2 : \{a\}$
3. $w_3 : \{b\}$
4. $w_4 : \{a, b\}$

Let's think about what the indices or labels are. $w_1 - w_4$ are called possible worlds, and the set W that contains all of the indices is the set of possible worlds. Looking at our example, each possible world is a complete specification of what could be the case, a possible state of affairs that includes everything we might want to know about. And the set of possible worlds includes all logical possibilities. This is the way that possible worlds are generally conceived of; it is certainly how we will think about them from here on.

Modal verbs give us the clearest indication that natural language makes reference to logical possibility.

(11) a. *I could be in New York now.*
"There is a possible world…"
b. *I can't run for president.*
"There is no possible world…"
c. *The American president must be US citizen.*
"All possible worlds…"
d. *The American president need not be a man.*
"Not all possible worlds…"

While we cannot refer to a possible world directly (which is presumably why we hadn't discovered them yet), we can quantify over them. In other words, there may not be constants denoting worlds, but there will be variables. Therefore, we want to do to natural language semantics something similar to what we did to our mini-language above. Most importantly, we will include possible worlds in our ontology.

(12) Denotation Domains:
W: the set of possible worlds
D: the set of individuals represented in at least one world
(i.e. the set of possible individuals)

(13) Semantic Types:
$\langle e \rangle$, $\langle t \rangle$ and $\langle s \rangle$ are types.
If α and β are types, then so is $\langle \alpha, \beta \rangle$.
Nothing else is a type.

(14) $D_{\langle s \rangle} = W$
$D_{\langle e \rangle} = D$
$D_{\langle t \rangle} = \{0, 1\}$
$D_{\langle \alpha, \beta \rangle} = [D_\alpha \longrightarrow D_\beta]$

(15) a. $\langle s, t \rangle$: proposition
b. $\langle s, \langle e, t \rangle \rangle$: property

You might be a student in one world but not in another. The lexical meaning of student should therefore contain a world parameter, or relate individuals and possible worlds.

(16) a. $[\![\textit{student}]\!] = \lambda w.\, \lambda x.\, x$ is a student in w
b. $[\![\textit{leave}]\!] = \lambda w.\, \lambda x.\, x$ leaves in w

(17) $[\![\textit{John left}]\!] = \lambda w.\, \textit{John left in } w$

This will be true in more than one possible world. We assume that if you utter a proposition p in a world w, this amounts to the claim that $p(w) = 1$. Intensions are a more adequate representation of linguistic knowledge of meaning: They are independent of the actual facts. Knowledge of what the facts are will allow you to determine an extension. If sentence meanings are propositions, not truth values, then our problem with (18-b) – repeated from (1) above – no longer arises, because the two complement clauses do not denote the same set of possible worlds.

(18) a. *Molly believes that NYC is in New Jersey.*
b. *Molly believes that Mount Everest is in Alaska.*

Similarly for the other cases noted above as problems for an extensional semantics. What we still have to do, however, is to specify what exactly the intensional operators mean.

2.2 A Heim and Kratzer (1998)-Style Intensional Semantics

2.2.1 World Pronouns

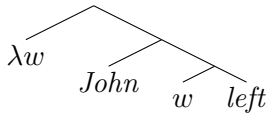
First, let's be a bit more precise about how we are going to treat the world arguments of predicates. We will use here a Heim and Kratzer (1998)-style system in which world variables are treated in the same way as individual variables: They will be represented in the Logical Forms we interpret, we will have variable binding and the same general interpretation principles apply. This is a completely representational system in which everything that happens in the semantics can be seen in the LF-tree.

ASIDE: This is not a necessary assumption. We could have further developed a system of interpretation in which all world variables are bound, always. Montague proceeds in this way, essentially. The best evidence for the Heim and Kratzer (1998)-style system to be introduced are the *de-re*/*de-dicto* effects to be discussed below. See von Fintel and Heim (2010).

I will work with the assumption that the world argument is the first argument slot to be filled. This is arbitrary, since the world argument is not syntactically visible. I will also assume that the world argument gets bound by an invisible binder.

(19) *John left.*

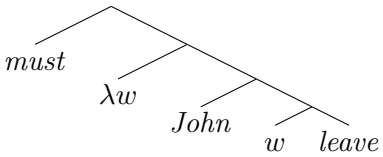
(20)



Let's look at an example in which we need a proposition argument.

(21) *John must leave.*

(22)



(23) a. $[\![\textit{must}]\!](p) = 1$ iff for all $w \in W : p(w) = 1$
b. $[\![\textit{can}]\!](p) = 1$ iff there is a $w \in W : p(w) = 1$

There are two problems with this:

1. We can truthfully state that John must leave even though this is not a logical necessity. It seems that we want to restrict the universal quantifier that represents the meaning of must. How exactly?

2. The result of applying must to a proposition is a truth value, not a proposition. Even if we made it a trivial proposition: $[\![\textit{must}]\!](p)(w') = 1$ iff for all $w \in W : p(w) = 1$, it would not be a contingent proposition, i.e. either always true or always false. That this is wrong is obvious. Also, intensional operators can be stacked:

   (24) a. *Molly believes that John must leave.*
   b. *You might have to file in New York.*

We have the formal/technical foundations. Let's now work on the linguistic side.

2.2.2 Intensional Linguistic Phenomena – Operators

Modals (Kratzer 1991). We take the two problems noted with modals as our starting point.

– EPISTEMIC: "In view of what we know..."

(25) *Joe must be the murderer.*

– DEONTIC: "In view of what the law provides..."

(26) *Joe must go to jail.*

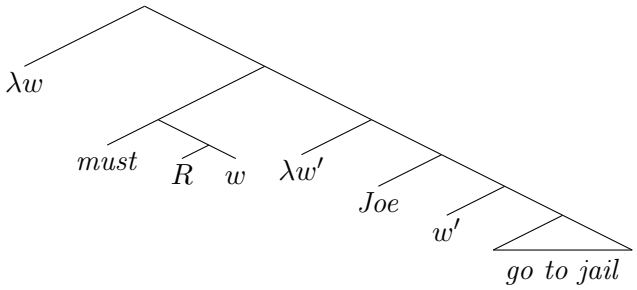
– CIRCUMSTANTIAL: "In view of the physical facts..."

(27) *Joe must sneeze.*

(28) For all w' such that w' is compatible with what the speaker knows in w, Joe is the murderer in w'.

(29) For all w' such that w' conforms to what the law provides in w, Joe goes to jail in w'.

(30)



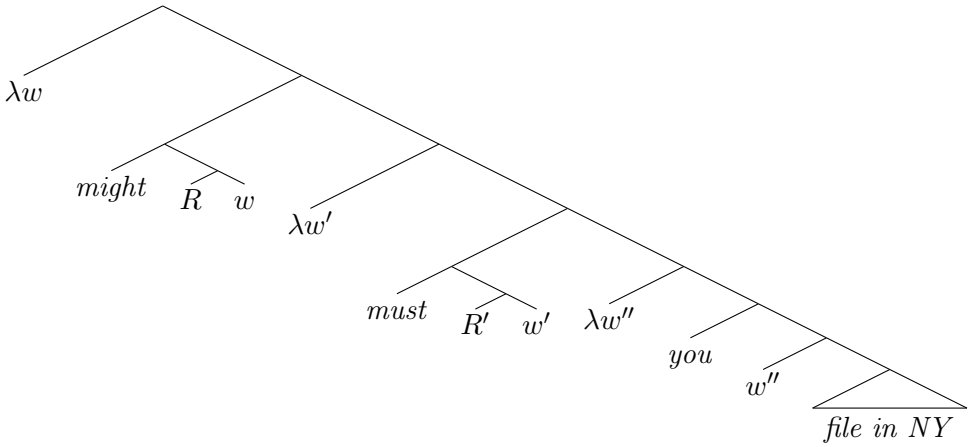
(31) $R = \lambda w_1.\, \lambda w_2.\, w_2$ is compatible with what the speaker knows in w_1

R is an accessibility relation between possible worlds, and *must* is of type $\langle\langle s,t\rangle, \langle\langle s,t\rangle, t\rangle\rangle$.

(32) $[\![\, must \,]\!](p)(q) = 1$ iff for all w such that $p(w) = 1,\ q(w) = 1$

(33) a. *You might have to file in New York.*
b. There is a w_2 compatible with what I know in w_1 such that for all w_3 in which what the law provides in w_2 holds, you file in New York in w_3.

(34)



How do we find a particular accessibility relation? Kratzer (1991) proposes: A discourse comes with a conversational background. A conversational background is a set of propositions. Its the kind of thing denoted by *what the law provides*, *what we know* etc. What the law provides is a set of propositions.

(35) a. $[\![\, what\ the\ law\ provides \,]\!] =$
$\lambda w.\, \lambda p.$ in w, the law provides that p

b. $[\![\, \textit{what we know} \,]\!] =$
$\lambda w.\, \lambda p.\ p$ is one of the propositions that we know in w to be true in w

Such a conversational background can be given explicitly or implicitly in a discourse. Here is how we calculate an accessibility relation from a conversational background. If the conversational background (CB) is as in (35-a), then for any w, RCB(w) is the set of worlds in which every p in CB(w) is true, that is, the set of worlds in which everything that the law provides in w is true. Generally:

(36) For any conversational background CB $\langle s, \langle\langle s,t\rangle, t\rangle\rangle$,
the corresponding accessibility relation RCB is the following:
For all w, w': RCB(w)(w') $= 1$ iff for all p such that CB(w)(p) : $p(w') = 1$.

Conditionals. Conditional clauses may further restrict modal quantification.

(37) a. *If she lives in New York, she must file in New York.*
b. For all w' such that w' conforms to what the law provides in w and she lives in New York in w', she files in New York in w'.

Kratzer suggests that conditionals are modal creatures. The *if*-clause is basically intersected with the accessibility relation to restrict universal quantification. The modal need not be explicit:

(38) a. *If she lives in New York, she files in New York.* (*must* – epistemic?)
b. *When I go to Stuttgart, I take the train.* (*always* – temporal)

Negative Polarity Items. The restriction of a universal quantifier is a downward monotonic context.

(39) *If she ever lived in Stuttgart, she knows Laugenweckle.*

Propositional Attitudes. Like modals, verbs like *believe, want, hope*, etc. embed a proposition.

(40) *Mary believes that the summit of Mount Washington is the coldest spot on Earth.*

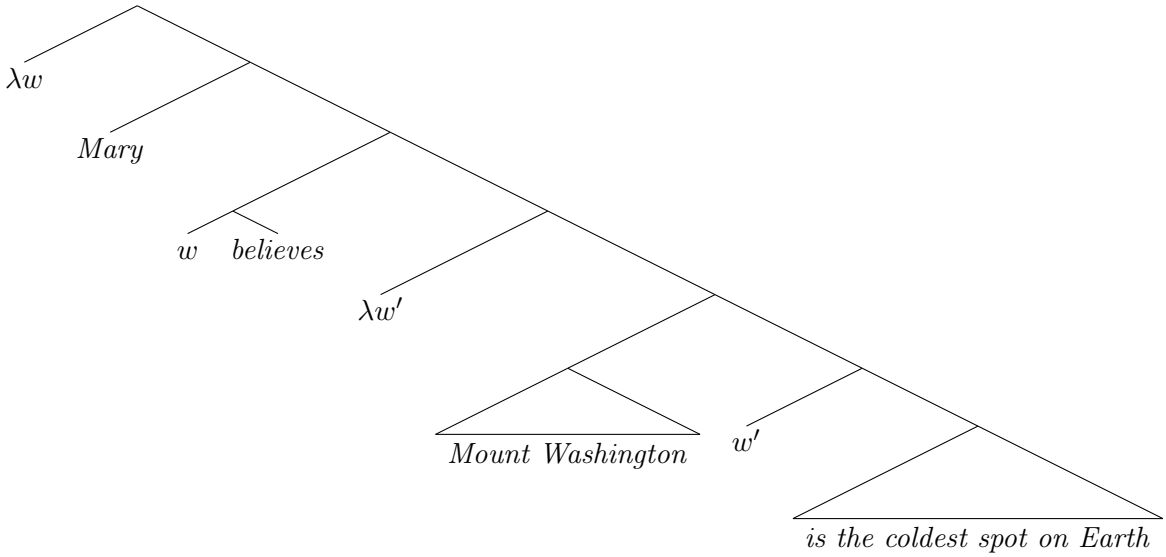
(41) $[\![\, \textit{believe} \,]\!] = \lambda w.\, \lambda p_{\langle s,t\rangle}.\, \lambda x.$ for all worlds w' that are compatible with what x believes in w, $p(w') = 1$

In all of Mary's belief worlds, Mount Washington is the coldest spot.

(42) BEL(w)(x):
the set of x's belief worlds in w,
the set of worlds compatible with all of x's beliefs in w

This is more than one world: We don't have beliefs about lots of aspects of the world. However, if you believe that p, then in all of your belief worlds p is true.

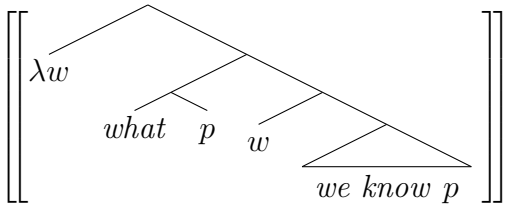
(43)



Note also that beliefs as well as knowledge vary from one world to the next.

(44) $[\![\textit{know}]\!] = \lambda w.\, \lambda p_{\langle s,t \rangle}.\, \lambda x.$ for all w' that are compatible with what x knows in w, $p(w') = 1$

(45) $[\![\textit{what we know}]\!] =$



The propositional attitude verbs *hope* and *want* are analogous. So, attitude verbs involve quantification over possible worlds – like modals. Difference: which worlds we quantify over seems more fixed, given by the lexical semantics of the respective verb (belief worlds, desire worlds, epistemically accessible worlds, instead of contextually determined accessible worlds).

2.2.3 Scope and *De Re*/ *De Dicto*

We have now discovered a whole bunch of new operators – quantifiers over possible worlds. We should ask ourselves how these interact with the quantifiers we already have. It turns out that there are interesting ambiguities.

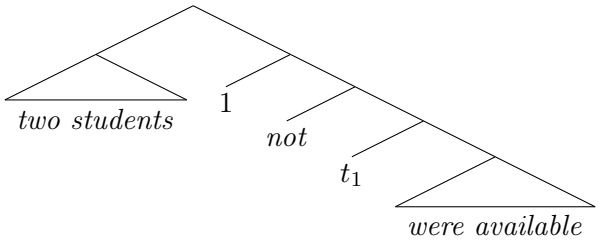
(46)
a. *Two students must be present.*
b. *Everybody could have filed on time.*
c. *I believe one of my students to have taken my textbook.*
d. *The president of the United States must be a US citizen.*
e. *I need a screwdriver.*

(47) *Einmal war kein Verstorbener da.*

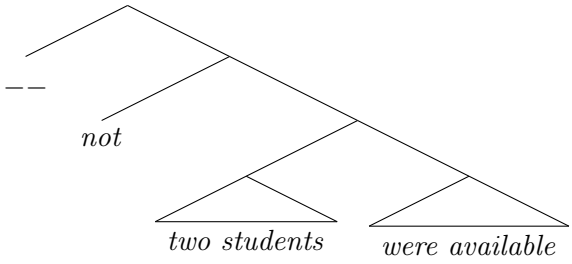
On the one hand, there are ambiguities that resemble familiar scope ambiguities, for example with negation.

(48) *Two students weren't available.*
"There are two students who were not available."
"It was not the case that two students were available."

(49)



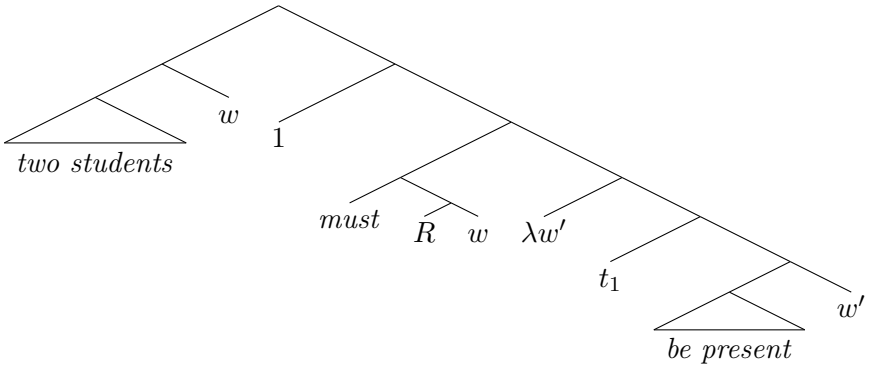
(50)



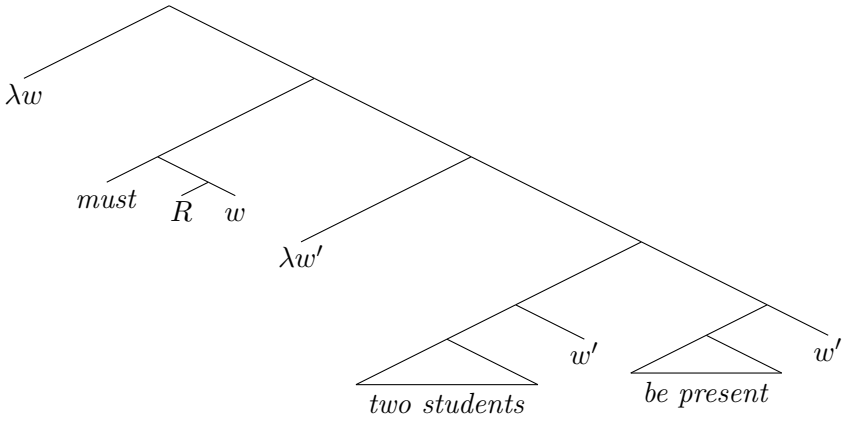
It looks as if the quantified DP should be interpreted in its original position, rather than in its overt position (SYNTACTIC RECONSTRUCTION). An alternative way of deriving the desired reading is to make the DP leave a trace of the quantifier type, $\langle\langle e, t\rangle, t\rangle$ (SEMANTIC RECONSTRUCTION).

(51) *Two students must be present.*
"There are two students who have to be present."
"It is necessary that two students are present."

(52)



(53)

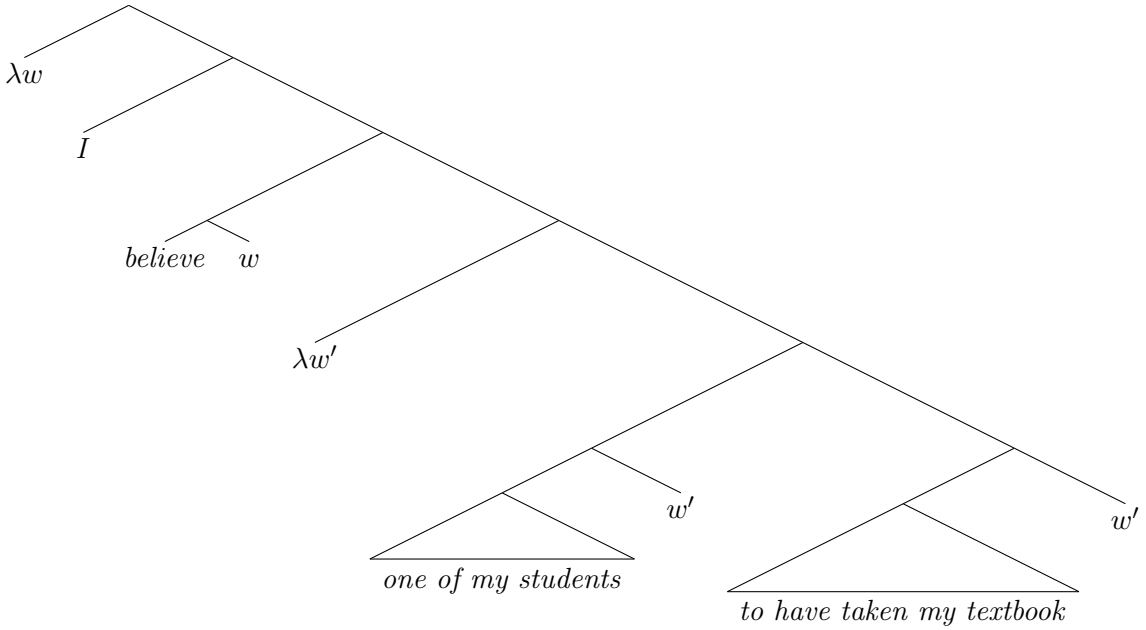


(54) *Everybody could have filed on time.*
"For everyone, there is a possibility that that person files on time."
"It might have happened that everyone was punctual."

The Logical Forms are analogous to above example. Similar ambiguities exist with intensional verbs. The following ambiguities can be derived by QR.

(55) *I believe one of my students to have taken my textbook.*
"There is a student of mine of whom I believe that s/he has taken my textbook."
"I believe that some student or other has taken my textbook."

(56)



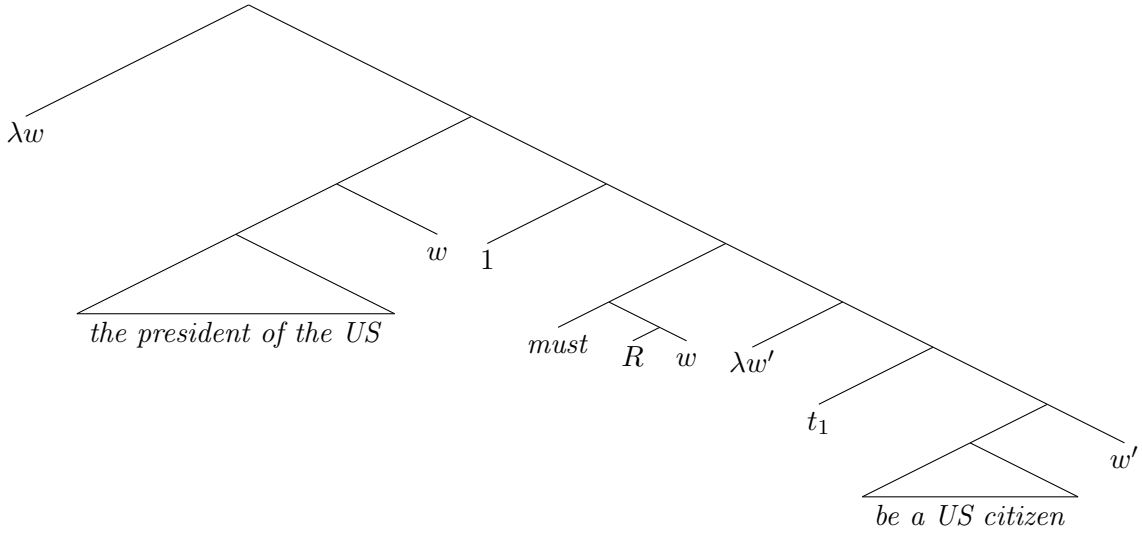
(57) *Sally wants to hire a Hungarian.*
"There is a Hungarian whom Sally wants to hire."
"Sally desires that she hires some Hungarian or other."

The Logical Forms are similar to the above example. There is, however, a type of example that goes beyond scope issues. Let us practice with the following sentence first:

(58) *The president of the United States must be a US citizen.*
"Necessarily, whoever is president of the United States is a US citizen."
"The actual president of the United States must be a US citizen."

We could derive the ambiguity in the same way as our first batch of examples:

(59)



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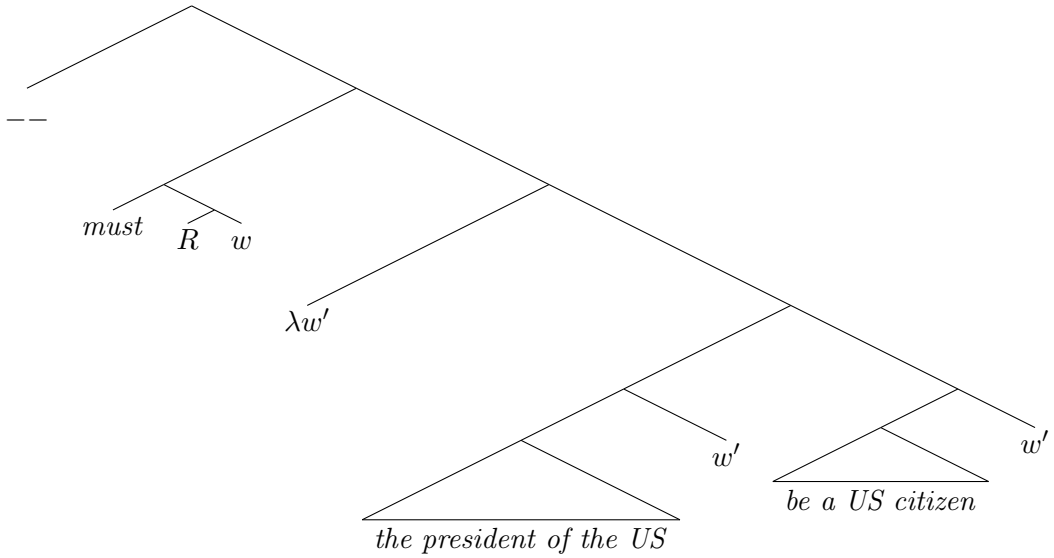
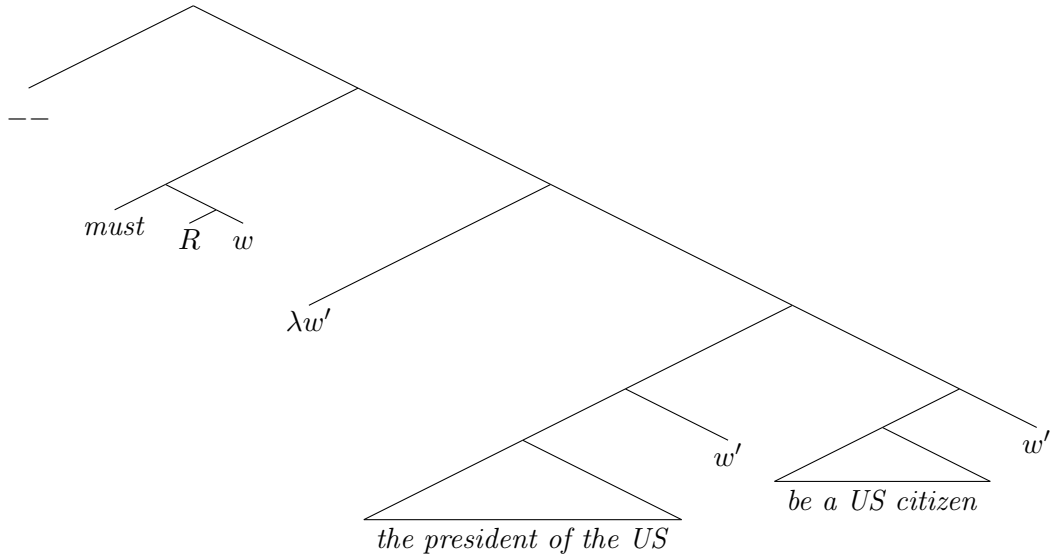


The difference to the previous examples is that our DP denotes an individual. There is no matter of scope to resolve here: on either reading, the DP will refer to an individual. In the first reading, that individual will be the actual US president. On the second reading, that individual will be whoever is US president in the possible world we are looking at.

We could, in fact, represent the first reading simply by changing the world variable in the LF for the second reading to the actual world:

(61)



Now, the example that we have just considered doesn't provide an argument that we **have** to do that - the LF ambiguity story will work as well. Here is some indication, though, that freedom of choice with the world argument is the right way to go:

(62) a. *We always have fish and chips when the president visits.*
b. *A man who works for the president must be very patient.*

These data have a reading in which the referent of the DP the president is fixed to the actual president. Note that the DP is embedded in an adjunct clause and in a relative clause respectively. QR would not be available here, according to our normal assumptions.

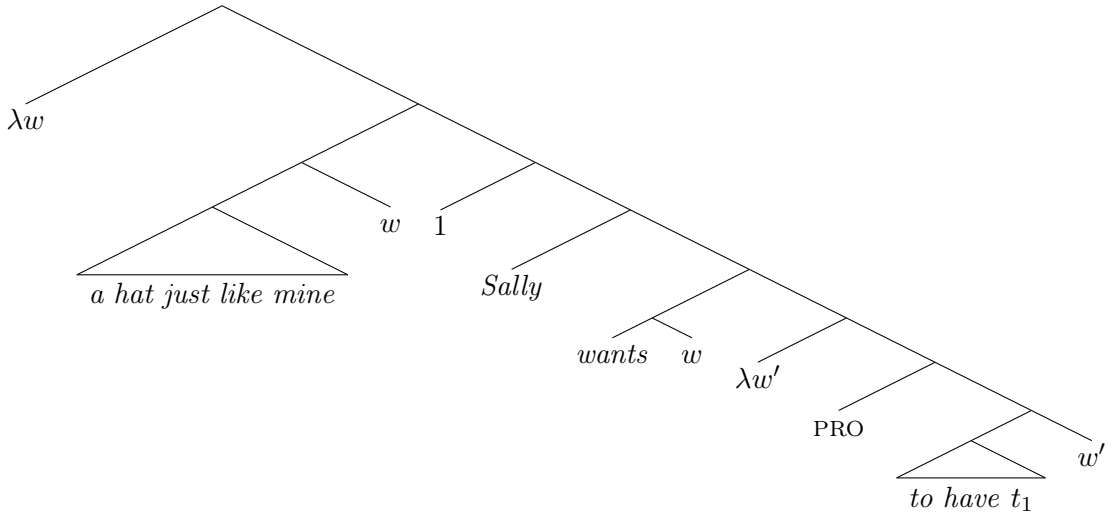
There is another, very forceful, argument in favour of choice of world variable that comes from data like (63).

(63) *Sally wants to have a hat just like mine.*

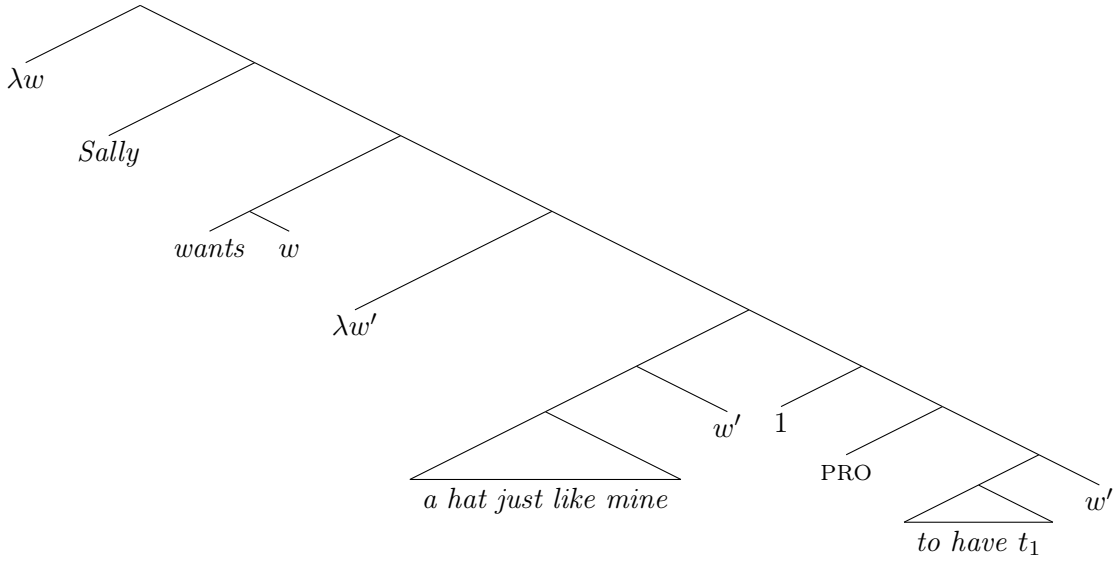
(64) a. "There is a hat that Sally wants, and that is just like my hat."
b. "Sally has the following desire: have a hat just like Sigrid's."
c. "Sally wants to have a hat of a particular kind
(not any particular hat though), and I happen to have just such a hat."

The first two interpretations are familiar from the Hungarian example, and pose no challenge for us.

(65)



(66)

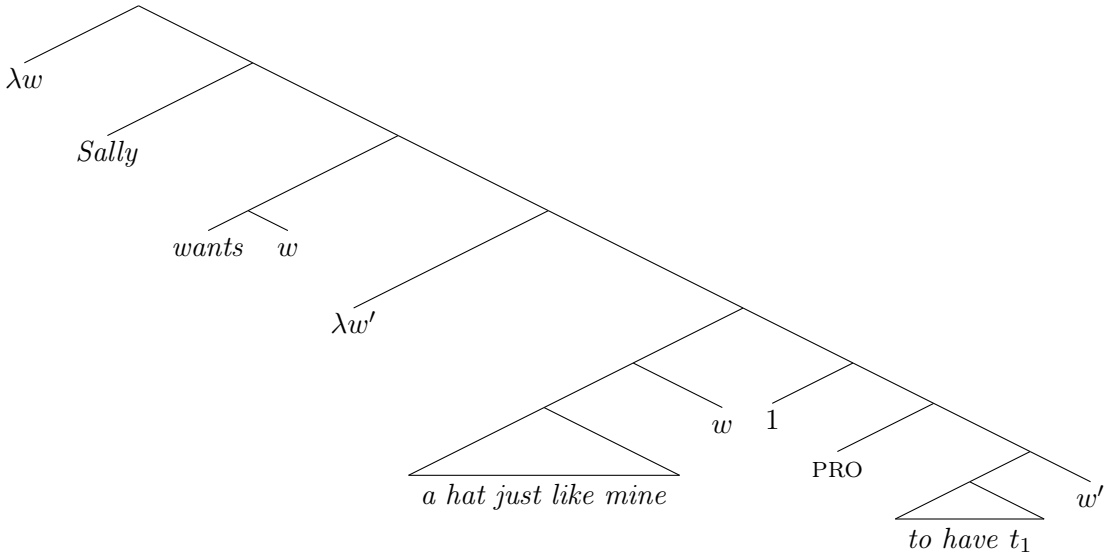


The last reading is the interesting one. Note that the indefinite DP takes narrow scope relative to want (there is no particular hat that Sally wants). At the same time, the description *hat just like mine* is evaluated relative to the actual world: Sally might not have described her desire in this way. Choosing a different world variable in the second LF will do the job.

The point is: The choice of world parameter is not a matter of scope.

(67) Terminology:
Readings with bound world variables are called *de dicto*.
Readings with free world variables are called *de re*.

(68)



The sentence in (69) is similar to sentence (63), i.e. it makes the same point with the time parameter.

(69) *Einmal war kein Verstorbener da.*
(Once no deceased was present.)

(70) a. "At one time, nobody who was then deceased was present."
(the zombie reading)
b. "There is nobody who is now deceased who was present at one time."
c. "At one time, nobody who is now deceased was present."

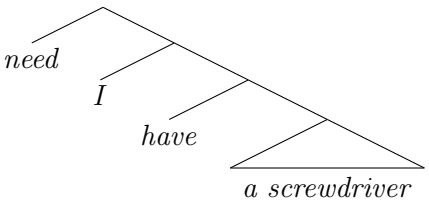
The third reading is the relevant one: The DP is in the scope of the temporal quantifier, but the time parameter it is evaluated relative to is still the actual time, now.

Finally, an intriguing problem is posed by sentences like (71).

(71) *I need a screwdriver.*

This can mean that my needs are satisfied by a screwdriver – any screwdriver. The indefinite seems to take scope below need. One option is to assume that the argument of need is in fact clausal, not phrasal:

(72)



Papers by Friederike Moltmann and Malte Zimmermann offer discussion of this issue.

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