

The dynamics of tense under attitudes

Anaphoricity and *de se* interpretation in the backward shifted past*

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Abstract. This paper shows that both anaphoricity and egocentric *de se* binding play a crucial role in the interpretation of tense in discourse. It uses the English backwards shifted reading of the past tense in a mistaken time scenario to bring out the tension between these two features. We provide a suitable representational framework for the observed clash in the form of an extension of DRT in which updates of the common ground are accompanied by updates of each relevant agent’s complex attitudinal state.

1 Introduction

The challenge of this paper is to deal with the interpretation of the embedded past tense in past-under-past sentences like (1):

- (1) Sam said that she was in London.

This sentence has two readings, a *simultaneous* reading, where Sam said *I am in London*, and a *backward shifted* reading, where she said *I was in London*. We show that the interpretation of the embedded past tense on the latter reading combines two independent features of tense interpretation: anaphoricity and *de se* binding. There is however a tension between these two features: anaphoricity means that the interval introduced by the tense morpheme is bound to a salient past time, whereas *de se* interpretation implies that it is trapped by the local now. In other words, the interpretation of tense seems to be both “wide” and “narrow” at the same time.

Current frameworks tend to focus on one of these features at a time and are unable to deal with the combination of the two. In this paper, we propose a new dynamic framework to solve this problem.

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The paper is organized as follows. In section 2 we formulate the challenge. We establish two distinct features of tense interpretation in general, anaphoricity in 2.1 and *de se* binding in 2.2, and show that the two come together in the case of the backward shifted interpretation of sentences like (1) (2.3). In section 3 we present an analysis that resolves the tension.

2 Challenge: two distinct features of tense interpretation

2.1 Anaphoricity

On the basis of examples like (2) and (3), Partee (1973) argues that tenses behave like pronouns, in that both are anaphoric:

- (2) Sheila owns a donkey. She likes it.
- (3) Sheila had a party on Monday. Sam got drunk.

In (2) the pronoun *she* picks up Sheila and *it* the donkey introduced by the first sentence. In the same way the time of Sam's getting drunk in (3) is not some arbitrary time before the utterance time, but picks up the time of the party on Monday.

Similarly, the phenomenon of narrative progression is often, in one way or another, attributed to the anaphoric nature of tense (Partee 1984, Hinrichs 1986, Kamp and Reyle 1993):

- (4) Sheila walked into the room. She sneezed.

Again, the time of Sheila's sneezing is not some arbitrary time in the past of the utterance time. Instead, the natural interpretation is that Sheila sneezed after her entrance. One way to obtain this result is to let the first sentence introduce an interval after Sheila's entrance and treat the sneezing time as an anaphor that binds to this interval (cf. Partee 1984, Hinrichs 1986).

The idea of tense as anaphora is quite naturally captured in the framework of Discourse Representation Theory (Kamp and Reyle 1993) with Presupposition-as-Anaphora (van der Sandt 1992) (henceforth, DRT+PA).

Let's use (5), with anaphora in the domains of both person and tense, to illustrate this framework:

- (5) Sheila had a party on Monday. She got drunk.

As a dynamic framework, interpretation happens in a context. We'll take the first sentence of (5), represented as in (6), as context:

- (6) Sheila had a party on Monday.

x t n
sheila(x)
party(x, t)
t < n
monday(t)

Against this background we can interpret the second sentence. This interpretation starts by assigning a preliminary structure (henceforth PreIDRS) in which presuppositions are marked by dashed boxes:

(7) She got drunk.

drunk(y, t')
┌───┬───┐
└─y─┬─t'─┘
└───┬───┘
she(y) t' < n
└───┬───┘
└───┬───┘

Next we merge the two and try to find antecedents for the presuppositions. The pronominal presupposition, *y*, has to bind to a female antecedent, and hence binds to *x*. The temporal presupposition, *t'*, looks for a past time, *t*:

(8) (6) \oplus (7) =

<table border="1"> <tr><td>x t n</td></tr> <tr><td>sheila(x)</td></tr> <tr><td>party(x, t)</td></tr> <tr><td>t < n</td></tr> <tr><td>monday(t)</td></tr> <tr><td>drunk(y, t')</td></tr> <tr><td>┌───┬───┐</td></tr> <tr><td>└─y─┬─t'─┘</td></tr> <tr><td>└───┬───┘</td></tr> <tr><td> she(y) t' < n </td></tr> <tr><td>└───┬───┘</td></tr> <tr><td>└───┬───┘</td></tr> </table>	x t n	sheila(x)	party(x, t)	t < n	monday(t)	drunk(y, t')	┌───┬───┐	└─y─┬─t'─┘	└───┬───┘	she(y) t' < n	└───┬───┘	└───┬───┘	~	<table border="1"> <tr><td>x t n</td></tr> <tr><td>sheila(x)</td></tr> <tr><td>party(x, t)</td></tr> <tr><td>t < n</td></tr> <tr><td>monday(t)</td></tr> <tr><td>drunk(x, t)</td></tr> </table>	x t n	sheila(x)	party(x, t)	t < n	monday(t)	drunk(x, t)
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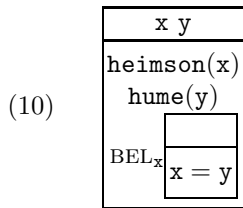
In this way we obtain the desired result: *she* refers back to Sheila and the getting drunk takes place during the party on Monday.

2.2 Temporal *de se* interpretation

Like the anaphoric feature of tense, its *de se* character is best illustrated in analogy with the domain of person. In the person domain, Perry (1977) introduces crazy Heimson who thinks he is Hume, to argue against the standard notion of belief as a propositional attitude. Let's reconstruct this argument first and then transfer it to the temporal domain.

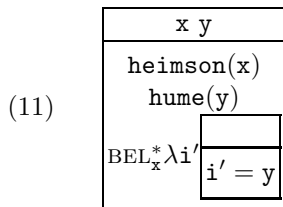
(9) Heimson thinks he is Hume.

A straightforward DRT+PA analysis of (9), with an intensional, i.e. propositional, belief operator BEL_x would yield (10). The pronoun *he* is bound by *Heimson* and the embedded name *Hume* is resolved globally.



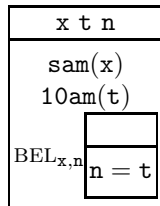
What's left in the belief is an equation between variables, rigidly denoting two different individuals, i.e. a contradiction. Semantically that means that Heimson's belief set is empty and therefore that he believes literally everything. This is clearly incorrect; Heimson is crazy but not that crazy. Such non-propositional beliefs about oneself are called *de se*.

Lewis' (1979) solution to this problem of *de se* belief is to reinterpret belief as the self-ascription of a property, like in (11). Here, BEL* is a new belief operator, denoting self-ascription and taking properties as argument. The self-ascribed property, *being Hume*, is constructed through λ -abstraction from the proposition-type embedded DRS. We suggestively use the variable *i'* to denote the first person within the belief, i.e. the cognitive center that does the believing:



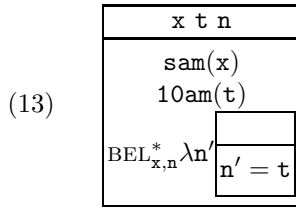
The same observation has been made for the temporal domain. Say Sam is confused about when, rather than who, she is. She thinks it's 10AM when it's actually 11AM. Straightforward interpretation of the present tense as denoting the utterance time *n*, with a propositional belief-operator again gives the wrong result:

(12) Sam thinks it is 10AM.



10AM in (12) names a specific time and ends up in the main DRS. The dedicated discourse referent *n* for 'now', representing the present tense in both *thinks* and *is*, denotes 11AM. So, semantically, what Sam is said to believe is the absurd 11AM=10AM

By analogy with the Heimson *de se* problem, we solve this by making the object of belief a property, now of times, rather than a proposition:

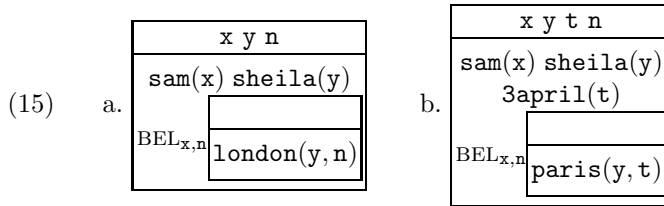


In (13), Sam ‘now-ascribes’, so to speak, the property of being 10AM, that is, she locates her subjective now n' at 10AM.

A second example to illustrate the need for temporal *de se* representations. Imagine that today is April 3rd and that Sam is confused about the time, thinking it’s April 2nd. Then it may be the case that both (14a) and (14b) are true:

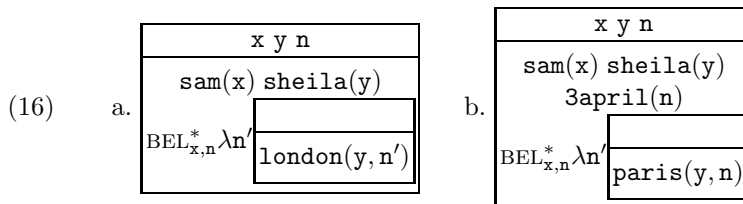
- (14) a. Sam thinks Sheila is in London.
- b. Sam thinks Sheila is in Paris on April 3.

With belief as propositional attitudes, however, Sam would believe a contradiction, since the beliefs would be represented as (15a) and (15b), respectively:



Note that in (15b) we have taken *April 3* from (14b) to be a kind of proper name for a particular time, hence the wide scope representation in the main DRS (as in (10) and (12) above). Since the utterance time is April 3rd, $n = t$, the combination of (15a) and (15b) implies that Sam has the absurd belief about one and the same time, April 3rd, that Sheila is in London and Paris at that time.

With belief as the self-ascription of a property, on the other hand, we can represent the difference between temporal *de se*, for (14a), and *de re* for (14b) (on account of the latter’s overt mention of a specific time, again represented as a proper name in the main DRS):



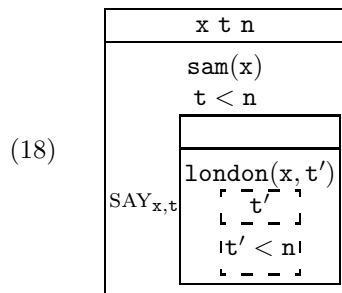
According to (16a) Sam now-ascribes the (temporal) property of Sheila being in London, and in (16b) the belief is really propositional, i.e. equivalent to (15b).³

2.3 Backward shifted past and mistaken time

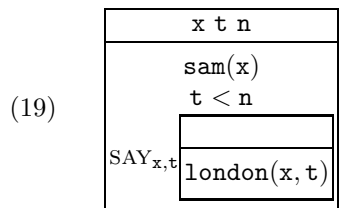
In the previous subsections, we have indicated two general features of tense interpretation, anaphoricity and *de se* interpretation. Now we turn to past-under-past sentences, sentences with a past tense verb embedded under a past tense attitude verb, like our (1), here repeated for convenience as (17). We show that both features come together in the backward shifted reading of such sentences.

(17) Sam said that she was in London.

Given the anaphoric nature of tense, let's first see what a simple anaphoric account of tense would do with the interpretation of the embedded past tense in (17). How would the simultaneous and backward shifted reading come about on such account? It would assign to (17) the preDRS in (18) with the tense presupposition in the dashed box:



The time of the stay in London t' looks for a past time and since in (18) t , the time of the saying, is the only time available, it will bind to this time. The output is given in (19).



In this way the stay in London ends up simultaneous with the saying, apparently capturing the simultaneous reading.

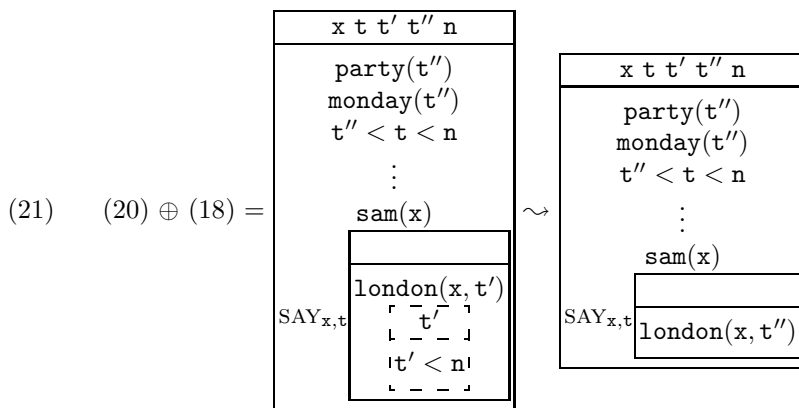
To get the backward shifted reading we must add some context:

³ Propositional beliefs can be reformulated in the more powerful property-self-ascription framework: Sam self-ascribes the property of being temporally located at some timepoint in a world in which Sheila is in Paris April on 3rd.

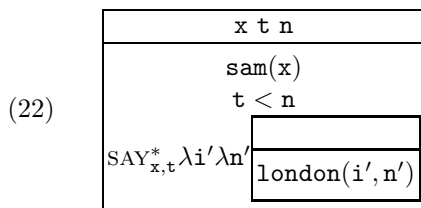
(20) Sue asked Sam why she wasn't at the party on Monday.

t t'' ...
party(t'')
monday(t'')
t'' < t < n
ask(t, ...)
⋮

If (20) precedes (17), the natural reading of (17) is a backward shifted one. On an anaphoric account of tense, this is because (20) makes available for t' a second time to bind to, the time of the party on Monday, t'':

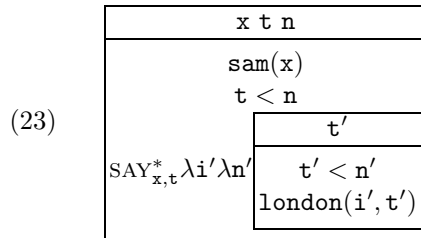


Now let's evaluate this simple anaphoric analysis. First, (19) is not the correct representation of the simultaneous reading of (17), since following the reasoning of section 2.2 with respect to (14a), the present tense equivalent to (17), it follows that the simultaneous reading is really a *de se* reading, as in (22):



Sam ascribes to her self and now the property of being in London. In other words, she says 'I am now in London'. In order to derive (22), one has to assume a "sequence of tense" rule, since the embedded past tense is not interpreted as a past, but rather as a present, be it a local/narrow one, n'. To obtain this result, one can follow von Stechow (1995) in that the binding of tenses by attitude verbs involves a system of morphological feature deletion.

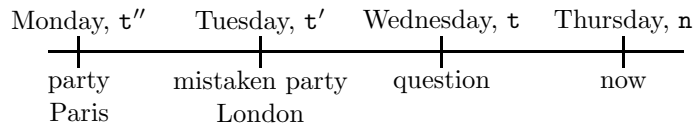
What about the backward shifted reading? In analogy with the simultaneous reading, we expect that it should be represented like the *de se* (23) rather than the *de re* (21):



To see the difference between the two representations we must have a mistaken time scenario:

Sam was invited to Sheila's party in Paris, but she didn't show up. She mistakenly thought the party was on Tuesday, when she happened to be in London, but it was actually on Monday. Sheila asked her on Wednesday why she wasn't at the party.

Schematically:



Let's compare (21), the representation provided by the simple anaphoric account, and (23), the *de se* representation, for the interpretation of (17) in this scenario. The purely anaphoric (21) is incorrect, since Sam does not make a statement about the actual time of the party, Monday. That particular time does not play any role in her subjective experience. She would never answer that she was in London at t'' (Monday) because she wasn't—she's not confused about where she was when, only about the time of the party. The *de se* (23), on the other hand, correctly captures this feature by locating the time of the stay in London in the answer, t', in the past of Sam's subjective now n'. The anaphoric element, however, is missing. Sam's utterance is given as an answer to Sheila's question and hence should relate to the party. Therefore the stay in London should not just be located at some arbitrary time in the past of Sam's subjective now, as currently happens in (23).

Intuitively, what we would like to do is to bind t', the time of the stay in London, to the time of the party as represented in Sam's belief worlds. In that way we would capture both the anaphoric and the *de se* feature of the interpretation of the embedded past tense. Even if we would represent Sam's mistaken beliefs about the party in the context DRS, however, this would be impossible in standard DRT. The reason is that the time of the party as represented in her belief worlds would not be accessible to bind to, since it would be embedded under an attitude operator. The next section provides a solution to this problem.

3 Towards a dynamic analysis

In the previous section we have seen that two conflicting features, anaphoricity and *de se* interpretation, come together in the case of the backward shifted interpretation of past-under-past sentences. In this section we propose to account for this observation using an extension of DRT where interpretation consists of updates of the common ground while also keeping track of the changing, complex attitudinal states of the various agents (Kamp 1990, 2006). The idea is that the content of Sam’s answer in (17) is to be evaluated with respect to her contextually given background belief, which contains her (mistaken) idea of a party on Tuesday. On such a view, interpretation is modeled as an update that combines the main DRSs’ conditions, but that also merges each of an agent’s individual attitude representations. To achieve this we need representations of an agent’s total attitudinal state: a ‘layered’ DRS (Geurts and Maier 2003).

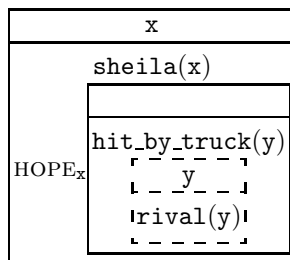
In section 3.1 we start with the idea of layered attitudes, followed by the mechanism of embedded updates in section 3.2. Finally, in section 3.3 we show how these two extensions to DRT allow us to deal with the combination of anaphoricity and *de se* binding as found in the backward shifted reading of past-under-past sentences.

3.1 Attitudes in Layers

If we want to have an anaphoric account of tense under attitudes, we must take into account the interaction of different attitudes (we’ve already encountered two distinct attitudes, believing and saying) and presuppositions. As it happens, belief is rather special among the attitudes in that presuppositions triggered in any attitude report tend to end up in the ascriber’s beliefs (Karttunen 1974, Heim 1992).

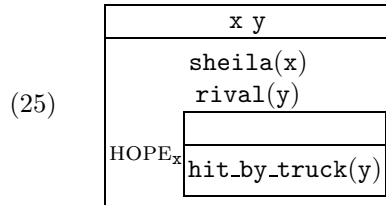
Take the hope report in (24), containing the presupposition trigger *her rival*. Note, by the way, that in this subsection and the next we ignore the independent issue of *de se* representation, i.e. for the sake of simplicity, we’ll represent attitudes as propositional rather than in terms of the self-ascription of properties):

(24) Sheila hopes her rival will be hit by a truck.⁴

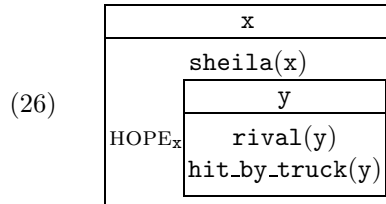


⁴ Example from Henk Zeevat.

Now, this could in principle be a *de re* report, paraphrasable as: she hopes that that guy (who we know is her rival, perhaps unbeknownst to her) will be hit by a truck. We derive this reading by global resolution of the presupposition:



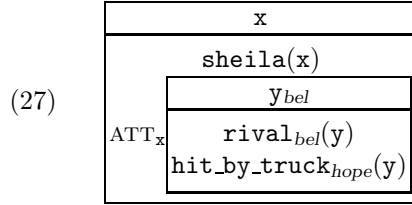
More interesting is the *de dicto* reading, as in ‘I hope my rival (whoever it is) will be hit by a truck’. This reading is not so easily represented. We might try a local accommodation of the presupposition:



(26) reads as ‘Sheila hopes that she has a rival and that he will be hit by a truck’. But of course Sheila doesn’t hope that she has a rival. That she has a rival is part of her belief rather than her hope. Her hope is restricted to the condition that this person be hit by a truck. In other words, Sheila hopes of whoever she believes to be her rival that he will be hit by a truck. This dependency of hope and other attitudes on belief (cf. Asher 1987) motivates the representation of an agent’s total attitudinal state as a complex DRS with different ‘compartments’ for the different attitudes.

We propose to formalize this using Geurts and Maier’s (2003) Layered DRT. This very general framework is meant to represent the interaction of different kinds of content, by splitting a DRS into layers connected by shared discourse referents. The ‘kinds of content’ here are the different attitudes and the ‘interaction’ is the observed asymmetric dependency between, for instance, hope and belief. More specifically, in the proposed framework, a complex attitude representation is a Layered DRS (LDRS) consisting of a set of (‘narrow’) discourse referents common to all attitudes, and conditions making up the various attitudes (belief, hope, assert, ...) about these attitude-internal objects. These conditions are labelled according to the attitude they belong to (*bel*, *hope*, *say*, ...). Instead of

a belief operator we now need a general ‘complex attitude’ operator.⁵ For our example, this gives:



The purely attitude-internal discourse referent y shows that we are dealing with a *de dicto* interpretation. This y, moreover, is shared between the hope and belief layer to capture the fact that Sheila’s hope, that he be hit by a truck, is about the same narrow individual that she believes is her rival.

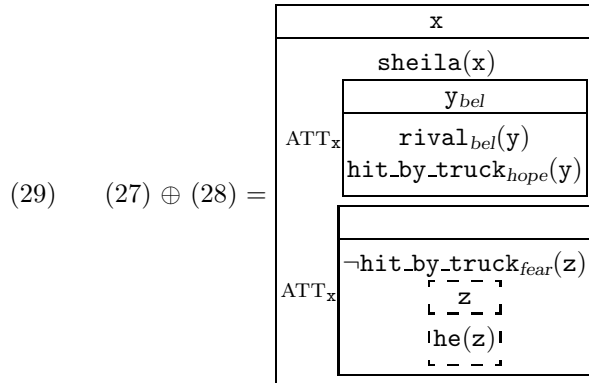
3.2 Embedded Updates

In order to deal with the dynamics of attitude ascriptions we need a further modification of the DRT framework: the update mechanism needs to be extended to cover merges of attitude embedded DRSs.

Let (24) (on the *de dicto* reading) continue as in (28):

(28) [Sheila hopes her rival will be hit by a truck.] But she fears he won’t be.

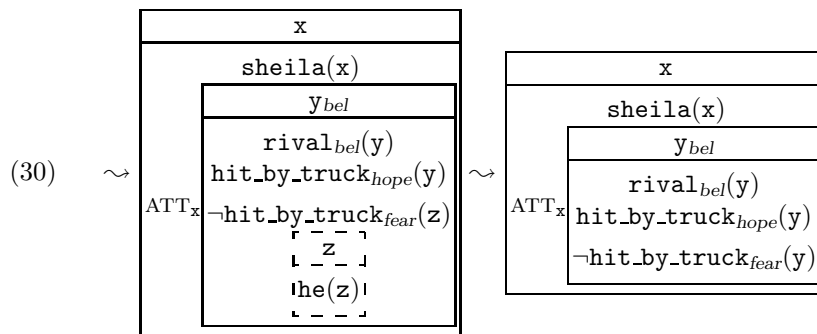
Intuitively, *he* picks up the rival of the first sentence. However, if we were to use the standard DRT+PA common ground update, i.e. merge context and preliminary DRS, we would only get to (29):



⁵ The exact semantics of this operator will have to wait until another occasion. The idea is that a model associates with an individual a set of belief alternative worlds (or rather, contexts), a set of hope alternatives, a set of say alternatives, etc. We then compute the proposition expressed by the LDRS’s belief layer as to see if it includes the set of belief alternatives. Next, the belief layer’s conditions are used to create an *anchor* against which, finally, the other layers can be evaluated and their propositions can be compared with the corresponding attitude’s set of alternatives.

If we were now to resolve the presupposition along its accessibility path, we would be unable to bind it. The intended antecedent y is not accessible because it is embedded under an attitude operator. We would end up with a DRS that ascribes two distinct attitudes to Sheila, missing the fact that she has a fear about the hypothetical rival in her belief worlds.

It is for this reason that we propose to update each agent’s attitudinal state along with the common ground, following Asher (1986), among others. That is, we merge not only the top-level of the DRS, but also the two attitude representations ascribed to Sheila, before resolving the embedded presupposition:



Thus, we can bind z to a local antecedent from the previous sentence, so that Sheila indeed hopes that her rival (whoever he is) is hit by a truck and fears he is not. In the next section we apply this mechanism to reconcile the anaphoricity of tense with the locality of *de se* interpretation.⁶

3.3 Mistaken past revisited

We now return to the challenge at hand, the backwards shifted past. Recall from 2.3 that in order to capture both the anaphoric and the *de se* feature of the embedded past tense of (17) we want to bind the time of Sam’s stay in

⁶ The anaphoric accessibility problem posed by (28) is reminiscent of Geach’s (1967) Hob-Nob puzzle of intentional identity:

- (i) Hob thinks a witch has blighted Bob’s mare and Nob wonders whether she killed Cob’s sow.

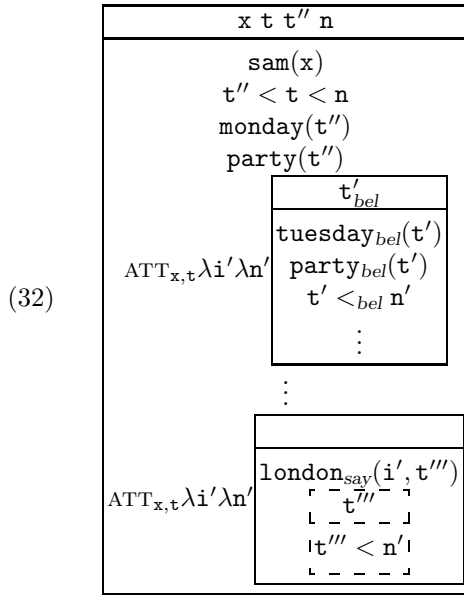
The pronoun *she* in the second conjunct has to pick up the witch narrowly introduced under a belief operator in the first conjunct. The crucial difference between this and (28) is that here an anaphoric dependency is supposed to hold between different attitudes of *different agents*. This more general problem of intentional identity is therefore not solved by our embedded update mechanism which only combines the different attitudes of a single agent to fix anaphoric dependencies within that individual’s complex attitudinal state. On the other hand, note that a solution to the general problem of intentional identity could probably be applied for our purposes below. Unfortunately, we are unaware of an elegant and satisfactory solution to the Hob-Nob and related puzzles.

London to the time of the party *as represented in her belief worlds* – something that was impossible in standard DRT+PA. The new machinery, layered attitudes and embedded updates, proposed in the previous subsections, however, enable us to do achieve this, as we will show now.

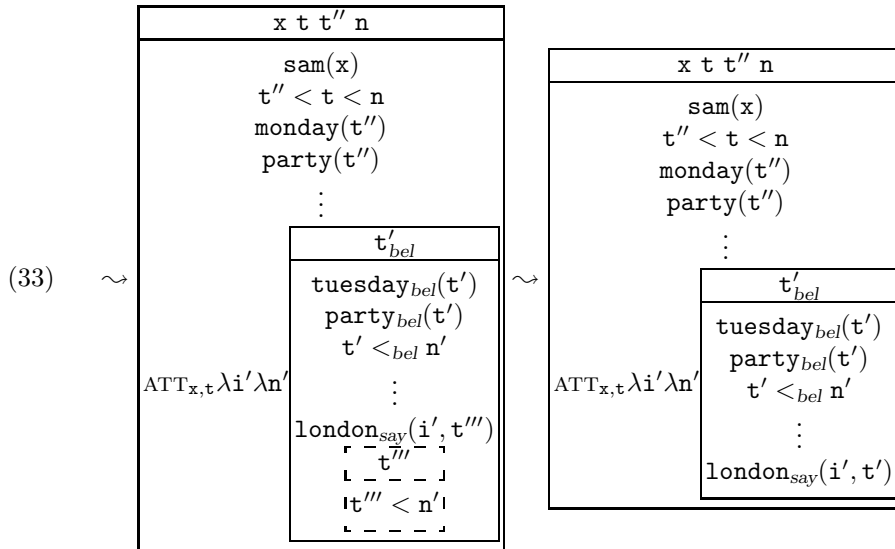
First we represent the context containing the relevant background information from our mistaken identity scenario. Note that at this point we don't (have to) know about the stay in London, as that is what (17) will contribute, but we (i.e. the reporter and her audience – not necessarily including either Sam or Sheila) do know about Sam's mistaken assumption about the day of the party. Also, from here on we take the *de se* character of attitudes with respect to tenses into account again. The relevant context in our enhanced DRT+PA looks like (31):

$$(31) \quad \text{ATT}_{x,t} \lambda i' \lambda n' \begin{array}{|l} \hline x \ t \ t'' \ n \\ \hline \text{sam}(x) \\ t'' < t < n \\ \text{monday}(t'') \\ \text{party}(t'') \\ \hline \begin{array}{|l} \hline t'_{bel} \\ \hline \text{tuesday}_{bel}(t') \\ \text{party}_{bel}(t') \\ t' <_{bel} n' \\ \vdots \\ \hline \end{array} \\ \hline \vdots \end{array}$$

The compositionally derived preliminary representation for the backwards shifted reading of (17) involves a past tense presupposition, more specifically, one that is past with respect to Sheila's local now, n' . Simply adding it to the context in (31), and performing the initial resolutions, gives:



At this point we could bind t''' to t'' , the actual time of the party, but this wouldn't give the intended interpretation (see section 2.3). The desired result would be obtained by binding t''' to t' , the time of the party according to Sam's belief. That would capture the intuition that t''' , the time of the asserted stay in London, coincides with Sam's idea of when the party was, i.e. Tuesday. Currently t' is not accessible for t''' to bind to. But according to the extended merge and update mechanism of 3.2 we can merge the representations of Sam's two attitudes and bind t''' narrowly yet truly anaphorically to t' , Sam's internal representation of the time of the party:



In this final output, Sam's stay in London given as reason for her absence indeed falls on the day she thinks there is a party, τ' , not the actual day of the party, τ'' . Through property self-ascription, presupposition-as-anaphora, Layered DRT, complex attitudinal states, and embedded merge we have thus arrived at a correct analysis of the backward shifted past.

4 Conclusion

The tension created by the independently motivated anaphoric and *de se* aspects of tense interpretation is resolved by an extension of DRT in which updates of the common ground are accompanied by updates of each relevant agent's complex attitudinal state. This is necessary in order to deal with the backward shifted reading of the past-under-past. In such constructions the embedded past tense is at the same time anaphoric to a salient past time in the context and *de se*, that is, narrow with respect to the attitude in which it occurs. The extended update mechanism lets the past tense be anaphoric to a narrow, *de se* antecedent in some earlier attitude in the context.

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