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Presupposition as Anaphora in the Verbmobil Semantic Formalism

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Abstract

In this report we discuss the treatment of presuppositional expressions in the Verbmobil Semantic Formalism (Bos *et al.*, 1994). First a classification of relevant presupposition triggers is given. Then the representation of presuppositions in the Semantic Formalism, which is an extended, compositional version of Discourse Representation Theory, is defined. Finally a procedure for presupposition projection, akin to Van der Sandt's theory (Van der Sandt, 1992), is proposed, illustrated, and discussed.

Zusammenfassung

Dieser Bericht beschäftigt sich mit der behandlung von Präsuppositionen im Verbmobil Semantikformalismus. Zuerst werden die relevanten Präsuppositionsauslöser klassifiziert. Dann wird die Repräsentation vor Präsuppositionen im Semantikformalismus, der eine erweiterte, kompositionelle Version der Diskurs-Repräsentation-Theorie ist, definiert. Abschließend wird eine Methode zur Präsuppositionsprojektion, ähnlich der Theorie von Van der Sandt, vorgeschlagen, illustriert und diskutiert.

Contents

1 Towards a uniform account of Anaphora, Presupposition & Ellipsis?

1.1 About referential expressions in discourse

What have anaphora, presupposition and ellipsis in common? The answer put forward in this paper is that they all anaphorically refer to some linguistic material established in the ongoing discourse or dialogue. This might be very clear for pronouns (apart from their deictic use) and ellipsis, but maybe less clear for presuppositional expressions. For what constitutes anaphora is a syntactically reduced expression, such as a wide variety of pronouns, and for instance one-anaphora and VP-anaphora in English. Elliptical expressions are on the other hand phonetically totally reduced. However, the deleted material in an elliptical expression is normally accessible from discourse. Furthermore, it has recently been claimed that presupposition subsumes anaphora, and this makes our picture of anaphoric expressions complete. What I mean by anaphoric expressions are phrases that presuppose an antecedent, which can be obtained from the discourse, dialogue, or to put it more generally, from the current situation.

The phenomena dealt with in this paper, anaphora and presupposition, which have been treated differently in the past, are claimed to be very related. Our aim is to cope with these phenomena using a single extension to Discourse Representation Theory. We will stress the representational means, and will not discuss resolving strategies in great depth. This obviously needs further attention but is not the topic of this paper. What is addressed is a proper discourse representation of the phenomena under discussion. In fact, we will emphasize presuppositional expressions.

1.2 Phenomena

Here I will list some examples of our interest, taken from Verbmobil corpora. Let me briefly sketch what Verbmobil is about. In the Verbmobil scenario, two people are arranging a date for a meeting. One of the participants is able to speak German, but only a bit of English, the other one understands English. Upon these requirements the German speaker can ask the Verbmobil device to translate a German utterance into an English one.

What actually is *presupposition*? In the first place presuppositions are lexically triggered. If an utterance contains a presupposition trigger, the presupposition associated with the trigger will be implied (Zeevat, 1991). A characteristic of presuppositions is that they survive under negation, implication and intensional context, which distinguishes them from entailments. Presupposition triggers are classified as follows:

Definite Descriptions Examples: *der Termin, der dreizehnte April, der Donnerstag*. They presuppose that whatever they describe, actually exist.

Proper Names Also have an existential presupposition (Van der Sandt, 1992; Zeevat, 1991).

Possessives Examples: *mein Terminkalender*. Presupposition: speaker has a Terminkalender.

Focus Sensitive Particles Examples: *nur, auch, sogar*. They are sensitive to focus, i.e. their presupposition (or, in the case of *nur*, the assertion) depends on the constituents in focus that appear in the scope of the particle, and is characterized as a state or event.

Iterative expressions Example: adverbials like *wieder, noch*. They presuppose that the event or state which it asserts, took place earlier.

Transformational Verbs Example: verlegen

Implicative verbs *schaffen* presupposes that it was difficult to perform the action under discussion.

Factives Ich sehe daß P, tut mir leid daß P, presuppose P, where P is proposition.

Subordinated clausal PPs bevor P, nachdem P, presuppose P, where P is a proposition.

This list is of course not exhaustive. It just functions to show the different types of triggers that exists. Some examples, associated with their presuppositions (abbreviated with P) serve for explanation. The presupposition stemming from possessives are straightforward, as in (1):

(1) Es geht nach meinem Terminkalender
P='speaker has a calender'

The interpretation of *wieder* depends on whether it receives stress or not. Kamp & Roßdeutscher distinguish between a restitutive and a repetitive interpretation (Kamp and Roßdeutscher, 1992). If *wieder* is stressed it presupposes an earlier occurrence of the event-type that it modifies. If *wieder* is not stressed it presupposes that there was "an earlier state like the one resulting from the described event" (Kamp and Roßdeutscher, 1992). This is the restitutive interpretation. Take this distinction into account for example (2):

(2) Bei mir geht es wieder im November
P='it was possible in November occurred before' (stressed 'wieder')
P='it was possible before' (unstressed 'wieder')

Focusing particles like *auch* are sensitive to stressed constituents in their scope. This ambiguity is demonstrated in (3). The particle *nur* presupposes the eventuality that it modifies, and asserts that alternatives are not possible. These alternatives depend on the constituents in focus. In (4) it is asserted that, for instance, it is not possible in the afternoon.

(3) Der Donnerstag ist bei mir auch belegt.
P='another day was not free' (*stress on 'donnerstag'*)
P='Thursday is not free for the hearer' (*stress on 'mir'*)

(4) Das geht nur morgens
P='it is possible in the morning'

Finally, we show examples of presupposition that are triggered by a transformational verb (5) and a factive verb (6):

(5) Wir verlegen es irgendwie auf Montag
P='it was agreed upon a date'

(6) Ich sehe gerade daß ich bis vier Uhr in einer Konferenz bin
P='the speaker is at a conference untill four o'clock'

What makes presupposition so interesting then? Well, what puzzled linguists and philosophers of language for a long time is the so-called projection problem for presupposition. As mentioned above, presuppositions normally survive negation and implication. This is not the case in (7) and (8), though:

(7) Wenn ich am Dienstag eine Vorlesung habe, kann ich die Vorlesung vergessen.

(8) Wenn wir jetzt einen Termin am Montag ausmachen, können wir es eventuell morgen noch verlegen.

In (7), the definite description *die Vorlesung* does not presuppose the existence of it. This effect turns up in (8) as well: the transformational verb *verlegen* does not presuppose that a date had been settled.

Furthermore, it is not always clear to which object a definite description refers (9), and the presupposition could be semantically formed (10).

(9) Der Samstag wäre mir lieber
Welcher Samstag, der sechste oder der dreizehnte?

(10) Am Dienstag den sechsten April hätte ich noch einen Termin frei.
Geht es da bei Ihnen auch?

To explain the point we wish to illustrate with example (10): the presuppositional trigger *auch* used in the question presupposes that it is possible for the speaker to have a meeting, which is satisfied by the first sentence of (10), because this utterance expresses that it is possible indeed to have a meeting at the proposed date.

There is rich literature about presupposition available, and the discussion on the properties of presuppositional expressions dates back to Strawson & Frege, and actually even earlier. The last decade brought some interesting new insights in the theory of presupposition, due to contributions of Irene Heim and Rob van der Sandt.

1.3 Presupposition as Anaphora

In his paper "Presupposition Projection as Anaphora Resolution" Van der Sandt (1992) convincingly argues that, first, presuppositions are not referring expressions in the sense of Frege & Strawson, second, presuppositions cannot be explained by a non-standard logic, and third, presuppositions should not be treated in a pragmatic theory.

Rather surprisingly maybe, presuppositions are a kind of anaphoric expressions, the interpretation of which is highly influenced by discourse structure. The main difference to pronouns is that they have more descriptive content, which enables them to *accommodate* an antecedent, in case it is not provided by discourse. This accommodation strategy enables utterances to "convey their presuppositions as new information" (Heim, 1983), and allows the hearer to make "repairs" on his knowledge of the discourse context (Lewis, 1979)

Presented in the framework of DRT, Van der Sandt's theory is indeed able to solve presupposition projection problems, and his algorithm straightforwardly treats several kinds of presuppositional NP-anaphora such as definite descriptions, proper names, and possessives. Van der Sandts claims that in principle the analysis also supports VP-anaphora and propositional anaphora. We will discuss this issue in the next section.

2 The Framework

2.1 Representation of Anaphora & Presupposition

In this section we define the DRS syntax. This will not differ from what we known from standard DRT (Kamp and Reyle, 1993), except for the representation of referential expressions. Let us start with a recursive definition of a DRS:

Definition 1. DRS Syntax

Syn1: If D is a (possibly empty) set of discourse markers, and C is a (possibly empty) set of conditions upon D, then $\langle$ D,C $\rangle$ is a DRS

Syn2: If P is an n-place predicate, x_1 ,..., x_n are variables, then $P(x_1,...,x_n)$ is a condition

Syn3: If Φ and Ψ are DRSs, then $\Phi \vee \Psi$, $\Phi \Rightarrow \Psi$ and $\neg\Phi$ are conditions.

Clause **Syn1** defines a DRS. A basic condition is stated in clause **Syn2**. In **Syn3** disjunction, implication and negation are defined. The next step is to define the syntax for anaphora, presupposition and elliptical expressions.

An important feature of Discourse Representation Theory is the use of discourse markers. Every new interpreted sentence of the ongoing discourse potentially introduces fresh discourse markers. These markers are "hooks" for anaphoric material in the succeeding discourse. Normally, noun phrases introduce discourse markers. For example, a discourse marker introduced by the constituent *a man* can be taken as antecedent for a personal pronoun *he*. This is possible only if the discourse marker is accessible, i.e. is not situated at a subordinated level. So let's define subordination first:

Definition 2. Subordination

Sub1: If Φ, Ψ, and K are DRSs, then Φ subordinates Ψ if $K \vee \Psi \in D_\Phi$, or $\Psi \vee K \in D_\Phi$, or $\Psi \Rightarrow K \in D_\Phi$, or $\Phi \Rightarrow \Psi \in D_K$, or $\neg\Psi \in D_\Phi$.

Sub2: If Φ, Ψ, and K are DRSs, then Φ subordinates Ψ if Φ subordinates K and K subordinates Ψ.

The next step is to define representational means for anaphoric expressions, i.e., simple pronouns, definite descriptions, and other presuppositional triggers. What we need is something that makes a clear distinction between assertional and anaphoric information in a DRS. A straightforward way to realize this idea is to put anaphoric information explicitly in a special DRS, an *anaphoric* DRS so to speak. And this is indeed the direction we take. The DRSs that contain anaphoric information are represented as alfa-conditions:

Syn4: If Φ is a DRS, x_1 and x_2 variables, then $\alpha(x_1)$:Φ and $\alpha(x_1,x_2)$:Φ are conditions.

Basically, all what an alfa-condition α:Φ does is state that the information in Φ is anaphoric, hence needs to find an antecedent. The additional argument

x_1 is the principal anaphoric discourse marker in Φ, while x_2 is the antecedent of x_1. The conditions in Φ constrain the choice of an antecedent for x_1.

There are two versions of an alfa-condition. The first condition in **Syn4** corresponds to an underspecified representation of anaphoric material. This representation occurs before anaphora resolution has been performed, or, as we shall see later, before the anaphoric information has been locally accommodated. Talking about accommodation, the DRS Φ exactly restrains the information that has to be accommodated, in case no proper antecedent can be found.

2.2 Some Sample Lexical Entries

We will give some examples of lexical entries. Presupposition triggers are marked in their lexical entries as anaphoric. This entails that presuppositional expressions pick up discourse markers introduced earlier. Apart from the standard cases in DRT (NP-anaphora), we will also discuss some triggers that have event or state discourse markers as antecedent. We use variables of type x, i to range over individuals, variables of type P, Q to range over properties, variables of type s to range over states, variables of type e to range over events, variables of type K to range over propositions, and finally variables of type E to range over event-types.

Consider the difference between a definite article *der* and the indefinite article *ein*. All what the semantics of the definite article does more is merge (merging of DRS is indicated by the symbol $\oplus$) the DRS of the restriction into the alfa-condition:

(11) der

$$\lambda\, P.\ \lambda\, Q.\ \begin{array}{|c|}\hline \ \\ \hline \alpha(x)\text{: } \boxed{x} \oplus P(x) \\ \hline \end{array} \oplus Q(x)$$

(12) ein

$$\lambda\, P.\ \lambda\, Q.\ \begin{array}{|c|}\hline x \\ \hline \ \\ \hline \end{array} \oplus P(x) \oplus Q(x)$$

A possessive is treated similarly (13). It takes the semantics of what is possessed and puts it into the alfa-condition. The alfa-condition already contains the information that there is something possessed by the speaker. Note that the discourse marker associated with the speaker is also situated in an alfa-condition. This ensures binding of the markers of the participants of the dialogue.

(13) mein

$$\lambda \text{ P. } \lambda \text{ Q. } \begin{array}{|c|}\hline \ \\ \hline \alpha(\text{x}): \begin{array}{|c|}\hline \text{x} \\ \hline \text{von(x,i)} \\ \alpha(\text{i}): \boxed{\text{i}} \\ \hline \end{array} \oplus \text{P(x)} \\ \hline \end{array} \oplus \text{Q(x)} < i, sprecher >$$

Factives, like *sehen*, take a proposition and presuppose it. As it stands at the moment, the basic semantic formalism has no markers corresponding to propositions. This is a problem, because it is not clear what the principle anaphoric variable for the alfa-condition should be. It seems that we need to extend the basic formalism with discourse markers for propositions, but this issue will not be discussed here. The lexical entry for *sehen* is roughly:

(14) sehen

$$\lambda \text{ y. } \lambda \text{ K. } \lambda \text{ s. } \begin{array}{|c|}\hline \ \\ \hline \text{s:sehen(y,} \begin{array}{|c|}\hline \ \\ \hline \alpha\text{:K} \\ \hline \end{array}) \\ \hline \end{array}$$

Transformational verbs, like *verlegen*, presuppose a state which describes the "preconditions" for the action to be performed. In (15), the verb *verlegen*, which has as one of its arguments an event-type, presupposes a state in which it is possible that this event-type has been realized.

(15) Verlegen auf

$$\lambda \text{ y. } \lambda \text{ E. } \lambda \text{ t. } \lambda \text{ e. } \begin{array}{|c|}\hline \text{e'} \\ \hline \text{e:verlegen(y,e',t)} \\ \alpha(\text{s}): \begin{array}{|c|}\hline \text{s} \\ \hline \text{s:}\Diamond \begin{array}{|c|}\hline \text{e" t'} \\ \hline \text{at(t',e)} \\ \neg \begin{array}{|c|}\hline \ \\ \hline \text{t=t'} \\ \hline \end{array} \\ \hline \end{array} \oplus \text{E(e")} \\ \hline \end{array} \\ \hline \end{array} \oplus \text{E(e')}$$

The entry for *wieder* is stated in (16). It takes a DRS of an event-type, and turns it into something of an event-type. It asserts the eventuality that it is modifying, and presupposes a similar event-type.

(16) wieder (repetitive)

$$\lambda \text{ E. } \lambda \text{ e. E(e)} \oplus \begin{array}{|c|} \hline \\ \hline \alpha(\text{e'}):\text{E(e')} \\ \hline \end{array}$$

We will not discuss the treatment of focusing particles, like *nur, sogar, auch*. They deserve a special treatment because, as their name does suggest, their presupposition heavily depends on the focus-background structure. This goes beyond the topic of this paper. A proposal has been made to incorporate focusing information for the treatment of presuppositional focalizers, in a similar semantic framework presented in this paper (Bos, 1994).

2.3 Semantic Interpretation

The last bit of this section addresses the interpretation of DRSs, which is essentially based on Dynamic Predicate Logic (Groenendijk and Stokhof, 1991). DRSs are interpreted in extensional first order models. A model consists of a set of individuals D and an interpretation function F that assigns sets of n-tuples to the n-place predicates (states and events are treated as a special type of individuals, to make the interpretation not too complicated). An assignment g is a total function that assigns an individual to each variable. h[x]g means that h differs from g at most in the value h assigns to x. The interpretation of DRSs and conditions is a set of pairs of assignments: a pair $\langle g, h\rangle$ can be viewed as an "input-output" pair, and is part of the interpretation of a DRS when h is a possible result of the evaluation of this DRS with respect to g. Formalized, the semantics are defined according to the following clauses:

Definition 3. DRS Semantics

Sem1: $[\![\langle x_1, ..., x_i, c_1, ..., c_j\rangle]\!] = \{\langle g, h\rangle \mid h[x_1, .., x_i]g$ &
$\exists k_1 : \langle g, k_1\rangle \in [\![c_1]\!]$ & $\exists k_2 : \langle k_1, k_2\rangle \in [\![c_2]\!]$ &, ..., &$\langle k_{j-1}, h\rangle \in [\![c_j]\!]\}$

Sem2: $[\![P(x_1, ..., x_n)]\!] = \{\langle g, h\rangle |\ g = h\ \&\ < g(x_1), ..., g(x_n) >\in F(P)\}$

Sem3: $[\![\Phi \vee \Psi]\!] = \{\langle g, h\rangle |\ g = h\ \&\ \exists k : \langle h, k\rangle \in [\![\Phi]\!] \vee \langle h, k\rangle \in [\![\Psi]\!]\}$

Sem4: $[\![\Phi \Rightarrow \Psi]\!] = \{\langle g, h\rangle |\ g = h\ \&\ \forall k : \langle h, k\rangle \in [\![\Phi]\!] \Rightarrow \exists j : \langle k, j\rangle \in [\![\Psi]\!]\}$

Sem5: $[\![\neg\Phi]\!] = \{\langle g, h\rangle |\ g = h\ \&\ \neg\exists k : \langle h, k\rangle \in [\![\Phi]\!]\}$

Sem6: $[\![\alpha(t) : \Phi]\!] = \{\langle g, h\rangle \mid \exists k :\ k[t]g \& \langle k, h\rangle \in [\![\Phi]\!]\}$

Sem7: $[\![\alpha(t_1, t_2) : \Phi]\!] = \{\langle g, h\rangle \mid g = h\ \& [\![t_1]\!]_g = [\![t_2]\!]_g\}$

The first clause interprets the semantics of a DRS. Clause **Sem2** interprets basic conditions, while rules **Sem3** to **Sem7** interpret complex conditions.

3 Presupposition Projection

3.1 To Bind or to Accommodate

In this section we will show how presupposition projection (and hence, anaphora resolution) is treated in DRT. The algorithm I present is in essence conform to Van der Sandt's proposal (Van der Sandt, 1992). Van der Sandt's theory is principally based on two mechanisms: *binding* and *accommodation*. Compared to classical presupposition theories, the former corresponds by and large to presupposition cancellation (or better: "neutralization"), while the latter is a sort of repairing the discourse in the style of Lewis (1979).

The idea of Van der Sandt's work is that "anaphoric expressions are either linked to some previously established antecedent or, if they have enough descriptive content, accommodated at some level of representation" (Van der Sandt, 1992). All anaphoric information is resolved conform to the following rules:

1. Try to bind the anaphoric material to an accessible antecedent.

2. If (1) fails, accommodate an antecedent.

Accommodation must take place at some accessible level of discourse. It has been argued in the literature that accommodation must take place *as global* as possible. (Heim, 1983; Van der Sandt, 1992). Van der Sandt proposes a non-monotone *moving* operation for accommodation. As an alternatively, a copying algorithm is stated:

1. If there is a superordinated level then (2) else (4).
2. Copy the presupposed information to this level, but only if this does not lead to semantic contradictions (unbound variables or inconsistencies) or pragmatic violations, else (4).
3. Repeat step (1).
4. Ready.

We will not elaborate in detail on the issue which constrains constitute the elimination of possible accommodation sites. The interested reader should consult Van der Sandt's paper (1992) for proposals.

Accommodation can be satisfied on different levels of discourse, and often more suitable candidates can play the role of antecedent for binding. Hence, the algorithm potentially generates more than one proper DRS (a DRS without any anaphoric material and no free discourse markers).

We exemplify the projection algorithm with a few standard examples in the literature about presupposition. Consider (17) and (18), where the former presupposes John as a dog owner, the latter, in contrast, does not presuppose that, although it contains the same presupposition inducer. Recall that this was named the *projection problem*.

(17) It is not the case that John beats his dog.

(18) If John has a dog, he beats his dog.

We will discuss these and other examples extensively. For (17), it might be clear that accommodation is going to be put into process. This is not the case for (18) though, where the presupposition that John has a dog is satisfied by "local context". The rest of the section shows has different forms of accommodation and binding are implemented in the present formalism.

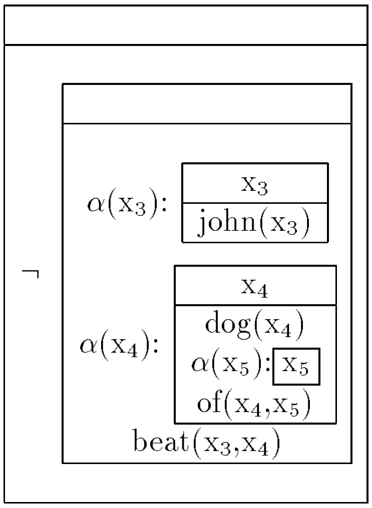
3.2 Global Accommodation

One issue we didn't address very clearly up to now is how accommodation actually is going to be performed in DRSs. The architecture of the semantic formalism can roughly be sketched as follows:

- all presupposition triggers are stated in the lexicon as alfa-expressions;
- given a syntactic tree of a parsed sentence, the DRS associated to this sentence is built via a bottom-up process;
- this Sentence-DRS is merged with the DRS of the previous discourse;
- anaphora resolution (and hence, presupposition projection) is performed

We now turn our attention to example (17) to exemplify these statements. The sentence-DRS for (17) is:

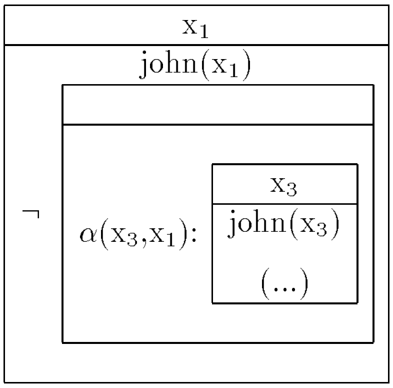
(19)



The next step is to merge this DRS with the DRS of the previous utterances of the discourse. In this example, there is of course not such a DRS available, or rather, it is still empty. What left then is performing anaphora resolution.

The first anaphoric material we encounter is the proper name. There is no antecedent (actually, there aren't any accessible discourse markers at this point) to which we can bind the anaphoric information. We can only *accommodate* the information in the alfa-box. We do this by copying an alphabetic variant to an accessible level of discourse, as global as possible, and bind the accommodated information to the information in the alfa-condition. This looks like:

(20)



We have not finished anaphora resolution yet. The possessive construction is a complex of two alfa-conditions. The deepest embedded anaphoric information has to be processed first. This is the condition corresponding to *his*, and can be linked to the marker of *John*. Finally, the third alfa-condition is going to be accommodated, since there is again no antecedent available.

This delivers the following, final DRS:

$$
(21)\quad \begin{array}{|c|}\hline \mathrm{x}_1\ \mathrm{x}_2 \\ \hline \mathrm{john}(\mathrm{x}_1)\\ \mathrm{dog}(\mathrm{x}_2)\\ \alpha(\mathrm{x}_6,\mathrm{x}_1):\boxed{\mathrm{x}_6}\\ \mathrm{of}(\mathrm{x}_2,\mathrm{x}_5)\\ \neg \begin{array}{|c|}\hline \\ \hline \alpha(\mathrm{x}_3,\mathrm{x}_1): \begin{array}{|c|}\hline \mathrm{x}_3\\ \hline \mathrm{john}(\mathrm{x}_3)\\ \hline\end{array} \\ \alpha(\mathrm{x}_4,\mathrm{x}_2): \begin{array}{|c|}\hline \mathrm{x}_4 \\ \hline \mathrm{dog}(\mathrm{x}_4)\\ \alpha(\mathrm{x}_5,\mathrm{x}_1):\boxed{\mathrm{x}_5}\\ \mathrm{of}(\mathrm{x}_4,\mathrm{x}_5)\\ \hline\end{array}\\ \mathrm{beat}(\mathrm{x}_3,\mathrm{x}_4)\\ \hline \end{array} \\ \\ \hline\end{array}
$$

To sum up, what happened is that the conditions corresponding to the proper name *john* and the definite description *his dog* were hit at the top level of discourse. This is what we mean by *global* accommodation. This operation effects the accessibility of the discourse markers of these NPs. Hence, the sentence *He likes it* is a felicitous succeeding of (17).

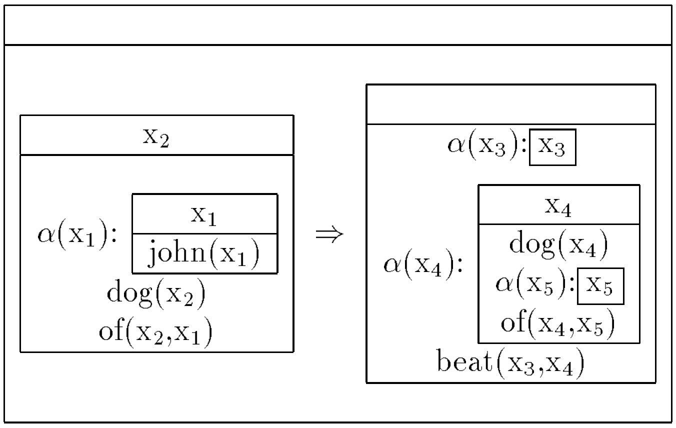
3.3 Binding

Consider again (18), repeated here as (22). The presupposition triggers in this sentence are the proper name in the antecedent of the conditional, and the possessive expression in the consequent part. Only the first of these triggers presupposes something. Why?

(22) If John has a dog, he beats his dog.

The result of the compositional semantic construction process for (18), given that presuppositions are marked in the lexicon as anaphoric, is the following s-DRS:

(23)

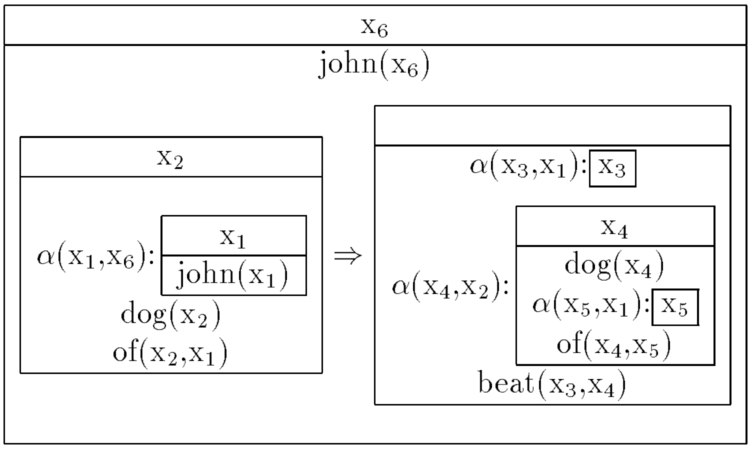


This s-DRS is merged with the DRS of the previous discourse, which is in this case an empty one. The next step is to examine the newly acquired conditions and see if there are any anaphoric DRSs among them.

In the first place we find the condition for the proper name *John*, which is treated as a presupposition. We cannot bind this expression to a referent, since there is none available, so we accommodate the information in the principle DRS. Accommodation is simply fulfilled by copying an alphabetic variant of the anaphoric DRS to the main DRS. *Linking* is possible for the personal pronoun x_3 to the referent of *John*.

The other anaphoric DRS in the consequent of the implication paraphrases *his dog* has an embedded anaphoric DRS, which has to be resolved first. In this case the referent x_5 can be linked to the marker corresponding to *John*. Finally we can resolve x_4 to x_2 because their corresponding conditions do not conflict and yield:

(24)



This DRS is fully specified and paraphrases the meaning of (18) correctly: *There is a male person called John, and if John owns a dog, he beats it.* Accommodation took place for the presupposition of the proper name *John*, since there was no suitable antecedent available. On the contrary, the presupposition that there is a dog owned by John found its antecedent in the restriction part of the conditional.

3.4 Intermediate Accommodation

The algorithm for accommodation that we presented at the beginning of this section states in its second clause that accommodation to an accessible discourse representation level is only possible if no unbound variables or inconsistencies follow from this operation. When do these cases actually appear? Van der Sandt (1992) discusses sentences like (25):

(25) Every farmer feeds his bull.

The quantificational sentence (25) contains a presupposition trigger (the possessive) in its nuclear scope. After presupposition projection a readings paraphrased as *every farmer that has a bull, feeds it* is derived. We obtain this reading in the following way. Consider the sentence-DRS for (25):

(26)
$$\begin{array}{|c|}\hline \\ \hline \begin{array}{|c|}\hline x_2 \\ \hline \text{farmer}(x_2) \\ \hline\end{array} \Rightarrow \begin{array}{|c|}\hline \\ \hline \alpha(x_4): \begin{array}{|c|}\hline x_4 \\ \hline \text{bull}(x_4) \\ \alpha(x_5): \boxed{x_5} \\ \text{of}(x_4,x_5) \\ \hline\end{array} \\ \text{feed}(x_2,x_4) \\ \hline\end{array} \\ \hline\end{array}$$

First of all we have to find an antecedent for x_5, the deepest embedded alfa-condition. The only possible candidate is x_2. The next step is resolve the alfa-box of x_4. No antecedent is available, so accommodation is put to work. The result is, after copying the anaphoric information from the consequent to the antecedent of the conditional:

(27)
$$\begin{array}{|c|}\hline \\ \hline \begin{array}{|c|}\hline x_2\ x_6 \\ \hline \text{farmer}(x_2) \\ \text{bull}(x_6) \\ \alpha(x_7,x_2): \boxed{x_7} \\ \text{of}(x_6,x_7) \\ \hline\end{array} \Rightarrow \begin{array}{|c|}\hline \\ \hline \alpha(x_4,x_6): \begin{array}{|c|}\hline x_4 \\ \hline \text{bull}(x_4) \\ \alpha(x_5,x_2): \boxed{x_5} \\ \text{of}(x_4,x_5) \\ \hline\end{array} \\ \text{feed}(x_2,x_4) \\ \hline\end{array} \\ \hline\end{array}$$

This is the reading paraphrased as *every farmer that owns a bull, feeds it (his bull)*. What we actually have done is termed *intermediate accommodation*. According to the accommodation algorithm we could try to accommodate into the main DRS as well, for this is an accessible discourse representation level. As a consequence, the variable x_2 would show up in the main DRS, since it is part of the anaphoric material, and we would be stuck with an unbound variable. Hence, this possibility is legitimately rejected.

3.5 Local Accommodation

Sometimes presuppositions are denied. The cases I am referring to often appear in combination with negation, as in the following sentence:

(28) John didn't regret that Marry killed his rabbit,
because she didn't kill his rabbit.

The presupposition triggered by the factive verb can be accommodated to the main DRS. This however is inconsistent with the follow-up sentence. Therefore, only a local accommodation option remains possible. Similar behaviour of presupposition is found in (29) and (30):

(29) It is not the case that John beats his dog.
In fact, he has no dog!

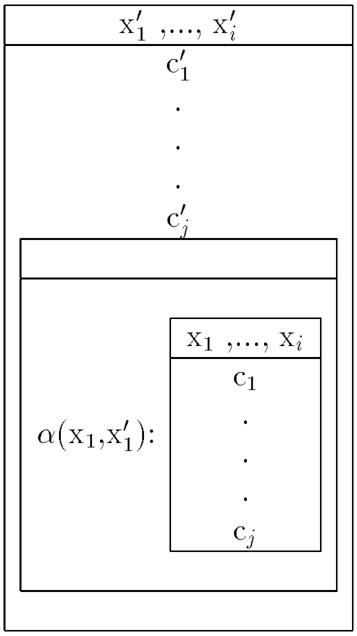
(30) I told you that John has no dog. Therefore, John does not beat his dog!

Note that the sentence-DRS for (30) is like DRS (19). Accommodating to the global DRS would violate the constraint of consistency. The main DRS would have both the conditions expressing that John has no dog and John has a dog! Therefore, in the context of (30), global accommodation is not allowed. We end up with the DRS:

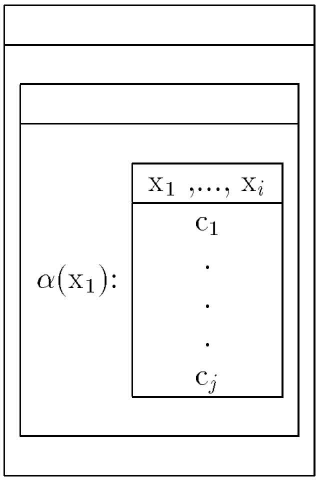
(31)
$$
\begin{array}{|c|}
\hline
\mathrm{x}_1\ \mathrm{x}_2 \\
\hline
\mathrm{john}(\mathrm{x}_1) \\
\neg \begin{array}{|c|}
\hline
\\
\hline
\alpha(\mathrm{x}_3,\mathrm{x}_1): \begin{array}{|c|}\hline \mathrm{x}_3 \\ \hline \mathrm{john}(\mathrm{x}_3) \\ \hline \end{array} \\
\alpha(\mathrm{x}_4): \begin{array}{|c|}\hline \mathrm{x}_4 \\ \hline \mathrm{dog}(\mathrm{x}_4) \\ \alpha(\mathrm{x}_5,\mathrm{x}_1): \boxed{\mathrm{x}_5} \\ \mathrm{of}(\mathrm{x}_4,\mathrm{x}_5) \\ \hline \end{array} \\
\mathrm{beat}(\mathrm{x}_3,\mathrm{x}_4) \\
\hline
\end{array} \\
\\
\hline
\end{array}
$$

Note that this DRS is very similar to the DRS we started with. The anaphoric information of the alfa-condition associated with x_4 didn't have an antecedent, and it couldn't be accommodated either. In such cases only local accommodation remains as an option. The difference between local and non-local accommodation can be pictured as follows:

Global Accommodation



Local Accommodation



3.6 Some Remarks and Possible Problems

Note that the way of treating proper names as presuppositions is more motivated, elegant and uniform than in the original treatment in DRT. It assures that proper names always raise to the main DRS: either by accommodation or by linking.

Summarizing, accommodation in the global context corresponds to the classical notion of presupposition. Binding is then what we could call *presupposition neutralization*. The term "presupposition cancellation" is conform to local accommodation.

One of the problems of finding a suitable antecedent for anaphoric information is to judge whether the information of the antecedent matches with the information of the alfa-condition. Consider the following examples, both due to David Beaver:

(32) An old woman hit me. The bitch run away.

(33) An old woman hit me. The knuckle-duster cut deep.

In (32) some "bridging" is involved. To allow the old woman to be the antecedent of the definite description *the bitch*, some inferencing of bitchiness is necessary. As for example (33), the knuckle-duster is licensed by the violent act expressed in the first sentence. Genuine problems appear in quantificational contexts:

(34) In every small Midwestern town the post office is next to the church.

In this example, taken from Kamp & Reyle (1993, p. 299), there is also this implicit dependency between a town, a post office and a church. Without recognizing these relations, the definite description would mistakenly be accommodated at the top level of the DRS.

Another issue that is worth mentioning addresses the treatment of quantification. We saw that in quantificational sentences with presupposition triggers in the nuclear scope, like (25), the presupposition actually acts as a quantificational restriction. This has been in dispute recently. According to the more traditional theories on presupposition, (25) should presuppose that *every farmer has a bull* . In the Van der Sandtian treatment of presuppositions there actually is no presupposition in the classical sense, but intermediate accommodation of the presupposition causes a reading *every farmer that has a bull feeds it.* Some linguists were puzzled by this, because if this is the preferred reading, then why is (35) infelicitous?

(35) There are fifty people of whom most do not have badges.
Everybody is wearing his or her badge.

This example, due to David Beaver, is rather puzzling indeed. To justify Van der Sandt's analysis, there must be a reason why intermediate accommodation is not allowed in (35). The only option left then is local accommodation, which causes a inconsistency in the discourse and therefore rules out (35). It is not clear to me what disallows intermediate accommodation in (35), though.

4 Conclusion

We proposed a way to treat a presupposition in the Verbmobil Semantic Formalism, in which we support the view that presuppositional expressions are in essence anaphoric. Discourse Representation Structures are enhanced with so-called alfa-conditions, that distinguish assertional information from anaphoric information. This makes the treatment of a wide variety of relevant presupposition triggers possible in DRT.

Some problems are encountered though. The first one is the behaviour of factives and clausal PPs, like *bevor*. They presuppose the proposition that they modify. Our semantic formalism does not support discourse markers for propositions, which are necessary when claiming that presuppositions are anaphoric of nature. A second problem is the analysis of focus sensitive particles. The presupposition of particles like *auch* depends on the constituent in focus. This information is not available in the current semantic formalism.

Finally we addressed the projection problem for presupposition. As long as presuppositions are able to find a suitable antecedent there is nothing to worry about. In case there is no antecedent available, presuppositional accommodation takes place. Accommodation is a process that creates the "missing" antecedent. Accommodation can take place at different (accessible) levels of the discourse representation, which has direct consequences for the interpretation of presupposition.

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