

Denials in discourse

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Abstract

The central characteristic of denials is that they perform a non-monotonic correction operation on discourse structure. A second characteristic is that they may be used to object to various kinds of information including presuppositions and implicatures. In this paper we first use standard DRT to capture these features, implement an earlier proposal of van der Sandt (1991) in DRT and point out a shortcoming of that approach. We then adopt *Layered DRT*. LDRT is an extension of standard DRT designed to represent and interpret different types of information conveyed in a conversation by distributing them over separate layers of the same LDRS. We will then show how LDRT allows us to solve the problems of the classic monostratal system. The resulting system makes use of a *directed reverse anaphora* mechanism to locate, remove and negate the material objected to.

1 Introduction

In the literature on denial and correction we can roughly distinguish two views. The dominant view has it that these phenomena are best captured within a general view of the semantics and pragmatics of negation. In terms of speech act theory this means that negatory force is located in the negative morpheme. A particular influential statement of this view is found in Horn (1985, 1989), who distinguishes between an ordinary ‘descriptive’ negation operator and a so-called metalinguistic negation. The former is the standard logical connective contributing to truth-conditional content, the latter is a non-truth-functional device that is meant to account for rejection of non-propositional material. This comprises objections to implicatural and presuppositional information, and to infelicities arising from style and

register. Horn characterizes this operator as a metalinguistic device which can be used to signal an objection to an utterance on whatever grounds. This view has a number of drawbacks. It implies that some instances of natural language negation are not interpretable by semantic means. It also implies an ambiguity in natural language negation which is not realized in any known language.

We defend a second view according to which the semantic notion of negation and the speech act notion of denial are fully independent. Denial patterns with assertion in that its nature and function should be accounted for in terms of the discourse effects it gives rise to. Just as the primary function of assertion is to convey new information, the primary function of a denial is to object to information which has been entered before and to remove it from the discourse record. The central characteristic of denial then is that it performs a non-monotonic correction operation on contextual information. This approach has several advantages. It yields a uniform account of denial, which comprises the standard ‘propositional’ and the marked cases, it does not force us to postulate an ambiguity in the natural language negation, and by incorporating ideas from Levinson (2000), van Leusen (1994, to appear) and van der Sandt (1991, 2003) it can be implemented in a natural way in a dynamic theory of discourse interpretation.

2 Denials

2.1 Denial versus assertion

Van der Sandt(1991) proposed a theory of assertion and denial in terms of their discourse function. In this paper he argued there that there is no inherent connection whatsoever between the concepts of denial and negation. Instead this theory explained the semantic and pragmatic properties of denials in terms of their discourse effects. The theory comprises proposition denials, presupposition denials, implicature denials and Horn’s style and register cases, that is it aimed to give a unified account of standard proposition denials and the marked cases which Horn labeled ‘metalinguistic negation’. This theory adopts Horn’s (1985, 1989) observation that denials can be used to reject an utterance of a previous speaker for whatever reasons. As Horn points out, a speaker may simply object to its truth or reject it in virtue of the presuppositions associated, the implicatures invoked or other inferences of non-truth-conditional nature. This account diverges from Horn’s in generalizing the latter to standard proposition denials, and by rejecting his distinction between a standard truth-functional operator for the unmarked

cases and a non-truth-functional metalinguistic device for the marked ones. On Horn's account the well-known truth-functional operator is found in negative assertions and proposition denials, while his non-truthfunctional metalinguistic device is taken to be an operator which does not apply to sentences but to utterances. This boils down to equating the notions of denial and negation, results in an ambiguity in the negation operator and forces us to account for the standard unmarked cases in a different way. The alternative divorces the semantic contribution of the negation operator from its discourse effects and thus separates the semantic from the pragmatic aspects.

We would like to stress that both assertion and denial are concepts of speech act theory and that both notions should thus be explained in terms of their discourse function. The essential function of assertion is to introduce new information. The function of a denial is to object to a previous utterance. And the utterance objected to may have been made by means of a positive or negative sentence. So, depending on the polarity of the utterance objected to, a denial may be a negative or a positive statement. Thus while (1b) can naturally be used as a denial of (1a), (1a) can equally naturally be used as a denial of (1b):¹

- (1) a. Herb is tolerant.
 b. Herb is not tolerant.

Negation on the other hand is an operation on sentences. Negative sentences will thus always contain some sign of negation. And the sentence resulting from applying the negation operator can, of course, be uttered with assertoric force. It is thus essential to distinguish between assertions of negative sentences and denials. The defining characteristic of assertions is that they introduce new information. They are purely incremental in that the context resulting from its utterance is augmented with the information conveyed. They can moreover occur naturally in isolation. Denials on the other hand always constitute objections to utterances of a previous speaker thereby involving a correction operation on contextual information. They are not incremental in the sense assertions are, nor can they naturally occur

¹The difficulty of making sense of denials as negative statements comes out clearly in the following remark by Frege

... , it is by no means easy to state what is a negative judgment (thought). Consider the sentences "Christ is immortal", "Christ lives for ever", "Christ is not immortal", "Christ does not live for ever". Now which of the thoughts here is affirmative, which negative? Frege (1918)

in isolation. If processed as the first sentence of a discourse (1a) or (1b) will not be interpreted as a denial but as a straightforward assertion. However, if uttered after (1a) sentence (1b) will be interpreted as a denial of a positive sentence and when uttered after (1b) (1a) will be interpreted as the denial of a negative sentence. Thus since the positive (1a) can naturally be used as a denial of (1b), it will be clear that a denial doesn't need to contain a negation sign.

2.2 Marked denials

Denials come in many varieties. Two examples of 'positive' denials are given under B. We will see below that positive denials exhibit exactly the same characteristics as their negative counterparts. And as Horn showed, they may be used to affect whatever part of the information conveyed by the utterance objected to. The propositional denials under B are the unmarked cases. The objection of the speaker concerns the truth of the propositions expressed. The denials in C through E are marked in that the objections of the speaker concern some part of the previous message which need not be truth-conditional in nature.

A. Assertions of negative sentences

- (2) Mary is unhappy.
- (3) Mary is not happy.
- (4) It does not matter that Mary read your letters.

B. 'Propositional' denials

- (5) Mary is not happy. (as a reaction to the utterance of 'Mary is happy')
- (6) Mary is happy. (as a reaction to the utterance of (2) or (3))
- (7) It does matter that Mary read my letters. (as a reaction to the utterance of (4))

C. Presuppositional denials

- (8) The king of France is not bald—France does not have a king
- (9) Virginia cannot know that the earth is flat.
- (10) John did not stop smoking, he never smoked.

D. Implicature denials

- (11) It is not possible, it is necessary that the pope is right.
- (12) That haggis is not good, it is excellent.
- (13) That wasn't a lady I kissed last night—it was my wife.

E. A variety of connotations (conventional implicature, style, register)

- (14) That is not a steed—it's a horse.
- (15) Grandma did not kick the bucket—she passed away.
- (16) They did not f*%\$ (engage in sexual intercourse etc.)—they made love.

2.3 Some linguistic facts

Negations in denials do not allow for lexical incorporation. While (8) and (11) are marked, but naturally interpretable, (17) and (18) amount to sheer contradiction:

- (17) ?It is impossible, it is necessary that the pope is right.
- (18) ?The king of France is unhappy—France does not have a king.

And note furthermore that positive and negative polarity elements exhibit the distribution that is predicted for simple assertoric sentences:

(i) *Denials containing negative morphemes accept positive polarity elements:*

- (19) John does NOT still live in Paris—he did live there but has moved now to his girlfriend's in Lyon. (propositional denial)
- (20) John does NOT still live in Paris—he has never set foot in France (presuppositional denial)
- (21) Johnny did not eat SEVERAL cookies—he ate them all (implicature denial)

(ii) *'Positive' denials (denials without a negative element) can accept negative polarity elements:*

- (22) It DOES matter that my bunny is dead.
- (23) Virginia DOES mind that her bunny has died.

Note again that none of these sentences is interpretable as the first utterance in a discourse. They all evoke a strong ‘echo’. (19) through (21) suggest that the corresponding non-negative sentence has been uttered just before, (23) and (23) that their negated counterparts have just been uttered.

These examples are all clear exceptions to the rule that negative polarity elements require negation for their carrier sentence to be acceptable and that sentences containing positive polarity elements don’t accept negation. Note first that positive polarity elements are equally acceptable in proposition, presupposition and implicature denials:

(24) John did not eat SOME cookies (he ate them all).

(25) Mary does NOT still beat her donkey (she has never beaten it).

(26) Clara does not feel unHAPPY (she feels miserable).

Note further that, even when we omit the clarificatory continuations, none of these sentences allows for an assertoric interpretation. An interpretation of (24) as the assertion of a negative sentence is excluded. And in (26) double negation does not hold.

Similar observations can be made with respect to sentences containing negative polarity elements.

(27) It does not matter that Mary has read my letters.

(28) Johnny did not pick any of the flowers.

While neither of these negative sentences can be interpreted as an echoic denial, a sentence containing a negative polarity element but lacking negation can only be interpreted as a rejection of a previous statement as (23) illustrates.

The proper conclusion seems to be that the phenomenon is in principle independent of presupposition denial or marked negation. Polarity reversal is a phenomenon attached to denials in general and an explanation is not difficult to find.

The relevant difference is a difference of use. It is the difference between the use of a negative sentence to convey new information and its use as a denial of a previous utterance. As I stressed before the defining characteristic of denials is that they refer to and reject a previous utterance. They simply retain the polarity of the sentence they take up or echo.

2.4 A semantic view: shifting denotations

Van der Sandt (1991, 2003) gives a mechanism in a Stalnaker-type framework to locate and remove the information conveyed by a previous utterance in a discourse in order to account for the non-incremental behavior of denials in discourse. Though many sentences can both be used with assertoric or denial force some only allow an interpretation as denial. Sentence (29a) and (29b) are cases in point. A denial needs some object to deny and this object normally is an utterance made by the previous speaker. Thus (29b) and (30b), which do not have an assertoric use will naturally occur in contexts in which the corresponding a-sentences have been uttered (or at least suggested) and are very odd indeed, if uttered out of the blue.

- (29) a. c_1 A: It is possible that the pope is right.
b. c_2 B: It is not POSSIBLE, it is NECESSARY that the pope is right.
- (30) a. c_1 A: The king of France is bald.
b. c_2 B: The king of France is NOT bald—France does not have a king.

By uttering (29b) the speaker rejects (29a) on the grounds that it conveys the implicature that it is not necessary that the pope is right. By his utterance of (30b) he objects to the utterance of (30a) because this utterance presupposes that there is a king of France. The important point to note is that the implicature objected to is *not* an implicature invoked by (29b), but the implicature conveyed by , i.e. the *previous* utterance. The first part, which is the denial proper, takes up or echoes the implicature invoking utterance, the the continuation of corrector makes clear that the reason for the rejection does not concern its propositional content, but the falsity of the implicature conveyed. We observe the same in (30b). The presupposition objected to is not a presupposition associated with this sentence, but the presuppositional information associated with the previous utterance. Again the utterance of the previous speaker is taken up or echoed in the first conjunct, the denial, the reason for the rejection, falsity of its presupposition, is given in correcting continuation.

In standard semantics $\|\neg\varphi\|_c$ will be computed in terms of the value φ has in c . But in the examples at issue the embedded occurrence of φ does not just function as a component sentence whose value has to be computed in the standard way with respect to the context in which it is uttered. The sentence uttered and, concomitantly, the information conveyed by its

utterance is taken up or echoed from the previous one. So if we take seriously the idea that by denying an utterance a speaker can object to *any* type of information conveyed by it, there is no need to stick to the assumption that the semantic value of $\neg\varphi$ in a context should always be computed in terms of the value φ would have had if it had been uttered here. From a semantic point of view the obvious object to assign is the *full informative content* of the previous utterance. This comprises the contribution of presuppositions, implicatures and other non-truthconditional inferences. Negation may thus be taken to apply to the sum of the propositional content and all information which is conveyed by non-truthconditional means. Under such an analysis we don't need to analyse (29b) or (30b) by means of a new negation operator, be it Horn's non-truthfunctional device or some presupposition cancelling operator for (30b).

This is easy to see. Consider (29a) again. By his utterance in c_1 A states that it is possible that the pope is right and implicates that this is not necessarily so. Thus, if we assign to the content of B's denial the informative content of the previous utterance instead of the proposition that would be expressed by *It is possible that the pope is right* in c_2 , B's utterance will get an interpretation which can be paraphrased as follows:

$$(31) \quad \neg [\Box \text{ the pope is right} \wedge \neg \text{ it is necessary that the pope is right}] \\ \wedge \Box \text{ the pope is right}$$

This simply conveys that it is necessary that the pope is right and rejects all the information conveyed by the previous utterance. We will sketch a formal account of such a solution in section 3.4 to 3.6.

3 Denials in DRT

3.1 Anaphora resolution in DRT

Before we present our account of denial formally in an extension of Discourse Representation theory, we first want to give a short sketch of the way anaphoric expressions are resolved in DRT and show why the standard accommodation mechanism is unsuited to treat the phenomenon of presuppositional and other marked varieties of denial.

The anaphoric account of presuppositions views presuppositional expressions as anaphoric expressions that should be resolved in discourse. Functionally they are on a par with pronouns. They refer back to and should link up with an antecedent that has previously been established in an evolu-

ing discourse. But presuppositional expressions distinguish themselves from pronouns or other types of semantically unloaded anaphors in one major respect. Presuppositional expressions carry information and have descriptive content. The information they carry does a double duty. In the binding process the descriptive content of a presuppositional anaphor has a disambiguating role. It may enable the hearer to select an antecedent out of a number of possible candidates. With respect to accommodation their information content has an even more important role. If no antecedent is available, it gives presuppositional expressions the capacity to establish an accessible antecedent by means of a default process of filling in information which may be implicitly assumed but which has not been explicitly introduced in the DRS established thus far. Faced with a presupposition-inducing utterance the hearer will first try to bind the presuppositional expression to a suitable antecedent. If this strategy fails the hearer will fill in the missing information so as to establish an accessible antecedent after all.

The following examples illustrate both the binding and the accommodation mechanism:

(32) If Sally has a dog, her dog will be a happy animal.

(33) If Sally is out, her dog barks.

Adopting Beaver’s notation to encode presuppositional material by a special condition the presuppositional anaphor *Mary’s/her dog* comes out as follows: $\partial[z: \text{dog}(z), \text{has}(x,z)]$. Let us assume that the initial context is empty. Assuming furthermore that the presupposition induced by the proper name has been dealt with and abstracting from details, the DRS constructed for (32) can be represented as follows:

(34) $[x: \text{Sally}(x), [y: \text{dog}(y), \text{has}(x,y)] \rightarrow [\partial[z: \text{dog}(z), \text{has}(x,z)], \text{happy-animal}(z)]]$

Note that this DRS is provisional in the sense that it contains the representation of ‘her dog’ as an unresolved anaphoric expression. This expression will search for an appropriate antecedent to link up with. Here the protasis of the conditional provides an appropriate antecedent. The presuppositional expression will be bound to this pre-established antecedent and the information triggered will thus be absorbed by its target. This yields (35) as the resulting DRS:

(35) $[x: \text{Sally}(x), [y: \text{dog}(y), \text{has}(x,y)] \rightarrow [: \text{happy-animal}(y)]$

This correctly predicts that by his utterance of (32) a speaker does not presuppose that Sally has a dog. Resolution proceeds differently in (33). The initial DRS for this sentence looks as follows:

$$(36) \quad [x: \text{Sally}(x), [: \text{out}(x)] \rightarrow [\partial[y: \text{dog}(y), \text{has}(x,y)], \text{bark}(y)]]$$

Again the resolution mechanism will search for an appropriate antecedent first checking the protasis of the conditional and subsequently the main context. But now the search will fail. Note, however, that the sentence will be felicitous in a context which contains the information that Sally has a dog. A co-operative speaker will thus accommodate the presuppositional material. Since, as a general rule, accommodation will take place as high as possible, the presupposition will end up in the main context thus yielding (37):

$$(37) \quad [x, y: \text{Sally}(x), \text{dog}(y), \text{has}(x,y), [: \text{out}(x)] \rightarrow [: \text{bark}(y)]]$$

This correctly captures the meaning of (33).

3.2 Non-global accommodation

Accommodation will preferably take place in the main context but threatening inconsistency or pragmatic infelicity of the resulting structure may force us to accommodate the presuppositional material in some subordinate context. The first happens in (38) and the second in (39):

(38) Sally has no dog, so it was not Sally's dog that bit her neighbour.

(39) Maybe Sally has no dog, but it is also possible that her dog is in hiding.

(40) and (41) illustrate that neither (38) nor (39) is acceptable in a context that contains the information that Sally has a dog:

(40) ?Sally has a dog. . . Sally has no dog, so it was not Sally's dog that bit her neighbour.

(41) ?Sally has a dog. . . Maybe Sally has no dog, but it is also possible that her dog is in hiding.

Consider first (38) . Once the first conjunct has been interpreted and the information that Mary has no dog has been established in the discourse structure, subsequent accommodation of the presuppositional information will result in a contradictory structure. So the default strategy of accommo-

ation into the main context is blocked. Accommodation will now take place one level lower, that is under the scope of the negation operator. Processing (42) thus will thus resolve it to (43):

$$(42) \quad [x: \text{Sally}(x), \neg [y: \text{dog}(y), \text{has}(x,y)], \neg[\partial[z: \text{dog}(z), \text{has}(x,z)], \text{bit-neighbour}(z)]]$$

$$(43) \quad [x: \text{Sally}(x), \neg[y: \text{dog}(y), \text{has}(x,y)], \neg[z: \text{dog}(z), \text{has}(x,z), \text{bit-neighbour}(z)]]$$

As in (38) the presupposition of (39) will be resolved under the scope of the embedding operator. Again accommodation in the main context is blocked. Though, in this case, accommodation would not result in plain contradiction, it would nevertheless violate Grice's Quantity principle. The presupposition is thus accommodated locally, which yields (44) as the final representation:

$$(44) \quad [x: \text{Sally}(x), \diamond[: \neg[y: \text{dog}(y), \text{has}(x,y)], \diamond [z: \text{dog}(z), \text{has}(x,z), \text{in-hiding}(z)]]]$$

In the examples just given accommodation acts as a strategy to adjust the representation structure under construction. If the context of utterance does not contain an appropriate antecedent for a presuppositional expression the algorithm will try to construct one and will be able to do so in view of the descriptive content associated with the trigger. Viewed this way accommodation thus acts as a repair strategy intended to ensure interpretation even if a presuppositional anaphor cannot be bound. We may however look at this process from a different point of view: the accommodation mechanism may be viewed as a process which both generates and constrains the scope of presuppositional anaphors.

Let us return to the first conjunct of (8) and observe how the algorithm yields the wide and narrow scope readings for presuppositional expressions.

$$(45) \quad \text{The king of France is not bald.}$$

Assuming that the incoming DRS is empty the initial structure is (46):

$$(46) \quad [:\neg[\partial[x: \text{KF}(x)], \text{bald}(x)]]$$

The structure does not provide an antecedent for the presuppositional expression. So the latter has to be accommodated. The structure provides two accommodation sites. Accommodation may ensue either globally in the main context or it will take place locally in the subordinate structure. The first option produces (47a), the second (47b).

- (47) a. $[x; KF(x), \neg[:bald(x)]]]$
 b. $[: \neg[x: KF(x), bald(x)]]]$

Given the preference for accommodation as high as possible (47a) is the default option and will *ceteris paribus* be preferred. However in (8) where it is already stated in the second conjunct that there is no king of France, accommodation at top level would be blocked in view of inconsistency of the resulting structure and (47b) would be the only solution. The full representation is of ?? is thus (48).

- (48) $[: \neg[x: KF(x), bald(x), \neg[x: KF(x)]]]$

This structure is equivalent to (47b). At first sight the accommodation mechanism thus seems to yield the same result as the echo-analysis.² This explanation is not tenable, however. We had to assume that (8) was uttered in an empty context. But as we already pointed out a couple of times, the typical feature of such utterances is that they require a context in which the non-negative sentence has been uttered just before, that is a context as in (30b). And with respect to an incoming context that contains the offensive material the sentence cannot even be processed in view of the fact that this would result in a plain contradiction. The explanation thus does not capture the fact that sentences like (30b) can not occur in isolation and can only be uttered with ‘denial force’. It puts presupposition denials on a par with cases like (39) where local accommodation has a very different function and, last but not least, by relying on the mechanism of presupposition resolution the analysis does not generalize to other types of marked and unmarked denials. A proper analysis thus has to rely on a dialogue system and has to incorporate an account of the non-monotonic update effects that are required to process such denials in the first place.

3.3 Dialogue

In section 2.4 we sketched the outline of an account which does not only generalize to different kinds of denials but also accounts for the non-monotonic update effects.³ An implementation of this account in DRT requires some minor extensions to standard DRT; we need to keep track of who said what and when in a dialogue in order to locate and remove a previous speaker’s

²See Geurts (1998) for a defense off this analysis with respect to presuppositional denials.

³See (van der Sandt 1991) for details

contribution. We let a discourse be a sequence of sentences, $\sigma_1, \dots, \sigma_n$.⁴ The first addition to the syntax of the DRS language is harmless: we index every DRS condition and reference marker with a natural number specifying the sentence σ_i it originated from.⁵

Our goal is now to incrementally build DRSs, $\varphi_1, \dots, \varphi_n$, representing the various stages of the ongoing discourse. We assume a given background representation φ_0 as starting point for the incrementation process.

3.4 Star conditions and reverse anaphora

In the following we will assume that whenever an utterance is analyzed as a denial of a previous utterance, this denial is not further parsed, but leaves a simple negated \star -condition ($\neg[\star : \star]$) in the DRS. DRS-construction now proceeds as follows. We first construct a preliminary sentence DRS from the parse of the sentence and merge it with the background DRS. The presuppositional resolution mechanism we sketched in section 3.1 will then bind or accommodate the unresolved presuppositions and other anaphoric expressions⁶. In the case of an assertoric utterance the output of this process is a new DRS which monotonically accumulates the new information conveyed by the utterance.

However, if the utterance under consideration gives rise to a \star -condition, we resolve it by a mechanism we call *reverse anaphora*. This mechanism collects all material originating from the previous utterance and *moves* it to the position of the \star . Reverse anaphora thus has a non-monotonic effect on the discourse structure established: the contribution of the previous utterance is removed from the main DRS and the material it originally introduced ends up under the scope of the negation introduced by the denial.⁷

3.5 Examples I

The following example of a presupposition denial illustrates the procedure in some detail:

⁴We will sometimes use the terms ‘utterance’ and ‘sentence’ rather loosely. The idea behind our terminology is that an utterance can be conceived of as a sentence combined with a representation of the *context*, where our notion of context comprises both a DRS representing the common ground and a Kaplanian context specifying the actual world, the speaker and the time of the sentence under discussion.

⁵Who said what and when can now be encoded in DRS conditions like *speaker*($x,37$) and *time*($t,37$), meaning that x uttered σ_{37} at time t .

⁶See van der Sandt (1992) and Geurts (1999) for detailed expositions

⁷Cf. the account of Levinson (2000) who calls this process *quasi-anaphora*

- (49) σ_1 The King of France walks in the park.
 σ_2 No, he doesn't,
 σ_3 France doesn't have a king.

We assume that the background φ_0 is empty. The presuppositional expression of σ_1 thus has to be accommodated. We denote the algorithms responsible for building preliminary sentence DRSs, resolution, and reverse anaphora, as **Prel**, **Res**, and **RA** respectively. \oplus is the merge operator. **Prel**(σ) is thus the preliminary DRS that is constructed out of the parse of σ . $\varphi \oplus \mathbf{Prel}(\sigma)$ is the merge of the representation of σ with the incoming DRS φ , and **Res**($\varphi \oplus \mathbf{Prel}(\sigma)$) denotes the resolved structure. In case a structure contains an \star -condition we apply the **RA**-algorithm.

- **Prel**(σ_1) =
 $[: \partial [x_1 : \text{King of France}_1(x)], \text{walk in park}_1(x)]$
- $\varphi_1 = \mathbf{Res}(\varphi_0 \oplus \mathbf{Prel}(\sigma_1)) =$
 $[x_1 : \text{King of France}_1(x), \text{walk in park}_1(x)]$
- $\varphi_1 \oplus \mathbf{Prel}(\sigma_2) =$
 $[x_1 : \text{King of France}_1(x), \text{walk in park}_1(x), \neg_2 [\star : \star]]$
- $\varphi_2 = \mathbf{RA}(\mathbf{Res}(\varphi_1 \oplus \mathbf{Prel}(\sigma_2))) =$
 $[x_1 : \text{King of France}_1(x), \text{walk in park}_1(x),$
 $\neg_2 [x_1 : \text{King of France}_1(x), \text{walk in park}_1(x)]]$
- $\varphi_3 = \mathbf{Res}(\varphi_2 \oplus \mathbf{Prel}(\sigma_3)) =$
 $[: \neg_2 [x_1 : \text{King of France}_1(x), \text{walk in park}_1(x)],$
 $\neg_3 [x_3 : \text{King of France}_3(x)]]$

The upshot is that the final interpretation, φ_3 , is equivalent to the predicate logical formula $\neg \exists x [\text{KF}(x) \wedge \text{walk}(x)] \wedge \neg \exists x [\text{KF}(x)]$ which is easily seen to be equivalent to the intuitively correct $\neg \exists x [\text{KF}(x)]$.

The resolution of the following example where σ_1 is rejected by σ_2 in view of the implicature invoked by the former, runs analogously. We assume that the existence of the pope has already been established in the incoming context.

- (50) σ_1 It is possible the Pope is right.
 σ_2 No, it's not POSSible,
 σ_3 it's NEcessary that he's right.

- $\varphi_0 = [x : \text{pope}(x)]$

- $\mathbf{Prel}(\sigma_1) = [: \partial[x_1 : \text{pope}_1(x)], \diamond_1[: \text{right}_1(x)], \neg\square_1[: \text{right}_1(x)]]$
- $\varphi_1 = \mathbf{Res}(\varphi_0 \oplus \mathbf{Prel}(\sigma_1)) = [x_0 : \text{pope}_0(x), \diamond_1[: \text{right}_1(x)], \neg\square_1[: \text{right}_1(x)]]$
- $\mathbf{Prel}(\sigma_2) = [: \neg_2[\star : \star]]$
- $\psi = \mathbf{Res}(\varphi_1 \oplus \mathbf{Prel}(\sigma_2)) = [x_0 : \text{pope}_0(x), \diamond_1[: \text{right}_1(x)], \neg\square_1[: \text{right}_1(x)], \neg_2[\star : \star]]$
- $\varphi_2 = \mathbf{RA}(\psi) = [x_0 : \text{pope}_0(x), \diamond_1[: \text{right}_1(x)], \neg\square_1[: \text{right}_1(x)], \neg_2[: \diamond_1[: \text{right}_1(x)], \neg\square_1[: \text{right}_1(x)]]]$
- $\mathbf{Prel}(\sigma_3) = [: \partial[z_3 : \text{masc}_3(z)], \square_3[: \text{right}_3(z)]]$
- $\varphi_3 = [x_0 : \text{pope}_0(x), \neg_2[: \diamond_1[: \text{right}_1(x)], \neg\square_1[: \text{right}_1(x)]], \square_3[: \text{right}_3(x)]]$

The final structure is equivalent to the predicate logical formula $\exists x [\text{pope}(x) \wedge \square \text{right}(x)]$. This is as it should be. The denial is not contradictory as would be predicted under a straightforward translation. The contextual material survives, the contribution of the previous speaker is removed and the second conjunct of the denial absorbs the first one.

3.6 Problems

The solution given in the previous section is not without problems, however. Strawson's famous (51) illustrates that we cannot always just remove whatever is conveyed by the offensive utterance:

- (51) a. A man jumped off the bridge.
b. He didn't jump, he was pushed.

Strawson (1952)

When processing (52b) we need to retain the discourse referent introduced for *the man* in (52a) in order to bind the anaphoric pronoun.

Geurts (1998) argued against the strategy of removing the *full* contribution of the utterance objected to, pointing out that the problem is a general one. Consider an example where several presuppositions are involved.

- (52) a. The King of France knows I quit smoking.
b. No he doesn't, France doesn't have a king.

The presupposition objected to is that France has a king and should be removed from the discourse record. The presupposition that I quit smoking seems to pass unharmed. We thus need to allow for the possibility that the final representation retains the latter information.

Another argument against removing the full contribution of a sentence is the fact that speakers sometimes overtly acknowledge parts of the last utterance’s contribution while rejecting other parts. A case in point is (53) where the second speaker confirms that the person referred to is nice, but denies the implicature evoked by the use of the indefinite term ‘a lady’.⁸

- (53) a. Now, THAT’s a nice lady
 b. Yes, she is, but she’s not a LAdy, she’s my Wife

In order to account for examples like (53) we need to represent and *interpret* different types of information conveyed by the very same utterance separately, thus enabling us to remove specific types information while retaining others.⁹

4 Using layers

We will use layered representations in order to *direct* the reverse anaphora module at the *offensive* material only. This requires a further extension of DRT which enables us to both encode and interpret the various kinds of information. We adopt Layered DRT (or LDRT for short).

⁸Adapted from the classic:

A: That was a nice lady I saw you with last night.

B: That wasn’t a LAdy, that was my Wife

Note that by his utterance B certainly does not imply that his wife is not a lady as a purely truth-functional analysis would predict. Grice (1989: 37) remarks: ‘Anyone who uses a sentence of the form *X is meeting a woman this evening* would normally implicate that the person to be met was someone other than X’s wife, mother, sister, or perhaps even close platonic friend.’

⁹In the next section we present a solution which relies on layered representations. An alternative is to exploit the information structure of a sentence. Note that the denial part of an utterance as ‘That wasn’t a LADY I kissed last night. It was my wife’ invokes a focal background λx [I kissed x last night]. Assuming that focal backgrounds can be strengthened to existential presupposition, this information would project out to the main context thus accommodating the information that I kissed someone last night. The algorithm in the previous section would then just remove the information that the person kissed is my wife. On this account all non-focal information would thus survive. Such a solution needs a careful analysis of the rather complicated information structure of the various kinds of denials and will be explored in a follow up paper.

4.1 LDRT's syntax

The syntax of LDRT is like that of standard DRT, except that every discourse referent and DRS condition is paired with a layer label, specifying which kind of information it encodes. For the purpose of this paper we index every label with a number corresponding to the number of the sentence from which it originated (and 0 for background information). We will here restrict ourselves to the set of labels Λ_0 given in (54):

- (54) $\Lambda_0 = \{0, fr_1, \dots, fr_n, acc_1, \dots, acc_n, imp_1, \dots, imp_n, pr_1, \dots, pr_n\}$
- $fr_i \approx$ the Frege layer, what is “said” in the contribution of σ_i
 - $acc_i \approx$ accommodated material coming from p_i -layer
 - $imp_i \approx$ implicature invoked by σ_i
 - $pr_i \approx$ presupposition triggered by σ_i

The primitive symbols of our LDRT language fragment are:

- (55)
 - a set \mathcal{X} of reference markers
 - (for some n) a set $\mathcal{P}red^{(n)}$ of n -place predicates
 - the set Λ_0 of layer labels

The syntactic rules are as follows:

- (56)
 - if $x \in \mathcal{X}$, $L \subseteq \Lambda_0$, then $x_L = \langle x, L \rangle \in \mathcal{X} \times \wp(\Lambda)$ is a labeled reference marker
 - if $P \in \mathcal{P}red^n$, $L \subseteq \Lambda_0$, then P_L is a labeled predicate
 - if $x, y \in \mathcal{X}$, $L \subseteq \Lambda_0$, then $x =_L y$ is a labeled condition
 - if $x_1, \dots, x_n \in \mathcal{X}$, P_L a labeled n -place predicate, then $P_L(x_1, \dots, x_n)$ is a labeled condition
 - if φ and ψ are labeled conditions, $L \subseteq \Lambda_0$, then $\neg_L \varphi$, $\varphi \vee_L \psi$, and $\varphi \Rightarrow_L \psi$ are labeled conditions
 - if U is a set of labeled reference markers and Con a set of labeled conditions, then $\langle U, Con \rangle$ is an LDRS (notation: $\varphi = \langle U(\varphi), Con(\varphi) \rangle$)

The following is an example of a sentence and its preliminary LDRS representation:¹⁰

- (57)
 - $\sigma_1 =$ It is possible the Pope is right.
 - $[x_{pr_1} : \text{pope}_{pr_1}(x), \diamond_{fr_1} [: \text{right}_{fr_1}(x)], \neg \square_{imp_1} [: \text{right}_{imp_1}(x)]]$

¹⁰We will use $\neg \square_{imp_1} [: \text{right}_{imp_1}(x)]$ as a notational shorthand for $\neg_{imp_1} [: \square_{imp_1} [: \text{right}_{imp_1}(x)]]$

This representation encodes the fact that the definite description ‘the Pope’ has a presuppositional status. Given an individual that satisfies this predicate the classical truthconditional (Fregean) contribution is that *he* is possibly right, and with a typical utterance of σ_1 the speaker furthermore conveys the implicature that *he* is not necessarily right. The crucial feature of the LDRT representation is that all conditions inhabit their own layer but nevertheless employ one and the same reference marker; the presuppositional, assertoric and implicature expressions are all linked to the same discourse referent, thus capturing the fact that they all attribute some property to the same individual.

4.2 LDRT’s semantics

The idea of LDRT’s semantics is that the truth definition is relativized to a set of labels, which means that we ignore all material labeled otherwise. The truth definition is thus only a minor extension of the standard definition of truth for DRSs in terms of verifying or truthful embeddings (Kamp and Reyle 1993; Geurts 1999), requiring only two small adaptations: First, since ignoring certain layers often causes the remaining layers to form only an incomplete representation, missing perhaps some essential reference markers, the truth definition should be partial, i.e. for some choices of layer sets a truthvalue is undefined. In the following we will use \uparrow and \downarrow to abbreviate undefinedness and definedness respectively.

Secondly, since we are going to talk about propositions, we need at least intensional models for interpreting our LDRT language fragment, i.e. we need possible worlds:

- (58) An *intensional model* is a quadruple, $\langle D, W, R, I \rangle$, with:
- a. D a set of individuals
 - b. W a set of possible worlds
 - c. $R \subseteq W^2$, an accessibility relation on possible worlds
 - d. I an interpretation function mapping basic predicates onto their intensions

In (60) we give our partial truth-definition with respect to such models, but first we introduce some notational shorthands:

- (59) For $L \subseteq \Lambda_0$, an LDRS φ , and embedding functions f, g , define:
- a. $U_L(\varphi) = \{x \in \mathcal{X} \mid \exists K[K \cap L \neq \emptyset \wedge x_K \in U(\varphi)]\}$
 - b. $Con_L(\varphi) = \{\psi \mid \psi \text{ is an LDRS condition} \wedge \exists K[K \cap L \neq \emptyset \wedge \psi_K \in Con(\varphi)]\}$

- c. $f[X]g = f \subseteq g \wedge Dom(g) = Dom(f) \cup X$
- (60) Let $\mathcal{M} = \langle D, W, R, I \rangle$ be an intensional model. Let f be a partial embedding of the set of reference markers into D , $L \subseteq \Lambda_0$, $w \in W$, and φ an LDRS.

$$\begin{aligned}
\text{a. } \|\varphi\|_{L,w}^f & \left\{ \begin{array}{l} = \{g \mid f[U_L(\varphi)]g \wedge \forall \psi \in Con(\varphi) \\ \quad [\|\psi\|_{L,w}^g = 1]\} \quad \text{if } \exists g[f[U_L(\varphi)]g \wedge \\ \quad \quad \quad \forall \psi \in Con(\varphi) \\ \quad \quad \quad [\|\psi\|_{L,w}^g \downarrow]] \\ \uparrow \\ \text{otherwise} \end{array} \right. \\
\text{b. } \|x =_K y\|_{L,w}^f & \left\{ \begin{array}{l} 1 \quad \text{if } K \cap L = \emptyset \text{ or} \\ \quad (x, y \in Dom(f) \text{ and } f(x) = f(y)) \\ 0 \quad \text{if } K \cap L \neq \emptyset, x, y \in Dom(f), \\ \quad \quad \quad \text{and } f(x) \neq f(y) \\ \uparrow \\ \text{otherwise} \end{array} \right. \\
\text{c. } \|P_K(x_1, \dots, x_n)\|_{L,w}^f & \left\{ \begin{array}{l} 1 \quad \text{if } K \cap L = \emptyset \text{ or} \\ \quad (x_1, \dots, x_n \in Dom(f) \text{ and} \\ \quad \langle f(x_1), \dots, f(x_n) \rangle \in I(P)(w)) \\ 0 \quad \text{if } K \cap L \neq \emptyset, \\ \quad \quad \quad x_1, \dots, x_n \in Dom(f), \text{ and} \\ \quad \quad \quad \langle f(x_1), \dots, f(x_n) \rangle \notin I(P)(w) \\ \uparrow \\ \text{otherwise} \end{array} \right. \\
\text{d. } \|\neg_K \psi\|_{L,w}^f & \left\{ \begin{array}{l} 1 \quad \text{if } K \cap L = \emptyset \text{ or } \|\psi\|_{K \cap L, w}^f = \emptyset \\ 0 \quad \text{if } K \cap L \neq \emptyset, \|\psi\|_{K \cap L, w}^f \downarrow, \text{ and} \\ \quad \quad \quad \|\psi\|_{K \cap L, w}^f \neq \emptyset \\ \uparrow \\ \text{otherwise} \end{array} \right. \\
\text{e. } \|\psi \vee_K \chi\|_{L,w}^f & \left\{ \begin{array}{l} 1 \quad \text{if } \|\psi\|_{K \cap L, w}^f \downarrow, \|\chi\|_{K \cap L, w}^f \downarrow, \\ \quad \quad \quad \text{and } \|\psi\|_{K \cap L, w}^f \cup \|\chi\|_{K \cap L, w}^f \neq \emptyset \\ 0 \quad \text{if } \|\psi\|_{K \cap L, w}^f = \|\chi\|_{K \cap L, w}^f = \emptyset \\ \uparrow \\ \text{otherwise} \end{array} \right. \\
\text{f. } \|\psi \Rightarrow_K \chi\|_{L,w}^f & \left\{ \begin{array}{l} 1 \quad \text{if } \|\psi\|_{K \cap L, w}^f \downarrow \text{ and } \forall g \in \|\psi\|_{K \cap L, w}^f : \\ \quad \quad \quad \|\chi\|_{K \cap L, w}^g \downarrow \text{ and } \|\chi\|_{K \cap L, w}^g \neq \emptyset \\ 0 \quad \text{if } \exists g \in \|\psi\|_{K \cap L, w}^f : \|\chi\|_{K \cap L, w}^g = \emptyset \\ \uparrow \\ \text{otherwise} \end{array} \right.
\end{aligned}$$

$$\text{g. } \|\Box_K \psi\|_{L,w}^f \begin{cases} 1 & \text{if } \forall w' R w : \|\psi\|_{K \cap L, w'}^f \downarrow \text{ and } \neq \emptyset \\ 0 & \text{if } \exists w' R w : \|\psi\|_{K \cap L, w'}^f = \emptyset \\ \uparrow & \text{otherwise} \end{cases}$$

Layered propositions or contents expressed by LDRSs are defined as follows:

$$(61) \quad \begin{aligned} \text{a. } \mathcal{C}_L^f(\varphi) &= \begin{cases} \{w \mid \exists g \in \|\varphi\|_{L,w}^f\} & \text{if } \exists w [\|\varphi\|_{L,w}^f \downarrow] \\ \uparrow & \text{otherwise} \end{cases} \\ \text{b. } \mathcal{C}_L(\varphi) &= \mathcal{C}_L^\emptyset(\varphi) \end{aligned}$$

This defines a wide variety of content notions at once. For example $\mathcal{C}_{\{pr_1, fr_1\}}$ ((57b)) is the proposition that the Pope is possibly right, and¹¹ $\mathcal{C}_{pr_1, imp_1}$ ((57b)) the proposition that the Pope is not necessarily right.

In order to determine e.g. \mathcal{C}_{imp_1} ((57b)), the proposition *implicated* by a sentence (the type of content we will often need), we will use a more sophisticated two-dimensional semantics, allowing us to determine such *open* propositions. Our strategy is to interpret the layers we want to evaluate, against a certain background of contextually given information, more specifically we will use a set of layers of our LDRS and a (Kaplanian) context parameter to construct an anchor, i.e. another partial embedding, to ensure definedness. In order to make this work we need a two-dimensional Kaplan-style semantics, so first we add a set of contexts C to our models:¹²

$$(62) \quad \text{A Kaplanian model } \mathcal{M} \text{ is a structure } \langle D, W, C, R, I \rangle \text{ s.t. } \langle D, W, R, I \rangle \text{ is an intensional model and } C \subseteq W.$$

Now, in order to define Kaplanian content, we take a set of layers K and evaluate an LDRS with respect to those layers and a context c . If the result is a singleton set, we take the embedding therein to provide referents in order to close of our open proposition. The final result will be a singular proposition since the originally free markers get their referents from the context, not the world of evaluation:

¹¹Leaving out subscripted and other obvious braces for convenience here and in the following.

¹²If we want to give a plausible treatment of indexicals as rigidly referring terms, we should take W to include not only the traditional full omnispacial possible world, but also smaller located situations so that we can define C as the set of ‘small’ possible worlds, viz. those with e.g. a unique speaker. This inclusion of C in W also necessitates the use of *partial* interpretation function, since in ‘big’ worlds, terms like ‘now’ or ‘here’ should be uninterpretable.

$$(63) \quad \mathcal{K}_L^{K,c}(\varphi) \begin{cases} = \mathcal{C}_L^f(\varphi) & \text{if } \|\varphi\|_{K,c}^\emptyset = \{f\} \\ \text{undefined} & \text{otherwise} \end{cases}$$

For the application of LDRT to denial we need the notion defined below as $\mathcal{C}_L^*(\varphi)$, the normal L -content if possible, but otherwise a suitable Kaplanian proposition, viz. one backgrounding/rigidifying only as many layers as is necessary to ensure definedness with respect to the actual utterance context c :

$$(64) \quad \begin{array}{l} \text{a. } \mathbf{Cl}(\varphi, L) = \text{the smallest } K \subseteq \Lambda_0 \text{ s.t. } \mathcal{K}_L^{K,c}(\varphi) \downarrow \text{ ('Closure set')} \\ \text{b. } \mathcal{C}_L^*(\varphi) \begin{cases} = \mathcal{K}_L^{\mathbf{Cl}(\varphi, L), c}(\varphi) & \text{if } \mathcal{C}_L(\varphi) \uparrow \\ = \mathcal{C}_L^f(\varphi) & \text{otherwise} \end{cases} \end{array}$$

As an example, consider again the possibly right pope of (57): we saw that $\mathcal{C}_{imp_1}((57b))$ is undefined because the implicature layer lacks a reference marker. Assuming the context of utterance is c and is such that it contains but one unique Pope, we can easily check the following:

$$(65) \quad \begin{array}{l} \text{a. } \|(57b)\|_{imp_1, w} \uparrow \text{ for all } w \\ \text{b. } \mathcal{K}_{imp_1}^{pr_1, c}((57b)) = \\ \quad \{w \in W \mid \text{the Pope of } c \text{ is not necessarily right in } w\} \\ \quad \text{(i.e. the singular proposition that the actual Pope (at the con-} \\ \quad \text{text of utterance } c) \text{ is not necessarily right)} \\ \text{c. } \mathbf{Cl}((57b), imp_1) = pr_1 \\ \text{d. } \mathcal{C}_{imp_1}^*((57b)) = \mathcal{K}_{imp_1}^{pr_1, c}((57b)) \end{array}$$

4.3 Directed reverse anaphora

The reverse anaphora algorithm depends on **Off**, a mechanism for singling out offensive material from an utterance that has been denied by a subsequent utterance. **Off** is defined as in (66), where L and K are sets of labels.

$$(66) \quad \mathbf{Off}(\varphi, K) = \text{the smallest } L \subseteq \Lambda_0 \text{ s.t. } \mathcal{C}_L^*(\varphi) \cap \mathcal{C}_K^*(\varphi) = \emptyset$$

So $\mathbf{Off}(\varphi, K)$ gives us a set of labels that, in φ , clashes with a given set K , in other words, the smallest set of layers disjoint from K that cause φ as a whole to be contradictory.

To direct the reverse anaphora mechanism in an assertion-denial-correction sequence, σ_1 - σ_2 - σ_3 (as in (49)), we again represent the contribution of σ_2 by a condition of the form $\neg_{fr_2}[\star : \star]$, as in 3.4. This however does not

suffice for **Off** to determine which layer is offensive, since there is no contradiction yet. We thus first add the layered contribution of σ_3 , causing a contradiction somewhere in our growing LDRS (say ψ). We then determine the cause of the contradiction on the basis of the *fr*-content of the correction: $\mathbf{Off}(\psi, \{fr_3\})$. The conflicting material in the offensive layer is now moved, by the modified reverse anaphora mechanism, to the place of the \star thus ending up under the negation in layer fr_2 .

Formally this comes down to the following redefinition of reverse anaphora, **RA***

$$(67) \quad \mathbf{RA}_i^*(\varphi) = \text{move } U_{\mathbf{Off}(\varphi, fr_i)} \text{ and } Con_{\mathbf{Off}(\varphi, fr_i)} \text{ from their original position in } \varphi \text{ to where the } \star\text{'s are in } \varphi \text{ (then erase the } \star\text{'s)}^{13,14}$$

Interpretation now proceeds as follows:

- If $\langle \sigma_i, \sigma_{i+1}, \sigma_{i+2} \rangle$ is an assertion-denial-correction sequence, then $\varphi_{i+1} = \mathbf{Res}(\varphi_i \oplus \mathbf{Prel}(\sigma_{i+1})) = \varphi_i \oplus [: \neg_{\{fr_{i+1}\}} [\star : \star]]$ and $\varphi_{i+2} = \mathbf{RA}_{i+2}^*(\mathbf{Res}(\varphi_{i+1} \oplus \mathbf{Prel}(\sigma_{i+2})))$
- Otherwise, $\varphi_{i+1} = \mathbf{Res}(\varphi_i \oplus \mathbf{Prel}(\sigma_{i+1}))$ and similarly for φ_{i+2}

In the next section we will illustrate the workings of the definitions given above by applying them to some selected examples.

4.4 Examples II

Consider first the example of an implicature denial, i.e. (57), we analysed in section 3.5 by means of the undirected variant:

$$(68) \quad \sigma_1 \quad \text{It is possible the Pope is right.}$$

¹³ $\varphi \oplus \varphi_{\mathbf{Off}(\varphi, \{fr_{i+2}\})} \left[[\star : \star] \mapsto \varphi_{\mathbf{Off}(\varphi, \{fr_{i+2}\})} \right]$

¹⁴Instead of moving the whole offensive layer determined by **Off** we may need an even more finegrained Reverse Anaphora algorithm moving only the smallest inconsistent subDRS within that layer. This is essentially what Van Leusen's (to appear) 'nonmonotonic updating' does in order to account for the discourse effects of denials and corrections in a compositional, monostratal variant of DRT. Something like this finer grained targetting of offensive stuff is needed to solve the problems posed by multiple accommodation (52b) and the Strawson example (51b). A definition of 'offensive material, conflicting with correction σ_i ', depending on the notion of syntactic DRS inclusion, \sqsubseteq , would have to be added:

(i) $\mathbf{OFF}(\varphi, i) =$ the \sqsubseteq -smallest subDRS ψ ,

$\psi \sqsubseteq \langle U_{\mathbf{Off}(\varphi, fr_i)}, Con_{\mathbf{Off}(\varphi, fr_i)} \rangle$, s.t.

$\mathcal{C}_{\mathbf{Off}(\varphi, fr_i)}^*(\psi) \cap \mathcal{C}_{fr_i}^*(\varphi) = \emptyset$

and **RA*** would be modified accordingly:

(ii) $\mathbf{RA}^{*i} =$ move **OFF**(φ, i) to the position of the \star 's.

- σ_2 No, it's not POSSible,
 σ_3 it's NEcessary that he's right.

We assume that the denial σ_2 pertains only to part of the content of σ_1 and that the correction σ_3 indicates that only the implicature is at stake. The step-by-step interpretation process of this dialogue according to the Directed Reverse Anaphora algorithm is shown below:

- $\varphi_0 = [x_0 : \text{pope}_0(x)]$
- $\mathbf{Prel}(\sigma_1) = [x_{pr_1} : \text{pope}_{pr_1}(x), \diamond_{fr_1}[: \text{right}_{fr_1}(x)], \neg\Box_{imp_1}[: \text{right}_{imp_1}(x)]]$
- $\varphi_1 = \mathbf{Res}(\varphi_0 \oplus \mathbf{Prel}(\sigma_1)) = [x_0 : \text{pope}_0(x), \diamond_{fr_1}[: \text{right}_{fr_1}(x)], \neg\Box_{imp_1}[: \text{right}_{imp_1}(x)]]$
- $\mathbf{Prel}(\sigma_2) = [: \neg_{fr_2}[\star : \star]]$
- $\varphi_2 = \mathbf{Res}(\varphi_1 \oplus \mathbf{Prel}(\sigma_2)) = [x_0 : \text{pope}_0(x), \diamond_{fr_1}[: \text{right}_{fr_1}(x)], \neg\Box_{imp_1}[: \text{right}_{imp_1}(x)], \neg_{fr_2}[\star : \star]]$
- $\mathbf{Prel}(\sigma_3) = [z_{pr_3} : \text{masc}_{pr_3}(z), \Box_{fr_3}[: \text{right}_{fr_3}(z)]]$
- $\psi = \mathbf{Res}(\varphi_2 \oplus \mathbf{Prel}(\sigma_3)) = [x_0 : \text{pope}_0(x), \diamond_{fr_1}[: \text{right}_{fr_1}(x)], \neg\Box_{imp_1}[: \text{right}_{imp_1}(x)], \neg_{fr_2}[\star : \star], \Box_{fr_3}[: \text{right}_{fr_3}(x)]]$
- $\mathbf{CI}(\psi, fr_3) = \{0\}$, so $\mathcal{C}_{fr_3}^*(\psi)$ is $\mathcal{K}_{fr_3}^{0,c}(\psi)$, i.e. the singular proposition that the actual Pope at the time of utterance is necessarily right (see (57))
- $\mathbf{Off}(\psi, fr_3) = \{imp_1\}$, because $\mathcal{C}_{imp_1}^*(\psi)$ is the, again singular, proposition that the actual Pope is not necessarily right one, which obviously contradicts $\mathcal{C}_{fr_3}^*(\psi)$
- $\varphi_3 = \mathbf{RA}^*(\psi) = [x_0 : \text{pope}_0(x), \diamond_{fr_1}[: \text{right}_{fr_1}(x)], \neg\Box_{imp_1}[: \text{right}_{imp_1}(x)], \neg_{fr_2}[: \neg\Box_{imp_1}[: \text{right}_{imp_1}(x)]]], \Box_{fr_3}[: \text{right}_{fr_3}(x)]]$

Note that (van der Sandt 1991) and our implementation thereof was able to handle this example, too, giving an equivalent representation as the final output. However, in the course of the resolution process it temporarily threw out the whole contribution of the assertion objected to.

The example in (53), repeated below as (69), shows that such an omni-layered removal is problematic:

- (69) σ_1 Now, THAT's a nice lady
 σ_2 Yes, she is,
 σ_3 but she's not a LAdy,
 σ_4 she's my Wife

The earlier monostratal proposal would in effect first have to somehow acknowledge that the person referred to is both nice and female with σ_2 , but then by reverse anaphora remove that information from the discourse representation along with everything else conveyed by σ_1 . The information that this person is female is then restored with the correction σ_4 , but the suggestion that she is nice does not survive. To see how the layered version handles this case, note first that this example is a little more involved than the previous ones since it features an *affirmation* or acknowledgement, σ_2 , of (part of the content of) σ_1 , before the familiar denial (σ_3) and correction (σ_4).¹⁵

- $\varphi_0 = [x_0 : \text{woman}_0(x), \text{pointed_at}_0(x)]$
 (we start with a representation of someone's pointing at a woman)
- $\mathbf{Prel}(\sigma_1) = [y_{pr_1} : \text{pointed_at}_{pr_1}(y), \text{lady}_{fr_1}(y), \text{nice}_{fr_1}(y),$
 $\text{stranger}_{imp_1}(y)]$
 (assuming the use of 'a lady' invokes the implicature that the person referred to is not a close relative of the addressee)
- $\varphi_1 = [x_0 : \text{woman}_0(x), \text{pointed_at}_0(x), \text{lady}_{fr_1}(x), \text{nice}_{fr_1}(x),$
 $\text{stranger}_{imp_1}(x)]$
- $\mathbf{Prel}(\sigma_2) = [z_{pr_2} : \text{fem}_{pr_2}(z), \text{nice}_{fr_2}(z)]$
 (affirmation is treated just like asserted content)
- $\varphi_2 = \mathbf{Res}(\varphi_1 \oplus \mathbf{Prel}(\sigma_2)) = [x_0 : \text{woman}_0(x), \text{pointed_at}_0(x),$
 $\text{lady}_{fr_1}(x), \text{nice}_{fr_1fr_2}(x), \text{stranger}_{imp_1}(x)]$
- $\mathbf{Prel}(\sigma_3) = [: \neg_{fr_3}[\star : \star]]$
 (the negative sentence σ_3 is marked as a denial)
- $\varphi_3 = [x_0 : \text{woman}_0(x), \text{pointed_at}_0(x), \text{lady}_{fr_1}(x), \text{nice}_{fr_1fr_2}(x),$
 $\text{stranger}_{imp_1}(x), \neg_{fr_3}[\star : \star]]$
- $\mathbf{Prel}(\sigma_4) = [w_{pr_4} : \text{fem}_{pr_4}(w), \text{wife}_{fr_4}(w)]$

¹⁵The formal handling of affirmations like this in the current framework necessitates among other things some minor revision of the assumed consecutive numberings in the formal definitions of section 4.3. We will not spell out the details.

- $\psi = \mathbf{Res}(\varphi_3 \oplus \mathbf{Prel}(\sigma_4)) = [x_0 : \text{woman}_0(x), \text{pointed_at}_0(x), \text{lady}_{fr_1}(x), \text{nice}_{fr_1fr_2}(x), \text{stranger}_{imp_1}(x), \neg_{fr_3}[\star : \star], \text{wife}_{fr_4}(x)]$
- $\mathbf{Off}(\psi, fr_4) = imp_1$, since $\mathcal{C}_{fr_4}^* \cap \mathcal{C}_{imp_1}^* = \mathcal{K}_{fr_4}^{0,c} \cap \mathcal{K}_{imp_1}^{0,c} = \emptyset$ (the two singular propositions in question, viz. that *that woman* (contextually, rigidly singled out by a pointing) is my wife, and that *that woman* is some attractive stranger, respectively, contradict each other)
- $\varphi_4 = \mathbf{RA}^*(\psi) = [x_0 : \text{woman}_0(x), \text{pointed_at}_0(x), \text{lady}_{fr_1}(x), \text{nice}_{fr_1fr_2}(x), \text{stranger}_{imp_1}(x), \neg_{fr_3}[: \text{stranger}_{imp_1}(x)], \text{wife}_{fr_4}(x)]$

5 Conclusion

In this paper we presented a representational account of the discourse function of denial in an extension of DRT. We treated the resolution of various kinds of denial as an anaphoric process which is similar to the standard process of presupposition and pronoun resolution in that it encodes a flow of information through the DRS under construction. The crucial difference with the standard algorithm is that this process takes place in reverse order. It inserts the information attached to the sentence objected to at the site of the denial and simultaneously performs a correction operation on the information already established in the DRS that resulted from the previous utterance. A formal implementation required an extension of the DRT apparatus. We first provided a means to keep track of who said what in a dialogue in order to locate and remove a previous contribution. This first version followed van der Sandt (1991) by removing the full contribution of a previous utterance from the discourse record. We then adopted a further extension (LDRT) to an encode and interpret various kinds of semantic and pragmatic information. This enabled us to direct the reverse anaphora mechanism to the offensive material only. In this framework we presented *directed reverse anaphora* which allowed us to direct and limit the retraction procedure to the offensive part of a previous utterance. The mechanism was able to do so by providing a means to formally interpret information that historically has been labeled pragmatic and non-truth-conditional in nature. The account has the advantage of being more general than Horn (1989) and Geurts (1998) in retaining a unified account of the propositional, implicature and presuppositional denials, providing a general semantics and accounting for the function of denials in terms of their non-monotonic discourse effects.¹⁶

¹⁶One might think that the style and register cases, discussed in Horn (1989) would escape our treatment since the information objected too does not seem propositional in

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an intuitive sense.

- (i) They didn't call the POlice—they called the poLIce.

We should remark that LDRT does allow us to account of denials like (i), by positing a layer for intonational and other surface features. However, the semantics of formal layers turns out to require heavier semantic apparatus than we have space here to develop, so we leave out examples like (i) in our treatment of denial, and refer the interested reader again to (Geurts and Maier ms).

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