Judging Unresolved Utterances in Context

PETER KRAUSE, *Institute for Computational Linguistics, Azenbergstrasse 12, 70174 Stuttgart, Germany.*
E-mail: peter@ims.uni-stuttgart.de

Abstract

A theory of judging unresolved utterances in dialogue is developed in discourse representation theory using techniques from belief revision and applied to a classical problem for the presuppositional theory of definite descriptions.[1]

1 Introduction

In this paper, a step toward a formalized solution of a basic problem from the debate on truth value gaps induced by presuppositions is taken. [9] had claimed that sentences like

EXAMPLE 1.1
The king of France is wise.

are neither true nor false, but rather truth-valueless. The problem for this theory that will be in the focus of this paper is a certain class of counterexamples against the original proposal of [9]. The following example has been given by [7].

EXAMPLE 1.2
The king of France is sitting in that chair.

This sentence should be considered in the following context. The speaker is pointing to a chair which is, for both the speaker and the hearer, visibly empty. In this case, most informants judge the utterance false, and the reaction of calling it undefined or lacking a truth-value does not come to mind easily. Nevertheless, the definite description in such an example remains presuppositional, as the projection behaviour shows.

EXAMPLE 1.3
Whenever the king of France is sitting in that chair, the chair to its right remains empty.

The existence of a king of France can be inferred from this sentence. This would not be expected if the presupposition that is normally attributed to definite description disappeared due to the predicate. What is the characteristic property of contexts in which a sentence containing an empty definite description is judged false ? [7] proposes the following analysis: a sentence containing a definite description that causes presupposition failure is false instead of indeterminate if the context supports

[1] Short version

its falsity even after it has been revised with the statement of unique existence that is presupposed by the definite description. As [11] points out, this account has to be refined in two ways. If we assume that the chair in question in example 1.2 is in fact the throne of the French monarch, and that at the time of utterance the head of state would in any case be in the place from which he or she is governing (the president's office in a republic, the throne in a monarchy), then the sentence would be predicted to be true rather than false. However, if the chair is visibly empty, the sentence would be judged false in such a situation. This can be accounted for by excluding perceptually given information from the revision process on which Lasersohn's account is based. The second problem is that there are examples that are judged false on another basis[2]:

EXAMPLE 1.4
The king of France is someone's subject.

The king of France cannot possibly be a woman (the expression *the queen of France* would have to be used instead) even if the context is revised to allow for his existence. This phenomenon can be accounted for by excluding general laws such as the meaning postulate that kings are male from revision. In this paper, I will start from the assumption that the empirical analysis of Lasersohn as refined by [11] is correct and give a technical account of it in terms of an independently motivated theory of judging utterances in dialogue. The theory is based on discourse representation theory (DRT) and dynamic semantics, presupposition justification, and a simple method for belief revision under integrity constraints. DRT is needed to account for the proper interpretation of definite noun phrases. The presupposition justification module is used to detect the cases in which a revision of the context is called for, and to bridge the gap between an unresolved sentence and one that can be judged by standard logical notions. The use of integrity constraints in belief revision accounts for the observations about the role of non-defeasible information in judging the examples after the context has been adjusted. The theory of judging utterances is applied in the formulation of an algorithm to judge unresolved sentences in context.

2 Expressing integrity constraints in DRT

In order to formulate an operation of belief contraction (and revision) that respects integrity constraints, the different kinds of information must be distinguishable from each other. In principle, there are two possibilities for achieving this. One option is to let different DRSs represent the information that is perceptually accessible information from the speech situation, the general laws and the defeasible information. Then a method for integrating and crossreferencing these different knowledge bases is needed. Secondly, and I will follow this option here because it seems technically simpler, the entire information can be represented in one DRS, but each discourse referent introduction and each condition on the top level of the DRS is prefixed by a label indicating what kind of knowledge the DRS-component expresses. Some simple functions are needed to handle the labelling. Meaningful DRSs are referentially coherent. Belief revision operations could easily destroy important anaphoric links and make the result uninterpretable if no special care is taken to avoid this problem. For instance, it must be avoided that an antecedent is removed by contraction without the

[2] the example is similar to one mentioned by von Fintel

conditions in which the discourse referent occurs free being removed as well. These are the problems that will be addressed in this section.

2.1 Basic DRT notions

The following syntactic notions will be used[3]: Labelled DRSs K with free and active variables $(fv(K), av(K))$ containing demonstrative descriptions $\delta x : K$ and definite descriptions $\iota x : K$. The top-level components are labelled with S_i (indefeasible situational knowledge), R_i (indefeasible rules), and D_i (defeasible information). The top-level components $tlc(K)$ of a DRS K are the conjunction-minimal non-embedded discourse referent introductions and conditions in K. A DRS K_1 is a proper part of another DRS K_2, written $K_1 \sqsubset_{DR} K_2$, if K_1 is the dynamic conjunction of all the top-level components of K_2 in the same order. As usual, $K' \sqsubseteq_{DR} K$ iff $K' \sqsubset_{DR} K$ or $K' = K$. The notion of test is defined as in dynamic predicate logic. An equation series is a dynamic conjunction of only equations. A DRS is called simple if it consists of atomic conditions and equations only. DRSs without definite or demonstrative descriptions are called description-free. A DRS K satisfies anaphoric integrity, $ai(K)$, if K has no free variables. The functions *Sl* and *Rl* return the situation and rule labels of a DRS, respectively. The integrity constraint $IC(K)$ of a DRS K is the maximal part of it such that $ai(IC(K))$ and all situation and rule labels are preserved.
As for semantics, an update semantics using partial variable assignments will be assumed, see [3]. Let σ_0 be the initial information state.
A DRS K_1 entails a DRS K_2, $K_1 \models K_2$, if (assuming $ai(K_1)$ and $ai(K_2)$) the corresponding predicate logical formulas entail each other. $K_1 \vdash K_2$ will be used for derivability in a DRS calculus. Then $K_1 \vdash_{update} K_2$ iff

- $ai(K_1; K_2)$
- $K_1 \vdash K_1; K_2$

I will write $K \vdash_{update} def(x)$ iff $x \in av(K)$.

3 Justification of context-dependent expressions

Although the theory of [9] has been confronted with many apparent counterexamples (not least the ones discussed here), a treatment of definite noun phrases in terms of presuppositions is commonly assumed in linguistics. I will here build on the anaphoric account of definite descriptions of [5]. In this theory and in particular in the in some respects similar DRT-account [10], a definite description gives rise to a process of presupposition justification, which can either result in resolution, in accommodation or in a failure to resolve the presupposition. By the way, the account of [7] is not formulated in terms of an anaphoric account of presupposition, but rather using non-dynamic predicate logical formulas. In the account developed below, only the assumption that in case of failure of the existence presupposition, the context will be revised will be taken over, not the treatment of presuppositions itself. The importance of the process of presupposition resolution for the problem described in the introduction lies not only in the fact that a presupposition failure triggers a revision

[3] Explicit definitions can be found in the long version of the paper. The notions are minor variants of standard ones.

process, but also in the process following the contraction of the context. The presupposition must be justified with respect to the new context. Whether the contraction with the negation of a presupposition that will be described below is actually part of the process of accommodation or a preparation for it is mainly a terminological issue. I decided to use the latter option. Because this paper is about the problem of presupposition failure and not about the problem of presupposition projection, only global binding and accommodation (using the terminology of [10]) will be considered. Local and intermediate accommodation will not play any role[4].

According to the theory of [10], there are basically two options for resolving definite descriptions: binding and accommodation. Both may be combined in cases of so-called partial match. In [10], the possibility of revision with a presupposition is not considered. This is the third basic case that is important for our analysis here. An additional complication comes from the fact that sometimes presuppositions may be bound in more than one way. This can occur also when some information has to be accommodated. For instance, a single definite description may be bound to two different antecedents after the descriptive content has been accommodated about either one. Another case would be a sentence with two definite descriptions, one giving rise to accommodation, the other to multiple bindings.

The following assumption will be made to avoid accidental identities between variables.

Convention 3.1 (Variable choice in translations)
When a sentence is formalized in context K, new variables (i.e. variables that do not occur in K) are used for indefinite, definite and quantificational expresssions.

The following notion is used in the definition of admittance below. The purpose is to recursively collect the presupposed *conditions* of definite and demonstrative descriptions occurring in an atomic condition.

Definition 3.2 (Elementary presuppositions)
Let K be an atomic condition with possibly recursive definite description arguments (where the restrictors of the definite descriptions again are atomic conditions) DRS. Then $ep(K)$, the DRS representing the set of elementary presuppositions of K, is given by the recipe:

- $ep(\iota x : K) \ = \ epaux(K)$
- $ep(\delta x : K) \ = \ epaux(K)$
- $epaux(R(t_1^{x_1}, \dots t_n^{x_n})) \ = \ ep(t_1^{x_1}); \dots \ ep(t_n^{x_n}); R(x_1, \dots x_n)$
- $epaux(K_1; K_2) \ = \ ep(K_1); ep(K_2)$

When is each presupposition in a sentence satisfied if it is evaluated with respect to a given context K ? The definition of admittance, which is modelled after [6] (see also [2], whose notation I adopt here) provides an answer to this question with respect to the DRT-language used here.

[4] Of course it would be interesting to extend the analysis to cover embedded occurrences of presupposition triggers and their effects on perceived presupposition failure. However, for such sentences the empirical analysis is complicated by the fact that there are usually other options besides belief revision to avoid presupposition failure, such as local accommodation.

DEFINITION 3.3 (Admittance)
A simple DRS K^+ is defined with respect to a context DRS K, or K^+ is admitted by K, written $K \rhd K^+$ as determined by the following recursion.

- $K \rhd \bot$
- $K \rhd R^n t_1 \dots t_n$ iff, for each $t_i \in \{t_1 \dots t_n\}$
  - for each $x \in fv(t_i)$: $K \vdash def(x)$ and
  - $K \vdash_{update} ep(t_i)$
- $K \rhd K_1; K_2$ iff $K \rhd K_1$ and $K; K_1 \rhd K_2$.
- $K \rhd t_1 = t_2$ analoguously to $R^n t_1 \dots t_n$.
- $K \rhd \overline{x}$.
- $K \rhd \neg K_1$ iff $K \rhd K_1$.
- $K \rhd K_1 \Rightarrow K_2$ iff $K \rhd K_1$ and $K; K_1 \rhd K_2$.
- $K \rhd K_1 \vee K_2$ iff $K \rhd K_1$ and $K \rhd K_2$.

The minimal presuppositions that a sentence places on a context are given by the following definition.

DEFINITION 3.4 (Minimal presuppositions in terms of admittance)
Let K^+ be a DRS. A DRS K with $ai(K)$ represents the minimal presuppositions of K^+, written $mp(K^+) = K$, if $K \rhd K^+$ and there is no K' with $ai(K')$ and $K' \sqsubseteq_{DR} K$ for which $K' \rhd K^+$.

As long as the presuppositions are not satisfied by their local context, they can be computed in a cumulative manner:

DEFINITION 3.5 (Minimal justifying context)
Let K^+ be a DRS containing anaphoric expressions. Then K^{min} with $ai(K^{min})$ is called a minimal justifying context for K^+ if

- every anaphoric expression in K^+ is defined in its local context if K^+ is placed in the context of K^{min}.
- There is no K^{sub} with $K^{sub} \sqsubseteq_{DR} K^{min}$ with respect to which K^+ is already defined.

Now we can turn to the basic concepts of presupposition justification. First the notions of resolution and

DEFINITION 3.6 (Resolution)
Let K be a DRS and let K^+ be an update DRS such that $K; K^+$ does not satisfy anaphoric integrity. A *resolution* of K^+ with respect to the context K is a minimal equation series K^{res} such that $ai(K; K^{res}; K^+)$ and $K; K^{res} \rhd K^+$.
Let $Res(K, K^+)$ denote the set of such resolutions K^{res}. K^+ is called resolvable with respect to K if $Res(K, K^+)$ is non-empty. It is called uniquely resolvable if $Res(K, K^+)$ has exactly one element.

DEFINITION 3.7 (Accommodation)
A DRS K^+ with elementary presupposition $ep(K^+)$ is called resolvable by accommodation with respect to a DRS K if there is a $\subseteq_{DR}$-minimal K^{acc} with $ai(K; K^+)$ and $K \rhd K^{acc}$ such that $Res(K; K^{acc}, K^+)$ is non-empty.

Let K^{accres} be in $AccRes(K, K^+)$, the set of accommodations, if $K^{accres} = K^{acc}; K^{Res}$, where K^{acc} is as above and $K^{Res} \in Res(K; K^{acc}, K^+)$.

Definition 3.8 (Justifications)
Let K^+ be a DRS with elementary presuppositions $ep(K^+)$ and K be a context DRS satisfying anaphoric integrity.
The set of justifications of K^+ with respect to K, $Just(K, K^+)$, is determined as follows:

$$\begin{array}{lll} \text{If } Res(K,K^+) \neq \emptyset, \text{ then } Just & = & Res(K,K^+) \\ \text{If } Res(K,K^+) = \emptyset, \text{ then } Just & = & AccRes(K,K^+) \end{array}$$

4 DRS base revision under integrity constraints

In this section, the elements of a method for belief revision usable with DRSs are described. The method takes into account integrity constraints and preserves anaphoric integrity. First some basic notions are defined. Then the properties a DRS contraction operation suitable for treating the problems described in the introduction are formulated. Finally, a concrete operation of guarded maxichoice contraction is formulated. The standard AGM method of belief revision [1] uses so-called belief sets, i.e. deductively closed theories as a basis for belief revision. Of course it is possible to form the logical closure of a DRS. However, certain computational intuitions and the important property that implicit entities are not available for unrestricted anaphoric reference would be lost under such an approach. This is why discourse representation structures correspond to belief bases rather than to belief sets. In addition, an adequate treatment of integrity constraints has to be given.
The problem is to contract a labelled DRS K in such a way with a DRS K^{new} that in the result, $K - K^{new}$, all top-level components labelled S_i or R_j are preserved and that it satisfies anaphoric integrity.

Definition 4.1 (Part containing the integrity constraint)
Let K and K' be labelled DRSs. and let K satisfy anaphoric integrity. K' is a part containing the integrity constraint of K, written $K' \sqsubseteq_{DR}^{IC} K$, if $K' \sqsubseteq_{DR} K$ and both $Sl(K') = Sl(K)$ and $Rl(K') = Rl(K)$.

There are two kinds of postulates for the DRS contraction operation: the requirements from discourse representation theory (anaphoric integrity and definedness) and the general conditions on contractions (success and inclusion). They are recorded in the following definition. Further conditions can be imposed if needed.

Definition 4.2 (DRS contraction operation)
A function $-$ from DRSs satisfying anaphoric integrity and defined update DRSs to DRSs is called a DRS contraction if the following conditions hold:

Anaphoric Integrity $ai(K - K_\alpha)$
Success Either $IC(K) \vdash K_\alpha$
 Or $K - K_\alpha \not\vdash K_\alpha$
Inclusion The result of the contraction is a part of the original DRS: $K - K_\alpha \sqsubseteq_{DR} K$

The topic of the next subsection is a concrete realization of a contraction operation. Now maxichoice contraction for DRSs taking into account anaphoric integrity will be defined. Given the decision to view DRSs as belief bases rather than belief sets, the fact that most accounts of presupposition justification insist on *minimality* of the adjustments of the context and the arguments of [8] to the effect that the problems of maxichoice contraction are only acute when it is applied to belief sets, but not with belief bases, the choice of maxichoice contraction has at least some justification. In order to save space, I will directly define maxichoice contraction respecting integrity constraints instead of first presenting a DRT- version of conventional maxichoice contraction. The handling of the integrity constraint is built into the definition of remainder set.

Definition 4.3 (Remainder set)
Let K be a non-empty DRS satisfying anaphoric integrity and let K_α be defined with respect to K. Suppose furthermore that $K \vdash K_\alpha$. The remainder set $K \perp K_\alpha$ is the set of DRSs that contains exactly those DRSs K^{rem} such that

- $K^{rem} \sqsubseteq_{DR} K$
- $K^{rem} \not\vdash K_\alpha$
- There is no K^{rem}_{sub} with $K^{rem}_{sub} \sqsubseteq_{DR} K$ and $K^{rem}_{sub} \not\vdash K_\alpha$
- K^{rem} satisfies the integrity constraint both with respect to information from the immediate situation and with respect to general rules:
  - $Sl(K^{rem}) = Sl(K)$
  - $Rl(K^{rem}) = Rl(K)$

Note that the remainder set may be empty if K_α is entailed by the situational and rule knowledge.

Definition 4.4 (Selection function)
A selection function γ yields, for each non-empty set of DRSs D, a member of D.

The following method of belief contraction is conservative, the change effected is minimal. The operation is called *guarded* maxichoice contraction because of the provision for the case in which the remainder set is empty because of the integrity constraints. In this case it is not possible to contract, but instead of returning an error message, the original belief base is returned.

Definition 4.5 (Guarded Maxichoice Contraction)
The guarded maxichoice contraction of K with K_α modulo the selection function γ, $K - K_\alpha$ is given by

- If $K \perp K_\alpha \neq \emptyset$, then $K - K_\alpha = \gamma(K \perp K_\alpha)$,
- if $K \perp K_\alpha = \emptyset$, then $K - K_\alpha = K$.

Revision can be defined in terms of contraction in the usual way.

5 Judgments of unresolved sentences

This paper is about the way in which conversation participants judge the assertive natural language utterances of other participants on the basis of their available information, not about the assignment of truth values to sentences relative to a model.

There are two main differences between the two processes that are relevant here. A model of predicate logic is complete in assigning a valuation to each atomic sentence. Information states are not, the information of a participant is partial and will only decide the truth or falsity of some sentences. Another difference between the two scenarios is that the translation of natural language sentences often contains free variables and presuppositions. In the literature on dynamic semantics (see e.g. [4], [3]) the resolution of anaphoric expression has usually been taken for granted by pre-indexing the translations of e.g. pronouns as variables to coincide with the variable dynamically bound by a currently active existential quantifier. In DRT, pronouns are usually translated as new variables that have to be equated, in a separate process of anaphora resolution, with an accessible discourse referent. The modelling in DRT is certainly more realistic from a computational point of view. However, it also makes the task of judging a sentence more complicated. By way of motivation for the definitions and the algorithm that will follow, let us ask: What would be a natural method of judging a sentence containing unresolved pronouns and definite descriptions ? Of course, a very radical and uncooperative method would be to simply refuse judging sentences when the reference cannot be uniquely determined. But in communication in natural language, speakers are usually interested in obtaining as much information as possible from what is said, even if this involves substantial reasoning. One reason for this is certainly that communication often takes place under severe efficiency constraints, there is no time for unlimited clarification dialogues. The following assumptions almost follow from the assumption that a participant tries to assign a specific judgment to a sentence whenever possible, and to move to a more differentiated judgment if a simple one is not available. The participant can use two main tools for arriving at judgments when, at first sight, none would be available: supervaluation with respect to the different anaphor resolution possibilities and contraction with the negation of a presupposition. It is plausible to assume that more complicated ways to justify a sentence are only tried out if no simpler ones are available, thus, the repair mechanism of accommodation is only resorted to when there is no resolution available, in order to keep the number of possible justifications minimal, and contraction with the negation of the presupposition is only carried out if there is no binding or accommodation. This assumption can be justified by the pragmatic consideration that if there is a resolution, it would normally be uncooperative that the speaker had intended an accommodation interpretation (although this argument depends on the exact role of the common ground that is not discussed here) and by the higher complexity of accommodation and contraction. Let us take a method for classifying resolved sentences as true, false or undecided with respect to an information state for granted. The term *resolution* is used for justifying a context-dependent expression by only introducing resolution equations. The more general term *justification* covers cases where additional assumptions are made (accommodations) as well. If the sentence can be resolved in a unique way, it should be judged just like its unique resolution. If there are several resolution possibilities, the only possibility is to see whether the resolution does not matter for the truth value. The sentence should be judged true (false) only if it is true under all resolution possibilities. Otherwise it should be judged as referentially unclear. If there is *no* resolution possibility, the sentence would normally be judged as undefined or truth-valueless in the sense of [9]. However, a cooperative participant may try to adapt his information state in order to nevertheless make room for the presupposition of the speaker – after all, presupposed information is presented as uncontroversial, so the speaker may have had good reasons in introducing the presupposition, and in any case it is cooperative to go along with it in order to keep the conversation going. There are two cases. Either such a contraction of the information state is not possible. Then the sentence should be judged as radically undefined. Or it is possible, and then the final judgment depends on the justification possibilities with respect to the contracted context. The judgments *undefined but false/true/unclear after revision* may result. This derivation of a certain method of judging sentences only from the requirement of saying as much as possible about the truth of a sentence on the basis of the given information as independent motivation for the algorithm in section 6. But first the basic notions of truth (or support), falsity (or incompatibility) and undecidedness of a *resolved* open proposition with respect to a context have to be defined.

Definition 5.1 (Support)
Let K be a DRS and let K^+ be defined with respect to K. Then K^+ is said to be supported by K iff $K \vdash_{update} K^+$.

Definition 5.2 (Incompatibility)
Let K be a DRS and let K^+ be defined with respect to K.
Then K^+ is said to be incompatible with K iff $K \vdash_{update} \neg K^+$.

Definition 5.3 (Undecided)
Let K be a DRS and let K^+ be defined with respect to K.
Then K^+ is said to be *undecided* with respect to K iff neither $K \vdash_{update} K^+$ nor $K \vdash_{update} \neg K^+$.

In the next section, an algorithm is defined that forms the judgments described at the beginning of this section in the order that suggests itself, namely by increasing complexity of the judgment[5]. First come the cases where the DRS to be judged is already resolved, then the cases where it is resolvable by (i) binding, (ii) accommodation without revision, (iii) accommodation with revision.

6 Judgment algorithm

Let K be a DRS satisfying anaphoric integrity and K^+ be a simple DRS representing the sentence s.

(1) If K^+ is resolved with respect to K:
If K^+ is supported by K according to Def. 5.1, then judge s as *true*.
If K^+ is incompatible with K according to Def. 5.2, then judge s as *false*.
If K^+ is undecided by K according to Def. 5.3, then judge s as *unknown*.

(2) Otherwise compute the justifications $Just(K, K^+)$ of K^+ with respect to K, according to Def. 3.8.
If there is a unique justification $Just(K, K^+) = \{K^{just}\}$ consisting of resolution equations only, then judge K^+ with respect to $K; K^{just}$ according to step (1).
If there is a unique justification $Just(K, K^+) = \{K^{just}\}$ consisting of accommodated information and possibly resolution equations, then judge K^+

[5] The method is an algorithm in the same sense as e.g. the presupposition justification algorithm of [10]. Termination is not guaranteed in the general case, because checking DRS consistency is equivalent to checking consitency for first-order logic. For the typical contexts used in discussions of linguistic examples this problem does not arise.

with respect to K; K^{just} according to step 1 and add the qualification *after accommodation* to the resulting judgment.

If the set of justifications $Just(K, K^+)$ contains more than one element, then
if s is true under all justifications, then judge it as *true*.
if s is false under all justifications, then judge it as *false*.
otherwise judge s as *referentially unclear*.

If $Just(K, K^+) = \emptyset$, then contract K with $mp(K^+)$.
if $K - \neg mp(K^+) = K$ (the contraction fails),
then judge s *completely unresolvable* (radical presupposition failure).
if $K - \neg mp(K^+) \neq K$ (the contraction goes through), then apply step 2 with respect to $K - \neg mp(K^+)$ and K^+ and wrap the result Res in the qualification *undefined but Res after revision with the presupposition.*

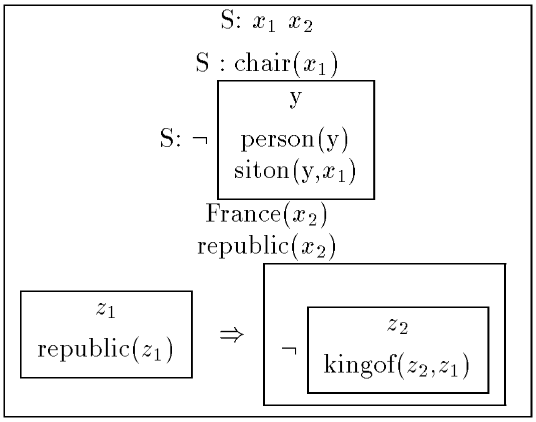
The case division is exhaustive because there is no justification if and only if the context DRS entails the negation of the presupposition. This aspect should still be refined, because judging a sentence true only after accommodation is intuitively different from judging it true directly in its context. The presence of the outcome *unclear after revision* is motivated by situations in which, e.g., the presupposition of one definite description in a sentence is inconsistent with the context, while another definite description has several possible antecedents.

Using the order given in the algorithm has the advantage of calling the expensive contraction operation only as a last resort.

7 Treatment of an example

EXAMPLE 7.1
The king of France is sitting on this chair.

Let us assume that we have the following context DRS K:



The sentence is formalized by the open DRS K^+:

$$\boxed{\text{siton}(\iota x_3 : kingof(x_3, \iota x_4 : France(x_4)), \delta x_5 : chair(x_5))}$$

$Just(K, K^+)$ is empty. The contraction $K - \neg x_3; x_4; France(x_4); kingof(x_3, x_4)$ with the critical presupposition (the demonstrative can be resolved unproblematically) yields

$$\boxed{\begin{array}{c} \text{S: } x_1\ x_2 \\ \text{S : chair}(x_1) \\ \text{S: } \neg \boxed{\begin{array}{c} \text{y} \\ \text{person(y)} \\ \text{siton(y,}x_1\text{)} \end{array}} \\ \text{France}(x_2) \\ \text{R : } \boxed{\begin{array}{c} z_1 \\ \text{republic}(z_1) \end{array}} \Rightarrow \boxed{\neg \boxed{\begin{array}{c} z_2 \\ \text{kingof}(z_2,z_1) \end{array}}} \end{array}}$$

The belief that France is a republic had to be given up .
In the new context, K^+ is judged *false (after revision)* using definition (5.2).

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