A problem with SDRT's formalization

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A problem with SDRT's formalization*

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1 Introduction

In this article, a previously unnoticed problem of Segmented Discourse Representation Theory ("SDRT") is discussed and a solution to it is provided. SDRT is a successful theory about discourses in the field of computational linguistics. The theory will be discussed on the basis of its standard account by Asher and Lascarides (2003). The problem relates to SDRT's central principle called "Maximise Discourse Coherence" ("MDC"). Coherence, and in particular MDC, is a central notion for such theories because it is required to explain what makes for a good discourse. MDC is defined in terms of an update mechanism. This mechanism is flawed as it presently stands. Roughly, the problem consists in defining updates as the set-theoretic union of simpler updates. The proposed remedies fix the mechanism locally without requiring fundamental changes to SDRT's explanatory architecture.[1]

2 An exposition of SDRT

To understand the formal problem, SDRT's general architecture has to be illustrated (see fig. 1(a)). I will do so by going through some steps in the construction of the discourse structure of the following discourse which has also been used to motivate the theory (p. 8):

(1)
π_1 Max had a great evening last night.
π_2 He had a great meal.
π_3 He ate salmon.
π_4 He devoured lots of cheese.
π_5 He then won a dancing competition.

SDRT applies to natural language discourses. The *NL-input* are here the sentences of (1). They are presented as *underspecified logical forms (ULFs)* constructed by a *parser*. ULFs describe logical forms in the base language to which SDRT's most important structures belong, the so called segmented discourse representation structures ("SDRSs"). SDRSs

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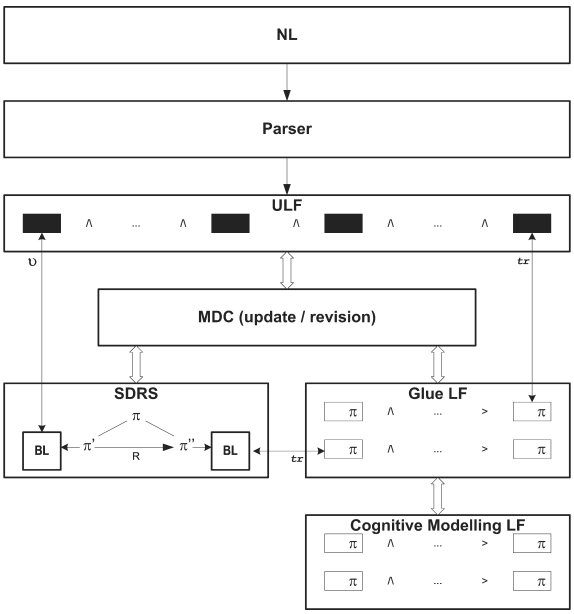
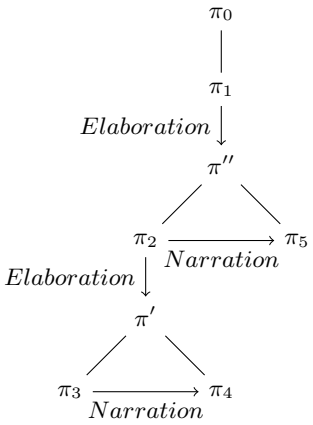
1 While the basic theory of SDRT has been advanced in different directions in recent years, these advances aimed mainly at a wider empirical coverage and at overcoming the theory-practice gap by working on implementations. Not much work has been done on the formal core of the theory and a closer look at SDRT's formalization reveals that the theory has other problems in this area.



(a) The general SDRT architecture



(b) The maximally coherent SDRS for discourse (1)

Figure 1: SDRT and an SDRS

are structures for which a truth definition is given. They are used to represent the truth conditions of discourses. For our sample discourse, Asher and Lascarides propose that the maximally coherent SDRS is the one depicted in fig. 1(b).

ULFs (partially) describe such SDRSs. The possible underspecification of an SDRS by a ULF reflects the fact that, in general, the grammar does not determine a unique logical form for a NL-sentence in the base language but a set of possible forms. Each such form corresponds to one of the possible interpretations of the sentence.

Before the construction of the possible discourse structures for (1) can begin, two assumptions have to be made. 1. Some discourse context σ has to be fixed. 2. It has to be assumed that the ULF of the first utterance π_1 of the discourse is part of σ.[2] Discourse contexts are sets of SDRSs which are compatible with the information the participants share.

In the next step, σ is updated with the ULF of π_2 yielding a new context σ'. The update is performed by SDRT's *update mechanism* which assumes that the new utterance is related to an available attachment point by means of an underspecified *discourse relation*, denoted by ?. In our case, π_1 is an attachment point for π_2. So the discourse relation holds between the two labels. This fact is expressed as $?(\pi_1, \pi_2)$.

Next, a representation of σ, the ULF of π_2, and the assumption $?(\pi_1, \pi_2)$ are translated to the *Glue logic* (and to the *Cognitive Modelling Logic*) in order to resolve underspecification by pragmatic reasoning. The resolutions are translated back to the logic of ULF and added to the common description of the so far consistent discourse structures. The update

2 Here I gloss over a minor problem: SDRT's update mechanism is not properly defined for the initial update.

mechanism restricts the resolutions to those that are consistent, *i.e.* describe well-formed SDRSs. Moreover, the mechanism eliminates SDRSs from the context which are not consistent with the new information. In this case, the Glue logic allows us to resolve $?(\pi_1, \pi_2)$ to $Elaboration(\pi_1, \pi_2)$ which expresses that π_2 elaborates on π_1.

This update process is applied in a similar fashion to the rest of discourse (1). Let us consider the update with π_3 and describe it in terms of SDRT's vocabulary. After the update with π_2, the output discourse context is σ' which serves as the input discourse context for the current update. In the update with π_3 we apply the function *update* to the context σ'. *update* is defined as a function from an input discourse context and a ULF of the current utterance to an output discourse context. Using this notion, we can write the output discourse context σ'' after the update with π_3 as $update(\sigma', \mathcal{K}_{\pi_3})$ where $\mathcal{K}_{\pi_3}$ denotes the ULF of π_3. *update* is in turn defined in terms of a simpler update operation called "simple update +".

In short, what *update* does is 1. to introduce assumptions of the form $?(\pi_i, \pi_j)$, 2. to create sequences of simple updates using these assumptions, 3. transferring their representations to Glue in order to resolve underspecification by pragmatic reasoning, and 4. checking the inferred results for consistency. 5. The consistent results finally determine the output discourse context.

At the end, the SDRSs in the final output discourse context are ranked on the basis of the principle MDC (see p. 20 f. and pp. 223–245). The informal content of this principle describes some general preferences over discourse structures like "An SDRS in which more anaphora are resolved is better than one with less". Formally, the principle is rather complicated. It is stated in terms of an update/downdate operation. This ranking is done as the final update step using a third update notion $Best-update$. According to Asher and Lascarides, the outcome of $Best-update$ for (1) is the SDRS depicted in fig. 1(b).

3 The problem with SDRT's update mechanism

With this exposition in mind, let us return to the problem with SDRT's update mechanism which consists in the way discourse contexts are updated with new information. I will identify three issues pertaining to the problem and propose remedies to fix them:

1. The minimal update sequence is not informative enough for MDC.
2. Longer update sequences collapse to shorter sequences.
3. Failed update sequences can undo the results of successful updates.

3.1 Preliminaries: Starting from definitions

Before I will turn to the issues, I will state the definitions which are criticized, namely *MDC* (p. 234), *SDRT update* (see p. 218), and *simple update +* (see p. 216).[3] Notice that the criticism concerns the declarative version of SDRT's update mechanism which Asher and Lascarides offer as an improvement to an earlier procedural version.

3 The definitions of MDC and SDRT update are simplified for purposes of presentation. In MDC, the definition of the order $\leq_{\sigma,\beta}$ only captures the intuitive content; for a preciser formulation see pp. 233 f. The simplification in SDRT update changes the meaning of the definition by 1. ignoring presuppositions and 2. diverging relations, and by 3. omitting the update "$LAST = \beta$" which says that the last discourse label is the one of the current ULF. The criticism below also holds for the non-simplified case.

MDC. Let σ be a set of SDRSs, let x_1 and x_2 be ULF-descriptions such that $\exists\sigma' \subseteq \sigma : \forall s \in \sigma', s \models_l x_1$ and $\exists\sigma'' \subseteq \sigma : \forall s \in \sigma'', s \models_l x_2$, and let $\mathcal{K}_\beta$ a ULF labeled β. Then:

1. x_1 is ranked higher in $\leq_{\sigma,\beta}$ than $x_2 \stackrel{\text{def}}{\Longleftrightarrow}$:
   a) x_1's SDRSs have fewer nodes than x_2's, unless x_2 is inconsistent, and
   b) x_1's discourse relations are at least as contextually coherent in σ as x_2's, and
   c) x_1 resolves at least as many underspecifications as x_2.
2. $Best{-}update(\sigma, \mathcal{K}_\beta) \stackrel{\text{def}}{=} \{s \in update(\sigma, \mathcal{K}_\beta) : \exists\mathcal{K} \in \mathcal{L}_{ulf}, s \models_l \mathcal{K}$ and $\mathcal{K}$ is $\leq_{\sigma,\beta}$ -maximal$\}$

$Best{-}update(\sigma, \mathcal{K}_\beta)$ implements the principle MDC by filtering the elements in the set $update(\sigma, \mathcal{K}_\beta)$ which is defined below. The filtering restricts this set to those SDRSs which satisfy some ULF-description $\mathcal{K}$ which is ranked highest by the partial order $\leq_{\sigma,\beta}$. In $Best{-}update$, the here undefined notion $\models_l$ is used. $\models_l$ is ULF's satisfaction relation which is defined between SDRSs and ULFs, that is, SDRSs are models of ULFs (*c.f* p. 131).

SDRT Update. Let σ be a set of SDRSs and $\mathcal{K}_\beta$ be a ULF labeled β. Then:

1. $avail{-}pairs(\sigma) \stackrel{\text{def}}{=} \big\{\langle\alpha, \lambda\rangle \in \Pi^2(\sigma) : \alpha \in avail{-}sites(\sigma)$ and $Succ_D(\lambda, \alpha)\big\}$
2. Let S_σ be the set of all possible sequences of all possible subsets of $avail{-}pairs(\sigma)$ and let $X \in S_\sigma$. Then: $\Sigma_X(\sigma, \mathcal{K}_\beta) \stackrel{\text{def}}{=} \sigma + \mathcal{K}_\beta + ?(\alpha_1, \beta, \lambda_1) + \ldots + ?(\alpha_i, \beta, \lambda_i) + \ldots$ where $\langle\alpha_i, \lambda_i\rangle \in X$ is the i^{th} element of X.
3. $update(\sigma, \mathcal{K}_\beta) \stackrel{\text{def}}{=} \bigcup_{X \in S_\sigma} \Sigma_X(\sigma, \mathcal{K}_\beta)$

In the definition of SDRT update, *avail–pairs*(σ) describes the set of available attachment sites (being labels of the set $\Pi^2(\sigma)$ of pairs of labels in σ) to which possible discourse relations can attach to.[4] All its possible subsets are used to define update sequences $\Sigma_X(\sigma, \mathcal{K}_\beta)$ in terms of simple update $+$. $\mathcal{K}_\beta$ denotes the ULF of the sentence labeled β with which the input discourse context σ is updated. $?(\alpha_1, \beta, \lambda_1)$ says that there is an underspecified discourse relation (but we don't know which one) between the ULF of the sentence labeled β and a prior attachment point labeled α_1. The label λ_1 is a name for the whole formula. Graphically speaking, these labels denote nodes in SDRSs like the one in fig. 1(b).

Simple Update $+$. Let σ be a set of SDRSs and x_1 be either the tr-image of a ULF or a formula of the form $?(\alpha, \beta, \lambda)$. Then:

1. $\sigma + x_1 \stackrel{\text{def}}{=} \big\{s \in \sigma : \forall\phi \in \mathcal{L}_{glue},$ if $Th(\sigma), x_1 \mathrel{|\!\sim} \phi$, then $s \models_l tr^{-1}(\phi)\big\}$ provided the result is not $\emptyset$;
2. $\sigma + x_1 \stackrel{\text{def}}{=} \sigma$ otherwise.

The definition of simple update $+$ makes uses of several notions which I have not introduced, namely tr (a relation between ULF formulas and Glue formulas which defines how information is transferred from ULF to Glue, see p. 197), its inverse image tr^{-1} (mapping Glue formulas to ULF formulas), Th (defining the common description of a discourse context, see p. 214), and $\mathrel{|\!\sim}$ (Glue's non-monotonic inference relation, see pp. 189 ff.).

4 For details on the notion of $avail{-}sites(\sigma)$, see p. 215.

The intuitive content of a simple update + of the form $\sigma + x_1$ is that the SDRSs in σ are updated with the information of x_1 resulting in a new context. The update can be procedurally described in the following way: 1. Create the ULF-description $Th(\sigma)$ of σ. 2. Extend it by x_1. 3. Transfer the extended description to Glue. 4. Use the Glue calculus to infer consequences, thereby resolving underspecifications. 5. Transfer the Glue consequences back to ULF and check for consistency. All SDRSs which survive this check are part of the new context. Normally, the output discourse contexts defined by simple update + and SDRT update are infinite sets.

3.2 Issue 1: The minimal update sequence is not informative enough for MDC

The first issue relates to MDC requiring discourse contexts which are rich enough structured to determine the contextually most coherent SDRSs. Discourse contexts are defined by *update* but fail to be rich enough structured because the discourse contexts only depend on the minimal update sequence. MDC requires a discourse context structured rich enough because otherwise it would overgenerate the number of predicted interpretations (SDRSs) of a discourse – or in Asher and Lascarides' words:

> [M]aximal coherence plays a distinct role from the axioms in the glue logic for inferring discourse relations. Abandoning the glue logic axioms and using maximal coherence instead to choose among *all possible* discourse structures (rather than only the ones where the discourse relations are inferred via default clues) would overgenerate the number of interpretations in the update. (p. 234)

The point is that without defining which possible discourse relations may hold at all, MDC has to compare wildly different SDRSs which cannot be compared by the relevant contextual coherence condition of MDC (clause 1b)). To see this, consider the case in (2).

(2) The discourse context consists of two SDRSs S_1 and S_2 which are identical except for:
   a. S_1 is such that $Elaboration(\pi_1, \pi_2)$ holds, while
   b. S_2 is such that $Narration(\pi_1, \pi_2)$ holds.

If there is no difference in the relative contextual coherence of $Elaboration$ and $Narration$, then the description of both SDRSs $S1$ and S_2 are equally ranked by MDC's order $\leq_{\sigma,\beta}$, while they have different interpretations. Though, if we could infer more by Glue about which one is the right one, then, clearly, something has gone wrong.

What I will show is that for any discourse context σ and ULF $\mathcal{K}_\beta$, $update(\sigma, \mathcal{K}_\beta) = \sigma + \mathcal{K}_\beta$. This states that the output discourse context of an update always reduces to the least informative update $\sigma + \mathcal{K}_\beta$ in which the ULF of the current sentence, $\mathcal{K}_\beta$, is not necessarily rhetorically connected by a discourse relation. All other update sequences generated by S_σ do not have any additional effect. This is not only technically weird but also raises a problem for MDC as explained above.

To show this, notice that *update* is a monotone decreasing function, that is, for any discourse context σ and ULF $\mathcal{K}_\beta$, $\sigma \supseteq \sigma' = update(\sigma, \mathcal{K}_\beta)$. This is so because simple update + is a monotone decreasing function, that is, $\sigma \supseteq \sigma + x_1 \supseteq \sigma + x_1 + x_2 + \supseteq \cdots$. Let us call this fact about simple update + "`Mono`".

Let us call $\sigma + \mathcal{K}_\beta$ the "minimal update sequence". We call it so because it is both the shortest update sequence and the common lexicographic prefix of all update sequences which

update considers. Any update sequence which has another update sequence as its prefix is called an "extension" of it. From `Mono` it follows that any discourse context defined by an extension of the minimal update sequence is a subset of the minimal update sequence. That is, all other update sequences generated by S_σ define sets which are equal to $\sigma + \mathcal{K}_\beta$ or are subsets of it.

Let us define $Seq_{\sigma,\beta}$ to be the set of all update sequences Σ_X generated by S_σ. Since *update* determines the output discourse context by taking the union of all the sets defined by the update sequences in $Seq_{\sigma,\beta}$, it follows that $update(\sigma, \mathcal{K}_\beta) = \sigma + \mathcal{K}_\beta$. Therefore, if we do not want to change SDRT's explanatory architecture by changing MDC, *update* fails to do its job properly. The obvious remedy for this issue is to exclude the problematic minimal update sequence:

R1. Exclude $\emptyset$ from S_σ.

3.3 Issue 2: Longer update sequences collapse to shorter sequences

The second issue is that even if we endorse R1, the worrying point from the first issue remains that longer update sequences do not have any effect. Applying R1, $Seq_{\sigma,\beta}$ contains update sequences of the following form: $\sigma + \mathcal{K}_\beta + ?(\alpha_1, \beta, \lambda_1) + \ldots + ?(\alpha_i, \beta, \lambda_i) + \ldots$ – but not the minimal update sequence $\sigma + \mathcal{K}_\beta$.

From `Mono` it follows that $\sigma + \mathcal{K}_\beta + x_1 \supseteq \sigma + \mathcal{K}_\beta + x_1 + \ldots + x_n$ where $x_1, \ldots, x_n$ are formulas for which simple update $+$ is defined, *e.g.* $?(\alpha_1, \beta, \lambda_1)$. So by `Mono` and by $update(\sigma, \mathcal{K}_\beta)$ being the union of all update sequences in $Seq_{\sigma,\beta}$, it follows that we can collapse $Seq_{\sigma,\beta}$ to the set $min_{<_{pre}}(Seq_{\sigma,\beta})$ of the minimal elements of $Seq_{\sigma,\beta}$ in the lexicographic prefix order of the update sequences. That is, the output discourse context $\sigma'_{Seq_{\sigma,\beta}}$ determined by the union of the update sequences in $Seq_{\sigma,\beta}$ is equal to the output discourse context $\sigma'_{min_{<_{pre}}(Seq_{\sigma,\beta})}$ determined by the union of the update sequences in $min_{<_{pre}}(Seq_{\sigma,\beta})$. Formally, $\sigma'_{Seq_{\sigma,\beta}} = \sigma'_{min_{<_{pre}}(Seq_{\sigma,\beta})}$ where $\sigma'_{Seq_{\sigma,\beta}} \stackrel{\text{def}}{=} \bigcup_{X \in Seq_{\sigma,\beta}} X$ and $\sigma'_{min_{<_{pre}}(Seq_{\sigma,\beta})} \stackrel{\text{def}}{=} \bigcup_{X \in min_{<_{pre}}(Seq_{\sigma,\beta})} X$. Call this fact "`Collapse`".

To see why the consequences of `Collapse` are unwanted, consider a case where $Seq_{\sigma,\beta}$ contains only the two update sequences in (3) where x_1 and x_2 are formulas for which simple update $+$ is defined. Furthermore, suppose that the discourse context defined by (3-a) is strictly bigger than (3-b).

(3) a. $\sigma + \mathcal{K}_\beta + x_1$
b. $\sigma + \mathcal{K}_\beta + x_1 + x_2$

Obviously, (3-b) is then more informative than (3-a) because it updates the discourse context also with x_2 which eliminates some SDRSs from the discourse context. Though, from `Collapse` it follows that $min_{<_{pre}}(Seq_{\sigma,\beta}) = \{\sigma + \mathcal{K}_\beta + x_1\}$. Thus, $update(\sigma, \mathcal{K}_\beta) = \sigma + \mathcal{K}_\beta + x_1$, that is, the more informative update (3-b) is lost. So even if we exclude $\emptyset$ from S_σ (R1), the output discourse does not depend on all possibly informative update sequences in $Seq_{\sigma,\beta}$ but only on the ones in $min_{<_{pre}}(Seq_{\sigma,\beta})$.

This behavior of *update* is bad for basically the reasons stated in the discussion of the first issue. Generally, among two otherwise identical SDRSs, the one which has more rhetorical connections is pragmatically to be preferred to the other. To this end, we should try to

infer as many rhetorical connections as possible. Though by `Collapse`, only the minimal extensions to the minimal update sequence determine the output discourse contexts.

The upshot is that R1 is at least not a good enough remedy. If we understand that the remaining problem is that there are supersets resulting from shorter update sequences among the discourse contexts defined by the update sequences in $Seq_{\sigma,\beta}$, then we can solve this problem by the remedy of excluding these supersets:

R2. Let *update* only union the maximal elements of $Seq_{\sigma,\beta}$ in the lexicographic prefix order.

3.4 Issue 3: Failed update sequences can undo the results of successful updates

A further issue with *update* is that even if we endorse both R1 and R2, failed update sequences can undo the results of successful updates. To see this, suppose that $Seq_{\sigma,\beta}$ contains only the two update sequences in (4) where x_1 and x_2 are formulas for which simple update $+$ is defined.

(4) a. $\sigma + \mathcal{K}_\beta + x_1 + x_2$
b. $\sigma + \mathcal{K}_\beta + x_2 + x_1$

Furthermore, let us assume that it turns out that any update with x_1 results in an inconsistency. However, updates with x_2 are consistent only if they are not performed after an update with x_1; otherwise they are inconsistent. By definition of simple update $+$, we get the results in (5).

(5) a. $\sigma + \mathcal{K}_\beta + x_1 + x_2 = \sigma + \mathcal{K}_\beta$
b. $\sigma + \mathcal{K}_\beta + x_2 + x_1 = \sigma + \mathcal{K}_\beta + x_2$

By `Mono`, $update(\sigma, \mathcal{K}_\beta) = \sigma + \mathcal{K}_\beta$ since $\sigma + \mathcal{K}_\beta \supseteq \sigma + \mathcal{K}_\beta + x_2$. However, intuitively, we would like that the output discourse context σ' results from the update with x_2, that is $\sigma' = \sigma + \mathcal{K}_\beta + x_2$. Thus the criticism is that when an update fails in such a situation, then the interesting update with x_2 resulting in a possibly smaller set of SDRSs is lost because the output discourse context is defined as the union of $\sigma + \mathcal{K}_\beta + x_2$ and its superset $\sigma + \mathcal{K}_\beta$. Thereby, the result of the inconsistent update is not eliminated from the output discourse context.

A remedy for this issue is to define the result of a failed update to be $\emptyset$. For the union of $\emptyset$ with some other set A is A again. That is, $\emptyset$ does not do anything "bad" in the construction of the output discourse context by taking the union of the results of the sequences of simple updates.

R3. Let simple update $+$ of a failed update be $\emptyset$.

3.5 An alternative solution to remedies that do not remedy

Let us endorse all the remedies proposed so far. The outcome is that we fail to include sets which should be included. The problem can be illustrated by considering $Seq_{\sigma,\beta}$ to contain the update sequences in (6) on the previous assumption that any update with x_1 is inconsistent and updates with x_2 are consistent only if they are not performed after an update with x_1; otherwise they are inconsistent.

(6) a. $\sigma + \mathcal{K}_\beta$
b. $\sigma + \mathcal{K}_\beta + x_1$
c. $\sigma + \mathcal{K}_\beta + x_1 + x_2$
d. $\sigma + \mathcal{K}_\beta + x_2 + x_1$
e. $\sigma + \mathcal{K}_\beta + x_2$

In this case, according to SDRT the resulting output discourse context is $\sigma + \mathcal{K}_\beta$, while according to the combined remedies the discourse context is $\emptyset$ because (6-a) is ruled out "exclude the minimal update sequence" (R1), (6-b) and (6-e) are ruled out by "take only maximal elements in the lexicographic prefix order" (R2), and (6-c) and (6-d) evaluate to $\emptyset$ by "the result of failed updates is $\emptyset$" (R3). However, the desired result in this case would be $\sigma + \mathcal{K}_\beta + x_2$.

Thus, an alternative solution is required. I propose the following. Let us define $update(\sigma, \mathcal{K}_\beta)$ by taking the union of only those sets from $Seq_{\sigma,\beta}$ which are not a superset of another set in $Seq_{\sigma,\beta}$. That is, we union only the most informative updates. Formally, this amounts to replacing the 3rd clause of the definition of SDRT with the following:

SDRT Update (3rd clause). $update(\sigma, \mathcal{K}_\beta) \stackrel{\text{def}}{=} \bigcup_{u \in min_\subset(Seq_{\sigma,\beta})} u$ where $min_\subset(Seq_{\sigma,\beta})$ is defined as the biggest subset of $Seq_{\sigma,\beta}$ such that $\forall v \in min_\subset(Seq_{\sigma,\beta}) : \neg\exists v' \in min_\subset(Seq_{\sigma,\beta})$ and $v' \supset v$.

This idea is based on two intuitions. First, one should shrink the discourse context as much as possible by using all the information we have to eliminate SDRSs from the context set. Secondly, different update sequences should not interfere "too much" with each other.

The reason for not including supersets is straightforward. If we did so, then we would loose the information of the update which allows to restrict the context set to a smaller set.

Based on this proposal we can also simplify the definition of simple update $+$ by dropping the second clause of the previous definition. For the update $\sigma + \mathcal{K}_\beta$ is almost always the minimally consistent update. The qualification "almost" restricts the claim to to "big enough" discourse contexts such as the ones which have been constructed by (repeatedly) applying *update* to the set $\top$ of all SDRSs.[5]

Simple Update $+$. Let σ be a set of SDRSs and x_1 be either the tr-image of a ULF or a formula of the form $?(\alpha, \beta, \lambda)$. Then: $\sigma + x_1 \stackrel{\text{def}}{=} \{s \in \sigma : \forall \phi \in \mathcal{L}_{glue},$ if $Th(\sigma), x_1 \mathrel{|\!\sim} \phi$, then $s \models_l tr^{-1}(\phi)\}$.

4 Conclusion

In this article an up to date unnoticed problem relating to SDRT's update mechanism has been presented and solutions to the issues it causes have been discussed. Interestingly, the obvious remedies which are suggested by each individual issue have undesired consequences when they are combined. The proposed solution to the problem does not only overcome this difficulty but arguably also simplifies the presentation of SDRT's update mechanism.

References

Nicholas Asher and Alex Lascarides. *Logics of Conversation: Studies in natural language processing.* Cambridge University Press, Cambridge, 1 edition, 2003. ISBN 0–521–65058–5.

5 Formally, what is required is that for at least one SDRS all its possible extensions are in the discourse context. In the deviant cases with arbitrary sets of SDRSs as discourse contexts which are technically possible, there seems to be no harm done if the minimal update sequence results in $\emptyset$.