Social constraints on rhetorical relations in dialogue

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Abstract

In dialogue a set of actions are realized by linguistic means, and have consequences on the state of the interaction between two speakers. Analysing the interaction, the emphasis can be put on the effects on the mental states of the participants or on the social effects of dialogue acts (obligations, commitments) resulting from conventions. We try here to relate a formal semantics approach to discourse (SDRT) with a concern for the social conventions bearing on participants via the notion of commitment to what has been said, recorded in a conversational gameboard.

1 Introduction

In dialogue a set of actions are realized by linguistic means, and have consequences on the state of the interaction between two speakers. Thus dialogue is seen as a sequence of utterances, each having a propositional content and fulfilling a function according to the type of the action realized.

We can distinguish two main issues addressed by theories concerned with the modelling of interaction within that perspective:

- how can we explain the behavior of speakers, or what are correct sequences of dialogue moves or dialogue acts ?
- how can we interpret this behavior ? (in terms of information exchange, beliefs modifications, social interactions, etc)

The emphasis can be put on the effects on the mental states of the participants (beliefs), in what can be called *mentalist* such as Cohen and Perrault (1979). Or the emphasis can be put on the social constraints generated by dialogue acts such as the obligations of Traum and Allen (1994) resulting from *conventions*, in what we can call social approaches. Also the analysis of the utterances themselves can be done under the light of the intention recognition paradigm of Grice (1975) (later implemented in various influential contributions such as Grosz and Sidner (1986)) or under a more social perspective in which the utterances respond to some interactive pressure or social obligations.

There is an other line of study, formal semantics of discourse, that takes a different point of view by taking the analysis of utterances as a starting point in building a model of human communication. In this perspective, the semantic/pragmatic interface becomes the focus of attention. Some proposals have explicitly tried to capture dialogue within such a framework Asher and Lascarides (2003), trying to relate the formal semantics of separate sentences to the more speaker-centered speech act vision of conversation. We try here to relate such a framework with a concern for the social constraints bearing on participants via the notion of propositional commitment, introduced by Hamblin (1970), to what has been said, recorded in a conversational gameboard *à la* Lewis (1979). This work is also influenced by Walton and Krabbe (1995) in which we are trying to integrate the notion of discourse coherence based on discourse semantics.

2 Interpreting relations and commitment dynamics.

2.1 The formal model

Our conversational gameboard consists of the discourse structure (DS) and two commitment stores ($\mathcal{CS}_A$ and $\mathcal{CS}_B$), one for each speaker A and B, over certain elements of DS: $\mathcal{CG} = \langle \mathcal{DS}, \mathcal{CS}_A, \mathcal{CS}_B \rangle$ DS is

simply a Segmented Discourse representation structure taken from Asher and Lascarides (2003), basically a set of labeled DRS related rhetorically where a function $\mathcal{F}$ assigns to each label a well-formed SDRS. Each DRS (discourse representation structure) represents the semantic content of a basic dialogue constituent (a speech act).

In case π labels a simple constituent, $\mathcal{F}(\pi)$ returns a DRS (sometimes written K_π). If π labels a complex constituent, $\mathcal{F}(\pi)$ returns a discourse relation of a conjunction of discourse relations (e.g $\mathcal{F}(\pi) = R(\alpha, \beta)$ or $\mathcal{F}(\pi) = R1(\alpha, \beta) \wedge R2(\beta, \gamma)$).

In accordance with this distinction, the elements of $\mathcal{CS}_X$ are public propositional commitments on SRDS, either *simple*: X is committed to the corresponding DRS, or *complex*: X is committed to the fact that a relation rel holds between the two utterances π_1, π_2.

These commitments should not be confused with private beliefs: they only reflect public information. In Hamblin (1987) terms, beliefs are idealized indicative commitments.

2.2 Commitment dynamics

We consider here how commitments evolve, and how this can be seen as an interpretation of coherence relations in a dialogue, whether we consider "monologic" relations or properly dialogic relations. The following rules can thus be seen as update rules of the board for each established act. According to discourse theories, to be coherent an act has to be involved in a discourse relation. There are two steps: (1) A Speech act update in which A's speech act (π_2) is attached as a discourse constituent to a previous discourse constituent π_1 to the discourse structure through a discourse relation (R) inferred from π_2 content and discourse context. If π_2 is assertive, π_2's content $\mathcal{F}(\pi_2)$ is added to A's commitment store. (2) The semantics effects ϕ_R of discourse relation $R_{(\pi_1,\pi_2)}$ update A's commitment store.

The first case to consider are monologic veridical relations. These relations verify the monologic satisfaction schema proposed in Asher and Lascarides (2003) :

$$(w, f)[\![R(\pi_1, \pi_2)]\!]_M(w', g) \; iff \; (w, f)[\![\mathcal{F}(\pi_1) \wedge_{dyn} \mathcal{F}(\pi_2) \wedge_{dyn} \phi_{R(\pi_1,\pi_2)}]\!]_M(w', g)^1$$

(1) A_1. John went to jail. (π_1)

A_2. He was caught embezzling funds. (π_2)

The notation ϕ_R stands for semantic effects due to the relation R, (e.g. *explanation*(π_1, π_2) implies the event described in π_1 has been *caused* by the one described in π_2 (i.e $cause(e_2, e_1)$) while *result*(π_1, π_2) implies the symmetric ($cause(e_1, e_2)$) in π_1 and π_2. In the following, we note $\Rightarrow_\pi$ the update of commitment stores by a constituent π. If both π_1 and π_2 are produced by the same speaker (A), her commitment store will evolve as follows (Public Commitment Update or PCU):

$$CS_A \Rightarrow_{\pi_1} CS_A \cup \{\mathcal{F}(\pi_1)\} ;$$
$$CS_A \Rightarrow_{\pi_2} CS_A \cup \{\mathcal{F}(\pi_2)\} ;$$
$$CS_A \Rightarrow_{explanation(\pi_1,\pi_2)} CS_A \cup \{explanation(\pi_1, \pi_2)\}$$

If, on the other hand, they are produced by different speakers, let's say $A : \pi_1$ and $B : \pi_2$ their commitment stores will evolve as follows:

$$CS_A \Rightarrow_{\pi_1} CS_A \cup \{\mathcal{F}(\pi_1)\};$$
$$CS_B \Rightarrow_{\pi_2} CS_B \cup \{\mathcal{F}(\pi_2)\};$$
$$CS_B \Rightarrow_{explanation(\pi_1,\pi_2)} CS_B \cup \{\mathcal{F}(\pi_1), explanation(\pi_1, \pi_2)\}$$

The remaining of the board is left unchanged. If it is a monologic relation across speech turns (π_1 is said by A, and π_2 by B), then only the update triggered by π_1 applies to A, while updates triggered by π_2 apply to B's commitment store. Likewise, other relations can be interpreted as commitment updates.

[1]The symbol $\wedge_{dyn}$ stands for the dynamic conjunction.

Relation type of R	Property	Examples
veridical	$R(a,b) \rightarrow K_a \wedge K_b \wedge \phi_{R(a,b)}$	monological relations
right-veridical	$R(a,b) \rightarrow K_b \wedge \phi_{R(a,b)}$	QAP, Correction
left-veridical	$R(a,b) \rightarrow K_a \wedge \phi_{R(a,b)}$	relation$_q$
not veridical	$R(a,b) \rightarrow \phi_{R(a,b)}$	Def-Consequence, Asher and Lascarides (2003)

Figure 1: Relation and veridicality in SDRT

2.3 Veridicality of relations and commitment stores

A relation is said *veridical* if the content of both constituent it relates needs to be satisfied in order to satisfy the relation semantics. Veridical relations correspond to the general case of monologic discourse interpretation that we presented in the previous section. However dialogic contexts require the introduction of non-veridical discourse relations. These relations appear mainly in the following cases:

- **Inconsistencies among speakers propositions:** In this situation, if we stick to classical interpretation we might get some inconsistency. To solve this issue non-veridical discourse relation are used. These relations do not require the satisfaction of both constituent's contents they relate. In the *correction* case, the content of target does not need to be satisfied. Therefore *correction* is right-veridical but not left-veridical (See Fig. 1).
- **Non-assertive utterances:** As we said, to satisfy a veridical relation semantics we must satisfy the semantics on the constituents it relates. There is no problem with (prototypical) indicatives denotating a proposition that can be evaluated in a vericonditional framework. But it is difficult to express interrogatives or imperatives semantics with the same tools. Questions are most commonly treated as set of propositions or as an unsatured proposition (with at least one free variable). Requests are sometimes treated as actions but the discussion on this topic is rather lively. In any case, prototypical interrogatives and imperatives do not denote propositions in truth-value semantics.

In our account veridicality of relations can be more accurately taken in account thanks to their interpretation in terms of public commitments. From a model-theoric viewpoint this integration can be done by imposing some structure to the models we are handling. Roughly, being true is here restricted to the public commitments of one participant (but does not reflect its beliefs). Therefore the satisfaction schema presented does not apply in the same way in a dialogic setting than in the monologic one. However, the construction of a turn is seen as a little monologue and the monologic satisfaction schema can be applied locally.

- Veridical relations:
  $CS_{speaker(\pi_2)} \Rightarrow_{R_{veridical}(\pi_1,\pi_2)} CS_{speaker(\pi_2)} \cup \{\mathcal{F}(\pi_1), \mathcal{F}(\pi_2), R_{veridical}(\pi_1,\pi_2)\}$
- right-veridical,
  $CS_{speaker(\pi_2)} \Rightarrow_{R_{right}(\pi_1,\pi_2)} CS_{speaker(\pi_2)} \cup \{\mathcal{F}(\pi_2), R_{right}(\pi_1,\pi_2)\}$
- left-veridical,
  $CS_{speaker(\pi_2)} \Rightarrow_{R_{left}(\pi_1,\pi_2)} CS_{speaker(\pi_2)} \cup \{\mathcal{F}(\pi_1), R_{left}(\pi_1,\pi_2)\}$
- not veridical at all
  $CS_{speaker(\pi_2)} \Rightarrow_{R_{not-veridical}(\pi_1,\pi_2)} CS_{speaker(\pi_2)} \cup \{R_{not-veridical}(\pi_1,\pi_2)\}$

3 Dialogic relations

Given that speaker B utters π_2, and that π_2 is to be attached to π_1 with the relation R we define the dialogic relations in the following way. For each relation we provide its satisfaction schema, its implicatures, and its effect on the participants public game-board. One could have added effects on mental states but as explained earlier this is not our focus.

Relations of the *Relation*$_q$ family are used for attaching an interrogative constituent that requires an answer realizing a specific rhetorical relation. For example, *Narration*$_q$ requires the answer to satisfy *Narration* with the target of the question. The constituent associated with the question answer pair will be attached to the context through the corresponding monologic relation. B's commitments are not affected but *relation* defines the commitments concerning the answer to the question (see next relation, QAP).

Relation Semantics 1 *Relation*$_q$

(SE) $\phi_{Rel_q(\pi_1,\pi_2)} \rightarrow \top$

(PCU) $CS_{speaker(\pi_2)} \Rightarrow_{Rel_q(\pi_1,\pi_2)} CS_{speaker(\pi_2)} \cup \{\mathcal{F}(\pi_1), Rel_q(\pi_1,\pi_2)\}$

3.1 Question-Answer Pair

The *QAP* relation is used for attaching an answer to the question it is answering. This relation is the SDRT version of the widely studied *question-answer pair*. To satisfy a question-answer relation, the answer has to be satisfied as well as a special predicate $Answer$ which states constraints on the content of the question and of the answer. Roughly, the predicate $Answer$ requires that the intension of the answer is included in the intension of the question. Formally $Answer$ is defined in Asher and Lascarides (2003) in the following way:

(w,f)**[**$Answer(^\wedge\mathcal{F}(\pi_1), p)$**]**$_M(w,f)$ iff $(w,f) = (w',g)$
and $[\![p]\!]_M^{w,f} \in [\![^\wedge\mathcal{F}(\pi_1)]\!]_M^{w,f}$.
Here, $^\wedge$ stands for the intensional operator.

Relation Semantics 2 *QAP (Question-Answer Pair)*

(SE) $\phi_{QAP(\pi_1,\pi_2)} \rightarrow Answer(^\wedge\mathcal{F}(\pi_1), ^\wedge\mathcal{F}(\pi_2))$

(PCU) $CS_{speaker(\pi_2)}[Rel_q(\alpha,\pi_1)] \Rightarrow_{QAP(\pi_1,\pi_2)} CS_{speaker(\pi_2)} \cup \{\mathcal{F}(\pi_2), QAP(\pi_1,\pi_2), Rel(\alpha,\pi_2)\}$

At the public commitment level (PCU), providing an answer commits to the answer content and to the link between the context and the resolved question. To express this last point we use a new notation. The bracketed part of $CS_{speaker(\pi_2)}[Rel_q(\alpha,\pi_1)]$ signals that $Rel_q(\alpha,\pi_1)$ must already be in the commitment store of $speaker(\pi_2)$.

3.2 Acknowledgment

The *Ack* relation is used for attaching an acknowledgment to its target. This can range from a simple marker of positive feedback (e.g yes, yeah) to full repetitions or reformulations.

Relation Semantics 3 *Acknowledgment*

(SE) $\phi_{Ack(\pi_1,\pi_2)} \rightarrow \top$

(PCU) $CS_{speaker(\pi_2)} \Rightarrow_{Ack(\pi_1,\pi_2)} CS_{speaker(\pi_2)} \cup \{\mathcal{F}(\pi_1), Ack(\pi_1,\pi_2)\}$

B commits itself to π_1 content.[2] This constituent is not always an isolated utterance. It might be the topic of a resolved question-answer pair.

[2] Acknowledgment is more complex when communication is not taken as "perfect". In this case, mere reception receipt have to be distinguished from genuine acceptances.

3.3 Wide scope acknowledgment

It is possible to extend an acknowledgment scope beyond its target utterance according to the veridical nature of the relation linking its target to the discourse context. For instance, for at least a left-veridical relation: Let's assume $ack(\pi_1, \pi_2)$, $R(\pi_0, \pi_1)$ and R is left-veridical:

$$\mathcal{C}S_{speaker(\pi_2)}[R_{left}(\pi_0, \pi_1)] \Rightarrow_{ack(\pi_1,\pi_2)} \{\mathcal{F}(\pi_0), \mathcal{F}(\pi_1), R(\pi_0, \pi_1)\} \cup \mathcal{C}S_{speaker(\pi_2)}$$

For a divergent relation (e.g. reject): assume $ack(\pi_1, \pi_2)$, $R(\pi_0, \pi_1)$ and R is divergent:

$$\mathcal{C}S_{speaker(\pi_2)}[R_{divergent}(\pi_0, \pi_1)] \Rightarrow_{ack(\pi_1,\pi_2)} \{\neg\mathcal{F}(\pi_0), \mathcal{F}(\pi_1), R(\pi_0, \pi_1)\} \cup \mathcal{C}S_{speaker(\pi_2)}$$

The commitment to a new relation through the acknowledgment also requires the update of the commitment store according to these new relations. An important issue in dialogue management is to determine how far such chains can go. Having a discourse structure and its discourse topics will be of great help for dealing with this issue.

3.4 Divergent relations

Regarding veridicality, we now introduce the last kind of relation we will consider, *divergent relations*. These relations, in the classical SDRT framework, are satisfied if they entail the negation of their target. A consequence of this effect is to require discourse structure revision which is a tricky operation that we would prefer to avoid. Our proposal consists in not directly evaluating the content involved in divergent relations at the "absolute truth"-level but rather in the commitment stores of the participant.

3.5 Reject

The *Correction* relation and the *Reject* relation are close. However *Correction* offers a proposition "attacking" the target, while *Reject* simply denies without proposing anything. *Correction* is then more sophisticated than *Reject*. It is used when a new utterance corrects a previous one, specifying what the speaker disagrees with.

Relation Semantics 4 *Reject*

(SS) $(w, f)[\![Reject(\pi_1, \pi_2)]\!]_M(w', g)$ iff $(w, f)[\![\mathcal{F}(\pi_2) \wedge_{dyn} \phi_{Reject(\pi_1,\pi_2)}]\!]_M(w', g)$

(SE) $\phi_{Reject(\pi_1,\pi_2)} \rightarrow (K_2 \rightarrow \neg K_1)$

(PCU) $CS_{speaker(\pi_2)} \Rightarrow_{Reject(\pi_1,\pi_2)} CS_{speaker(\pi_2)} \oplus \{\neg\mathcal{F}(\pi_1), Reject(\pi_1, \pi_2)\}$

(PCU-2) $CS_x[\pi_\alpha] \Rightarrow_{Reject(\pi_\alpha,\pi_2)} CS_x \oplus \mathcal{F}(\pi_\alpha)$

In the last line, $\oplus$ stands for a revision operator. B negatively commits himself on π_1 content.

In this first attempt we consider only simple constituent rejection since we did not find any example of a complex turn rejected without an explicit correction on the target.

3.6 Correction

We will try to illustrate here some of the properties of our proposal, in the well-known "embezzling" case, next section, and the case of multiple corrections.

Relation Semantics 5 *Correction*

(SE) $\phi_{Correction(\pi_1,\pi_2)} \rightarrow (K_2 \rightarrow \neg K_1)$

(PCU) $CS_{speaker(\pi_2)} \Rightarrow_{Correction(\pi_1,\pi_2)} CS_{speaker(\pi_2)} \oplus \{\neg\mathcal{F}(\pi_1), \mathcal{F}(\pi_2), Correction(\pi_1, \pi_2)\}$

As with $Acknowledgment$, the scope of the correction might be ambiguous. In the last line, $\oplus$ stands for a revision operator.

4 Examples

4.1 Correction of a coherence relation

(2) A_{1a}. John went to jail. A_{1b} He was caught embezzling funds.

B_{2a}. No. B_{2b} He went to jail B_{2c} because he was convicted of tax evasion.

A_3. oh... OK.

This example has already been investigated in Asher and Lascarides (2003); Kreutel and Matheson (2002).

Turn	$\mathcal{DS}$	$\mathcal{CS}_A$	$\mathcal{CS}_B$
A_{1a}	π_{1a}	$+\mathcal{F}_{1a}$	
A_{1b}	$+\pi_1 : expl(\pi_{1a}, \pi_{1b})$	$+\mathcal{F}_{1b}, +expl(\pi_{1a}, \pi_{1b})$	
B_{2a}	$+\pi_A : reject(\pi_1, \pi_{2a})$		
B_{2b}	$+\pi_B : ack(\pi_{1a}, \pi_{2b})$		$+ack(\pi_{1a}, \pi_{2b}), +\mathcal{F}_{1a}$
B_{2c}	$+\pi_C : expl(\pi_{2b}, \pi_{2c})$ $+\pi_D : corr(\pi_A, \pi_{2b})$		$+\mathcal{F}_{2c}, +expl(\pi_{2b}, \pi_{2c})$ $+\neg expl(\pi_{1a}, \pi_{1b}), +corr(\pi_1, \pi_2)$
A_3	$+ack(\pi_2, \pi_3)$	$+ack(\pi_2, \pi_3) + \mathcal{F}_{2b}, +\mathcal{F}_{2c}$ $+cor(\pi_1, \pi_2), \oplus\neg expl(\pi_{1a}, \pi_{1b})$	

The first *Explanation* is inferred from world knowledge stating that being caught embezzling fund is a possible cause for going to jail. We consider B_2's turn as made of three moves. First, B rejects A's contribution. Inferring the rejection and the acknowledgment does not raise any problems. Acknowledgement is inferred thanks to some redundancy in the utterance. A similar world knowledge rule to the one use for A_1 can be used for inferring the explanation between π_{2b} and π_{2c}. However, we still need the link between π_{1a} and π_{2b} for establishing the correction. The content of the acknowledgment is simply the content of its target. At the commitment's level the acknowledgment commits the speaker to its target. The last inference concerns the establishment of the full turn by B as a correction of A's turn. It is possible to identify a background (the repetition) and a focus (the new explanation) in B's turn. The only possible target for the correction is the explanation relation as emphasized by the use of the discourse marker *because*. Finally A accepts B's correction and commits herself to what B said. While doing this, she has to revise her position about the explanatory link.

As the treatment of this example show, the main part of the work is done at the level of the discourse structure, specially for establishing the scope of the relations (in particular *Reject*, *Correction* and *Ack*). These aspects are not fully developed in our proposal and require a deeper investigation in which discourse topics and dialogue games have a special importance.

4.2 Multiple corrections

In our framework, multiple corrections can easily be treated too, using the same set of rules, without revising any part of the discourse structure.

For instance:

(3) A1a. Taipei 101 is 509 meters high.

A1b. It's the tallest tower in the world

B2. No, it's not

A3. Why not ?

B4. There are the Petronas Tower in Malaysia reaching 552 meters

A5. no, it's only 452 meters

B6. oh, OK

The first turn by A is a description of the building and is articulated around the *Narration* relation. B's initial contribution is a simple *Reject* and it is easy to infer from the semantic content. B is expected to justify his rejection and this expectation is made explicit by A's challenge. *Challenge* is inferred both from the content and the very fact that a rejection requires a justification. Then B answers the challenge by providing a correction[3] attacking A_{1b}. But A corrects B's information. Finally B accepts A's correction forcing himself to reconsider his own correction. However at this point of the dialogue, it is not clear whether B commit himself to A's initial proposal or not. One can think about a following where B provides a new attack on A proposition like *What about the Sears tower in Chicago?*.

Turn	$\mathcal{DS}$	$\mathcal{CS}_A$	$\mathcal{CS}_B$
A1a	π_{1a}	$+K_{1a}$	
A1b	$+cont(\pi_{1a}, \pi_{1b})$	$+K_{1b}, +cont(\pi_{1a}, \pi_{1b})$	
B2	$+rej(\pi_{1b}, \pi_2)$		$+K_2, +\neg K_{1b}$ $+rej(\pi_{1b}, \pi_2)$
A3	$+expl_q(\pi_2, \pi_3)$	$+expl_q(\pi_2, \pi_3)$	
B4	$+QAP(\pi_3, \pi_4), +cor(\pi_{1b}, \pi_4)$		$+K_4, +expl(\pi_2, \pi_4), +cor(\pi_{1b}, \pi_4)$
A5	$+corr(\pi_4, \pi_5)$	$+K_5, +\neg K_4$ $+cor(\pi_4, \pi_5)$	
B6	$+ack(\pi_5, \pi_6)$		$+K_5$

5 Conclusion

What we believe is interesting here is the integration of social conversational constraints with a semantic framework. The next step towards the integration of discourse structure approaches and conventional approaches consists in the unification of discourse structure and dialogues games, cf. Mann (1988). More precisely, SDRT topics are constituents of the discourse structure which ensure *thematic coherence* of particular sequences such as narrative chains. These constituents are *simple* and correspond to a kind of sum-up of an utterance sequence. Dialogue games are structures taking care of coherence of chain of utterances. These "macro-structures" are dedicated to interaction management but in a broader sense they have the same purposes as topics. In fact, dialogue games definitions include a sequence of specific moves (question/answer/ack) and a topic or theme, see Lewin (2000).

References

Asher, N. and Gillies, A. (2003). Common ground, corrections and coordination. *Argumentation*, 17(4).

Asher, N. and Lascarides, A. (2003). *Logics of conversation*. Cambridge University Press.

Cohen, R. and Perrault, C. (1979). Elements of a plan-based theory of speech-acts. *Cognitive Science*, 3:177–212.

Grice, P. (1975). Logic and conversation. In Cole, P. and Morgan, J., editors, *Syntax and Semantics*, volume 3. Academic Press, London.

Grosz, B. and Sidner, C. L. (1986). Attention, intentions, and the structure of discourse. *Computational Linguistics*, 12(3):175–204.

Hamblin, C. (1970). *Fallacies*. Methuen.

Hamblin, C. (1987). *Imperatives in Dialogue*. Basil Blackwell.

[3] A more accurate account may use the relation of counterevidence instead of correction, see Asher and Gillies (2003) for more precisions.

Kreutel, J. and Matheson, C. (2002). From dialogue acts to dialogue act offers: Building discourse structure as an argumentative process. In *Proccedings of EDILOG*.

Lewin, I. (2000). A formal model of conversational game theory. In *Proceedings of Gotalog*.

Lewis, D. K. (1979). Scorekeeping in a language game. *Journal of philosophical logic*, 8:339–359.

Mann, W. C. (1988). Dialogue games : Conventions of human interaction. *Argumentation*, 2(4):511–532.

Traum, D. and Allen, J. F. (1994). Discourse obligations in dialogue processing. In *Proceedings of the 32nd annual meeting of the Association for Computational Linguistics*, pages 1–8.

Walton, D. N. and Krabbe, E. C. W. (1995). *Commitment in dialogue: basic concepts of interpersonal reasoning*. State University of New York Press.