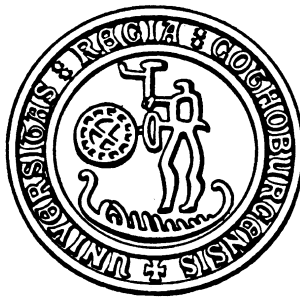


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99-2

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April 30, 1999



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Department of Linguistics, Göteborg University,
Box 200, SE-405 30 Göteborg, Sweden

Accommodating Information States in Dialogue

Peter Bohlin, Robin Cooper, Elisabet Engdahl, Staffan Larsson
{peb,cooper,engdahl,sl}@ling.gu.se

Dept of Linguistics, Göteborg University
P.O. Box 200, S-405 30 Göteborg, Sweden
Phone: +46 31 773 1000
Fax: +46 31 773 4853

April 30, 1999

Abstract

In this paper we will look at the role of accommodation in information state transitions associated with dialogue updates. We will point to examples of three kinds of accommodation: accommodation of grounding information, of questions under discussion and of dialogue plan. The informal representation of dialogue information states we present here has been developed in the TRINDI¹, SDS² and INDI³ projects to explore the nature of dialogue moves.

We first give a brief introduction to the information states we are assuming, after which we discuss the three kinds of accommodation.⁴

Keywords: dialogue, semantics, information states, accommodation

1 Information states

The notion of information state we are putting forward here is basically a simplified version of the dialogue game board which has been proposed by Ginzburg (1996a, 1996b, 1998). We are attempting to use as simple a version as possible in order to have a more or less practical system for annotating dialogues with a view to specifying an automated dialogue system based on Ginzburg's ideas. In this section we briefly present our version of information states, see Cooper & Larsson (1998) for a more detailed discussion.

We represent information states of a dialogue participant as records of the following type:

$$(1) \left[\begin{array}{l} \text{PRIVATE} : \left[\begin{array}{l} \text{BEL} : \text{SET}(\text{PROP}) \\ \text{PLAN} : \text{LIST}(\text{ACTION}) \\ \text{AGENDA} : \text{STACK}(\text{ACTION}) \\ \text{TMP} : \left[\begin{array}{l} \text{BEL} : \text{SET}(\text{PROP}) \\ \text{QUD} : \text{SET}(\text{QUESTION}) \end{array} \right] \end{array} \right] \\ \text{SHARED} : \left[\begin{array}{l} \text{BEL} : \text{SET}(\text{PROP}) \\ \text{QUD} : \text{STACK}(\text{QUESTION}) \end{array} \right] \end{array} \right]$$

¹TRINDI (Task Oriented Instructional Dialogue), EC Project LE4-8314

²SDS (Swedish Dialogue Systems), NUTEK/HSFR Language Technology Project F1472/1997

³INDI (Information Exchange in Dialogue), Riksbankens Jubileumsfond 1997-0134.

⁴We will illustrate our discussion from a Swedish dialogue that has been collected by the University of Lund as part of the SDS project. We quote the transcription done in Göteborg as part of the same project.

The main division in the information state is between information which is private to the agent and that which is shared between the dialogue participants. What we mean by shared information here is that which has been explicitly established during the conversation (akin to what Lewis (1979) called the “conversational scoreboard”).

The private part of the information state contains a set `BEL` of private beliefs. The `PLAN` field contains a dialogue plan, i.e. is a list of dialogue actions that the agent wishes to carry out. The plan can be changed during the course of the conversation. For example, if a travel agent discovers that his customer wishes to get information about a flight he will adopt a plan to ask her where she wants to go, when she wants to go, what price class she wants and so on. The `AGENDA` field, on the other hand, contains the short term goals or obligations that the agent has, i.e. what the agent is going to do next. For example, if the other dialogue participant raises a question, then the agent will normally put an action on the agenda to respond to the question. This action may or may not be in the agent’s plan.

We have included a field `TMP` that mirrors the shared fields. This field keeps track of shared information that has not yet been grounded, i.e. confirmed as having been understood by the other dialogue participant⁵. In this way it is easy to delete information which the agent has optimistically assumed to have become shared if it should turn out that the other dialogue participant does not understand or accept it. If the agent pursues a cautious rather than an optimistic strategy then information will at first only be placed on `TMP` until it has been acknowledged by the other dialogue participant whereupon it can be moved from `TMP` to the appropriate shared field.

The `SHARED` field is divided into two. One subfield is a set of propositions which the agent assumes for the sake of the conversation. The other subfield is for a stack of questions under discussion (`QUD`). These are questions that have been raised and are currently under discussion in the dialogue. Our view of this is again very local and a simplification of what Ginzburg proposes. Another simplification we have made in order to make this a practical tool for annotating dialogues is that we represent propositions and questions by English sentences.

With this type of annotation, we have a snapshot of the contents of the participants’ information states at each stage in the dialogue. Given what is present in `PLAN`, `AGENDA` and `QUD`, we can make reasonable predictions concerning the following utterances and we see this as a step in the specification of part of an automated dialogue system.

2 Accommodation

We define dialogue moves as updates to information states directly associated with utterances. If you take a dialogue or information update perspective on Lewis’ (1979) notion of accommodation, it corresponds to moves that are tacit (i.e. not associated with an utterance). Tacit moves could also be called “internal” or “inference” moves. The motivation for thinking in terms of accommodation has to do with generality. We could associate expressions which introduce a presupposition as being ambiguous between a presuppositional reading and a similar reading where what is the presupposition is part of what is asserted. For example, an utterance of “The king of France is bald” can either be understood as an assertion of that sentence and a presupposition that there is a king of France or as an assertion of the sentence “There is a king of France and he is bald”. However, if we assume an additional tacit accommodation move before the integration of the information expressed by the utterance then we can say that the utterance always has the same interpretation.

In a similar way we can simplify our dialogue move analysis by allowing tacit moves rather than requiring that utterances sometimes are associated with more complex moves than normal to incorporate the effect of accommodation.

2.1 Accommodation in grounding

A speaker can indicate that she has understood or accepted a contribution from the other dialogue participant by explicit grounding, uttering a word like *yes* or *right*. However, a speaker may simply continue with the conversation with something relevant to the previous utterance. Rather than say that every move has an alternative variant where the previous

⁵In discussing grounding we will assume that there is just one other dialogue participant.

contribution is grounded, we assume that the grounding information is tacitly accommodated when the conversation is continued in this way. Accommodation is involved in this case independently of whether we adopt an optimistic or cautious strategy for grounding (Cooper & Larsson 1998). On the optimistic strategy the agent places the information associated with her utterance on both TMP and SHARED. When the other dialogue participant continues the conversation by a new utterance without explicit grounding, she first accommodates by clearing TMP and then integrates the information from the new utterance. On the cautious strategy (see e.g. Traum 1994) the agent places the information associated with her utterance only on TMP. In this case she has to accommodate the other dialogue participant's utterance without explicit grounding by moving the information from TMP to SHARED before integrating the information associated with the new utterance.

An utterance can fail to be grounded, e.g. because the other dialogue participant does not hear or understand. (2) is an example of this:

- (2) \$J: ska du ha: en returbiljett
 < do you want a return ticket >
 \$P: va sa du
 < what did you say >

In this case, assuming an optimistic strategy, *J* has to remove *Do you want a ticket?* both from QUD and from TMP, before updating his agenda with an action to respond to *What did you say?*. On a cautious strategy he would only have to remove the question from TMP.

2.2 Accommodating a question onto QUD

Dialogue participants can address questions that have not been explicitly raised in the dialogue. However, it is important that a question be available to the agent who is to interpret it because the utterance may be elliptical. Here is an example from our dialogue:

- (3) \$J: vicken månad ska du åka
 (what month do you want to go)
 \$P: ja: typ den: ä: tredje fjärde april / nån gång där
 (well around 3rd 4th april / some time there)
 \$P: så billit som möjligt
 (as cheap as possible)

The strategy we adopt for interpreting elliptical utterances is to think of them as short answers (in the sense of Ginzburg 1996a, 1996b, 1998) to questions on QUD. A suitable question here is *What kind of price does P want for the ticket?*. This question is not under discussion at the point when *P* says “as cheap as possible”. But it can be figured out since *J* knows that this is a relevant question. In fact it will be a question which *J* has as an action in his plan to raise. On our analysis it is this fact which enables *A* to interpret the ellipsis. He finds the matching question on his plan, accommodates by placing it on QUD and then continues with the integration of the information expressed by *as cheap as possible* as normal. Note that if such a question is not available then the ellipsis cannot be interpreted as in the dialogue in (4).

- (4) A. What time are you coming to pick up Maria?
 B. Around 6 p.m. As cheaply as possible.

This dialogue is incoherent if what is being discussed is when the child Maria is going to be picked up from her friend's house (at least under standard dialogue plans that we might have for such a conversation).

2.3 Accommodating the dialogue plan

After an initial exchange for establishing contact the first thing that *P* says to the travel agent in our dialogue is:

- (5) \$P: flyg ti paris
< flights to Paris >

This is again an ellipsis which on our analysis has to be interpreted as the answer to a question in order to have content. As no questions have been raised yet in the dialogue the travel agent cannot find the appropriate question on his QUD. Furthermore, as this is the first indication of what the customer wants, the travel agent does not have a plan with detailed questions. We assume that the travel agent has various plan types in his domain knowledge determining what kind of conversations he is able to have. E.g. he is able to book trips by various modes of travel, he is able to handle complaints, book hotels, rental cars etc. What he needs to do is take the customer's utterance and try to match it against questions in his plan types in his domain knowledge. When he finds a suitable match he will accommodate his plan, thereby providing a plan to ask relevant question for flights, e.g. when to travel?, what date? etc. Once he has accommodated this plan he can proceed as in the previous example. That is he can accommodate the QUD with the relevant question and proceed with the interpretation of ellipsis in the normal fashion.

This example is interesting for a couple of reasons. It provides us with an example of "recursive" accommodation. The QUD needs to be accommodated, but in order to do this the dialogue plan needs to be accommodated. The other interesting aspect of this is that accommodating the dialogue plan in this way actually serves to drive the dialogue forward. That is, the mechanism by which the agent interprets this ellipsis, gives him a plan for a substantial part of the rest of the dialogue. This is a way of capturing the intuition that saying *flights to Paris* to a travel agent immediately makes a number of questions become relevant.

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