DISTINGUISHING USER MODELS FROM DISCOURSE MODELS

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1 INTRODUCTION

In the discussion about the relationship between user models (UMs) and discourse models (DMs) so far, at least three positions have been stated explicitly.

Pl. the DM is a part of the UM (e.g., Schuster)
P2. the DM intersects the UM (e.g., Chin)
P3. the DM and the UM are distinct (e.g.,Wahlster 1986, Cohen)

Of course, the interpretation of these positions depends on the definition of the terms involved and the underlying notion of the "part-of", "intersect", and "distinct" relations. The relationships cannot simply be interpreted in a set-theoretic sense, since all definitions for UMs and DMs proposed so far depend not only on representation structures, but also on processes used for the construction, maintenance, and exploitation of these structures.

Since this is a terminological, and not an empirical, discussion, as I pointed out in Wahlster (1986), P1-P3 are primarily normative statements. So, P3, for instance, must be interpreted as "The terms UM and DM should be defined in such a way, that they do not overlap".

This view seems not to be shared by all participants in the discussion. Schuster, for example, tries to prove her position (P1) in a set-theoretic sense. First, she argues that "the user model contains information that does not appear in the discourse model" and then she "proves" that "any information in the discourse model is also in the user model".

I disagree not only with the form, but also with the content of Schuster's argumentation. She writes "only if the discourse model is part of the user model can the system take it into account in its responses and its reasoning about the users". By considering an isomorphic argumentation like "only if a tomato is part of cheese, can one use it to prepare pizza" it becomes clear that this proof is flawed.
Also, Morik points out correctly that if one follows Schuster's argumentation one should "view the grammar as part of the user model, because the grammar is necessary for understanding and producing utterances".

Today, it is a standard hypothesis in AI and computational linguistics that models for the language understanding and generation process must exploit various knowledge sources, including in many cases a DM and a UM. For example, in Jameson and Wahlster (1982) we described the NP generator of the HAM-ANS system, in which the generation of a definite or indefinite description was influenced both by the UM and the DM. But this in no way means that one must be included in the other.

As long as there is no definitive evidence (e.g., from psychology or the neurosciences) for a particular structure, content, and use (or even existence) of UMs and DMs in the human information processing system, in AI the notions of UM and DM are concepts that help on the one hand to construct a theory of natural language dialog behavior, and on the other hand to structure the software systems that realize natural language systems.

From the second point of view, which is the engineering perspective, the question of whether Pl, P2, or P3 holds, is easy to decide so far. In most of the implemented systems the data structures and procedures labeled UM and DM are completely distinct. Even the recent GUMS package (Finin 1988), a general user modeling component, contains no specific representation structures or processes for discourse modeling.

Since the discussion above suggests that we view the relation between the UM and the DM mainly as a terminological problem, in the next section we focus on possible definitions for UMs and DMs. Although often terminological discussions become quite tedious, at this point it seems to be important to define these concepts as precisely as possible, since many researchers are discovering interesting relationships between discourse and user models.

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2 Defining User Models and Discourse Models

Some authors define user models simply as information that the system has about its users (e.g., Schuster). I think this definition is too broad. Consider an NL interface to a data base, which contains the following relation:

EMP#	NAME	AGE	BONUS
26	Jones	32	40

When Mr. Jones happens to be the user of this system and asks, "What is my bonus?", the system should respond "40". In this case, the system has information about the user, but one would not like to say that its response was based on a user model.

Even if one restricts the definition above to "information about the user put to use" (see Sparck Jones), it is not strong enough. If a deductive data base in addition to the relation above includes a rule like "If AGE(X) > 30 and BONUS(X) > 35 then STATUS(X) = 10" and Mr. Jones asks, "What is my status?" the system should respond "10". Even though the deductive DBMS uses information about the user to instantiate the inference rule, such a system should not be construed as having a user model.

I propose the following joint definitions of user model and user modeling component (see Wahlster and Kobsa 1988) as well as discourse model and discourse modeling component in the context of NL dialog systems:

A *user model* is a knowledge source that contains explicit assumptions on all aspects of the user that may be relevant for the dialog behavior of the system. A *user modeling component* is that part of a dialog system whose function is to

- incrementally build up a user model;
- store, update, and delete entries in it;
- maintain the consistency of the model; and
- supply other components of the system with assumptions about the user.

A *discourse model* is a knowledge source that contains the system's description of the syntax, semantics, and pragmatics of a dialog as it proceeds. A *discourse modeling component* is that part of a dialog system whose function is to

- incrementally build up a discourse model;
- store and update entries in it; and
- supply other components of the system with information about the structure and content of the previous segments of the dialog.

While it seems commonly agreed upon that a DM should contain a syntactic and semantic description of discourse segments, a record of the discourse entities mentioned, the attentional structure of the dialog including a focus space stack, anaphoric links, and descriptions of individual utterances on the speech act level, there seem to be many other ingredients needed for a good discourse representation which are not yet worked out in current computational discourse theory. Therefore, I prefer to refer only to the abstract levels of necessary discourse representation in the definition above.

3 Some Differences And Similarities Between User Models And Discourse Models

An important difference between a discourse model and a user model is that entries in the user model often must be explicitly deleted or updated, whereas in the discourse model entries describing the structure and content of utterances of the ongoing dialog are never deleted (except for forgetting phenomena, which are beyond the scope of the current discussion). Thus, according to our definition above, a belief revision component is an important part of a user modeling component.
Consider the following dialog with a hypothetical tutoring system in the SCHOLAR tradition.

System: (1) Tell me about California.
User: (2) San Francisco is the capital of California.
System: (3) No, that's wrong.
User: (4) I see. So, that's not the capital.
(5) Then, what is its capital?
System: (6) Sacramento.
(7) Now, tell me why you mentioned San Francisco first, when you began to talk about California.

A simple consequence of the user's response (2) is an entry in the system's user model, which represents the fact, that the system believes that the user believes (B1). After (3), and certainly after (4) the user model should contain (B1').

(B1) capital(California, San-Francisco)
(B1') not(capital(California, San-Francisco))
(B2) capital(California, Sacramento)

This means that the user modeling component has to remove (B1) from the user model (in a reason maintenance system this causes (B1) to be added to the set of beliefs, which are currently "out"). After (6) the user's belief (B2) should be added to the system's user model. If the apriori user model contains "For each state there exists one and only one capital" as a mutual believed fact, then the user modeling component can also remove (B1) after adding (B2).

In the discourse model, of course, the fact that the user uttered sentence (2) should not be deleted. For example, the system could go on and ask the user a question like (7), which explicitly refers to the fact that (2) was the first reaction to (1). What this simply means is that the fact that the user made a particular assertion remains true even if the user's belief changes and he withdraws his previous assertion.

Even a metacommunicative act like (9) should not delete entries in the discourse model, as the successful anaphoric reference in (10) to a discourse entity introduced in (8) suggests. But it is obvious that in the user model the corresponding representation of the user's wants has to be changed.

User: (8) I don't want to travel with my kids.
(9) Forget what I just said.
(10) I want to travel with them.

This does not imply that the discourse model is static and the user model is dynamic. The discourse model is also highly dynamic (consider, e.g., focus shifting), but it lacks the notion of logical consistency, which is important for belief revision and default reasoning in a user modeling component. In my view, the discourse model is like an annotated trace of the various levels of the system's processing involved in understanding the user's utterances and generating its own dialog contributions.

Let's consider another example to emphasize the differences between a UM and a DM. Suppose that the system plays the role of a travel agent, who wants to sell trips to the well-known holiday places A and B, for which it has some reasonably priced offers. When the user asks, "What are your cheapest trips?" the system lists A and B first, followed by a hastily presented list of eight other places with names, which it assumes are totally unfamiliar to the user. In the system's DM all ten places appear, but the user modeling component of the system explicitly assumes that the user only believes "cheap-trip-to(A)", "cheap-trip-to(B)" together with the belief that there are some other cheap trips available. This is exactly the aim of the uncooperative behavior of the travel agent: Now, it is likely that the user wants to know more about the offers A and B ' which the agent wants to sell. But if the user later finds out that a trip to one of the other places is much cheaper and better, and complains to the travel agent, "Why didn't you suggest this trip right at the beginning?", the travel agent can refer back to his DM and say, "I mentioned this place among my first suggestions".

Some authors claim that the discourse model expires at the end of a dialog, while parts of the user model may be saved for further use (e.g., Chin). I think that is wrong. Often a dialog participant is able to paraphrase a segment of a previous dialog without remembering who the dialog partner was and at what time and location the dialog took place. While he may not be able to reconstruct the exact phrasing, he has access to a representation of the semantics and pragmatics of the interaction. Furthermore, I think that often conversational rules and tactics are learned by induction over a large set of interaction patterns extracted from discourse models, which were partially saved in episodic memory, where they are not necessarily associated with a long-term user model. In order to learn how to use a language it seems to be important to not always discard the complete discourse model after the end of a conversation.

On the other hand, one often has many assumptions about the beliefs, plans, and goals of a dialog partner before a new dialog begins (cf. Wahlster and Kobsa 1988), without having a clear idea from which actual dialogs the assumptions in this user model were derived. Thus I agree with Morik that the short-term/ long-term criterion cannot be used to distinguish user models and discourse models. If one prefers to restrict the term discourse mode] to an ongoing conversation and to define the saved portions of it as part of the world knowledge, then one should do the same for the term user model, so that again the criterion does not discriminate.

While in many cases the UM component and the DM component process the same input (e.g., a meaning representation of the last utterance), and their output is used by the same processes, I would suggest that both components be kept separate. Even if there is some information, which should be present in both models, it will be represented in another form, since, as I pointed out above, the functionality and the type of processing of the UM and DM components are so different. In this case we have a multiple knowledge representation in the UM and the DM, which is quite common in complex AI Systems.

As I remarked in the beginning, in asking who is right in this discussion, one must carefully evaluate the corresponding definitions for UM and DM proposed by the respective authors. In this paper, I introduced and motivated definitions, under which a UM and a DM are separate, but related to each other.

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