A Natural Language Interface for Intelligent Tutoring Systems

A.Díaz de Ilarraza (*), M. I. Fernández de Castro(*) M. F.Verdejo Maillo(**)
(*)Facultad de Informática de San Sebastián, U. P. V.Ap 649, 20080 San Sebastián, Spain, Tel (34)(43)218000 Ext 34, email: aradiaz@if.ehu.es
(**)Facultad de Informática de Barcelona , U. P. C.
Pau Gargallo 5,08028 Barcelona, Spain, Fax(34)(3)(4017040)

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Abstract

In this paper we describe a natural language interface for tutorial tasks in ITS. Our proposal provides a new way to recognize and generate instructional dialogues capturing participant's intentions.

To present knowledge in a problem-solving context, a tutor has to decide the sequence of instructional episodes; we see this task as a planning activity, and a full description of the proposed approach has been given in [4]. To communicate in a reasonable and cooperative way, the system must recognize what goals the student want to achieve at each point of the dialogue. In order to do this, NL-utterances have to be interpreted in their context. Previous works [7,8] on natural language processing for ITS systems present an approach where pedagogic strategies are interleaved with linguistic knowledge for generating tutorial discourse. Our proposal provides a new way to recognize and generate instructional dialogues capturing participant's intentions: we distinguish the pedagogical model from the discourse model, this one being managed by the interface.

Written dialogues corresponding to a teaching session are composed by interrelated sentences, reflecting the underlined pedagogical strategy stated by the tutor component; each dialogue is partitioned on segments aggregating the linguistic expressions produced by the student and the tutor to communicate about a particular instructional goal. The interface operates in close cooperation with the tutor module; communication between them is performed by messages containing relevant information about the current state of the instructional task. A parser produces the interpreted meaning of student´s utterances, sending the information to the tutor. Natural language processing is carried out using contextual, semantic and syntactic knowledge.

Current theories of discourse try to define basic units and their relationships, in order to structure a dialogue and provide mechanisms for the processing of utterances. In particular Grosz [1], and Ferrari [5] propose abstract models where the intentional structure and the focus of attention are considered. Taking into account these ideas, our aim is to define a framework for tutorial dialogue i.e. cataloging communicative acts in terms of teaching actions, how they form regular patterns and in which way are they related to pedagogic goals and strategies.

We propose a dialogue structure formed by five levels: teaching session, thematic dialogue, exchange, intervention and NL-utterance. Information attached to different levels provide the intentional and attentional state needed to analyze student's sentences.

The most general level is **session**, it involves the complete tutor-pupil interaction from the beginning of the interaction to the end. A session is carried out to reach a set of tutoring objectives established by the pedagogic component, i.e. a session is composed by a set of related dialogues corresponding to the strategy followed to attain an objective's sequence.

Each pedagogic objective is refined into more concrete pedagogic-thematic objectives, depending on the student's knowledge. This thematic refinement is dynamically included as a global focus of attention in order to maintain information about the domain knowledge being handled in the current dialogue.

A dialogue has always a purpose and a subject (global focus) and is formed by a sequence of exchanges. For each exchange a local thematic focus is defined. A catalogue of exchanges has been built following the taxonomy defined for the pedagogic-thematic objectives.

Furthermore an exchange is composed by a set of exchanges and interventions (i.e. a fragment of text produced by each interlocutor). As mentioned, each type of tutor 's objective determines a class of exchange forms and so defines a possible combination of interactions/exchanges. For example, a type of explanatory exchange is characterized by a) a tutor intervention to send an explanatory text, b) A student´s confirmation, and optionally c) an evaluation exchange. This knowledge provides a way to create expectations for guiding the parsing process.

An intervention is formed by NL-utterances. We distinguish five major types of student communicative acts:

* Confirmation: the student express that he does or does not understand the explained concepts without more detail. For example *"I don't understand what you are talking about"*.
* Request: The student proposes the Tutor to perform an action. For instance to solve a problem or a more detailed explanation.
* Query: The student has a doubt about a concept and asks for an explanation.
* Information: The student states precisely which concepts he knows and which he does not
* Evaluable answer: the student proposes a solution to a problem or a domain question.
* Comment: messages included in this group are related to the student own activity (learning state) not belonging to the previous types.

Request, query, information and confirmation are further subclassified forming a hierarchy taking into account the focused objects of the student´s intervention.

For thematic objects we distinguish the following cases:

* Thematic objects related to the subject matter
  - an item, either to validate a hypothesis or to know its conceptual definition, the value of a property, its relationship with other items.
  - a related subset of subject-matter items to perform some comparative operations.
* Thematic objects related to the Tutor activity.
  - asking for the purpose of the teaching task itself.
  - requesting explicitly a teaching concept (a problem, an example, etc.)

Thematic objects are derived by the parser in two different ways, implicitly (inferred from the dialogue attentional structure) or explicitly (the student gives information about the potential focus).

Illocutionary acts combined with thematic objects define the set of possible objetives for a student´s intervention. Nine different types of objectives have been detected: (1) "give information", (2) "get an example related to a concept", (3) "get a problem related to the concept explained in order to acquire practice", (4) "obtain an explanation about a concept", (5) "obtain an explanation about the teaching activity", (6) "to continue the teaching activity", (7) "to change the teaching activity", (8) "obtain a confirmation for an hypothesis", (9) "to verify the correction of a problem".

The type of objective is used to update the dialogue structure, in particular for deciding if a new interchange has to be created. For example, a "get a problem related to the concept explained in order to acquire practice" produces a new student´s guided interchange.

The interface has been completely designed and a prototype is currently implemented The morphologic and syntactic components include a large dictionary and a Spanish grammar, (being also used in other applications). The semantic component is based on a frame formalism. The sublanguage accepted has been defined to cover the experimental material collected (140 hours of interactive teaching). Portability has been considered, for instance the taxonomy for verbs contains three groups: the first one related to the communication process (to say, tell,..), the second one to the instructional task (to explain, make clear,..) and the third one about the domain (to specify, program,...). A change of domain will require to modify only this third class.

References

[1] B. Grosz, C.L.Sidner.1986. Attention, Intention and the structure of discourse. Computational Linguistics, Vol 12,n.3.p 175-204.

[2] I.Fernández, A.Díaz, M.F. Verdejo. 1988. Building a programming tutor by dynamic planning:case studies and a proposal. Proceedings of the International Conference on Intelligent Tutoring Systems. Montréal. CSCCI, AFCET, BCS, ACM-SIGCUE and SIGART.

[3] I.Fernández, A.Díaz, M.F. Verdejo. 1988 . A cooperative architecture for tutorial tasks. Proceedings of Expert Systems and their applications. 8th International Workshop.Avignon.

[4] I.Fernández, A.Díaz, M.F. Verdejo. 1988. Modelling an authomatic tutor by dynamic planning. Proceedings of the IEEE 1988 International Conference on System Man & Cybernetics. Beijing.

[5] G. Ferrari, 1986.A two level dialogue representation. Proc. of COLING 86.

[6] R.Winkels, J.Breuker, J.Sandberg. 1988. Didactic discourse in intelligent help systems. Proceedings of the International Conference on Intelligent Tutoring Systems. Montréal. CSCCI, AFCET, BCS, ACM-SIGCUE and SIGART.

[7] B. Woolf, D. McDonald.1984."Building a computer tutor: Dessign Issues". Computer IEEE, (Sept. 84), pp 61-73

[8] B.Woolf, T,Murray . 1987. A framework for representing tutorial discourse. Proc.10 IJCAI

Dear Prof.Blasi: please find enclosed a paper entitled "a natural language interface for Intelligent Tutoring Systems" to be submitted to Eact'90. Four copies are sent by ordinary mail. Yours sincerely.
M.Felisa Verdejo