

## LOCAL AND GLOBAL STRUCTURES IN DISCOURSE UNDERSTANDING

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### I INTRODUCTION

We are interested in the nature of content structures in terms of which it would be possible to account for reasoning processes in understanding natural language texts. One of the most crucial problems here at the present time is: how and by which mechanisms these reasoning processes are controlled and directed. As the emphasis in the design of discourse understanding systems so far has been on the problems of knowledge organization and representation, we are only beginning to guess what the corresponding processing mechanisms are and how they function, although an increasing number of papers has been devoted to these problems as well. There are studies of the relation of understanding to such types of knowledge processing as problem solving and planning (e.g., Black and Bower 1980, Wilensky 1981). Various types of content units and structures needed to account for knowledge processing have been proposed in the general context of modeling discourse understanding (e.g., Allen 1981; Cohen 1981; Dyer 1982; Wilensky 1980). We ourselves have discussed an approach to knowledge units and processing mechanisms in questions, as a part of a computer system which understands stories of a certain kind (Litvak et al. 1981), as well as on a more theoretical level (Oim 1980).

To our mind, there are two general faults that characterize present day computer systems designed to understand coherent natural language texts. First, they make too heavy and rigorous use of predetermined knowledge schemes relating to the subject matter of texts and to the organization of reasoning processes which carry out understanding. Secondly, these predetermined knowledge and reasoning structures operate on levels of organization that are too far away from the level on which immediate text contents are presented. So the understanding processes modelled by these systems are prevalently knowledge-driven and, secondly, reflect relatively high level, global macro-operations upon events described in a text. There is little knowledge of the ways in which a text itself dynamically manipulates reasoning processes and decision makings of human understanders.

We do not want to claim that global schemes are not needed at all in discourse understanding. But there is a theoretical and empirical lacuna between this global level of processing, where story schemes or plan and goal hierarchies are acting, and the level of immediate text presentation.

### II LOCAL REASONING STRUCTURES

There should exist, between two levels, a "local" level of processing and, correspondingly, "local reasoning mechanisms" that are sensitive to the ways in which immediate text contents are organized. These local mechanisms should operate in terms of knowledge units and structures they obtain from text, on the one hand, and they should reflect intuitive attention, interest and judgment processes of the understander that occur during reading a text, on the other. They should be usable in interpreting very different kinds of texts--just as words, for instance, when looked at from the side of their contents, constitute preorganized "packets" of knowledge which can be used to build up different kinds of sentences and texts. There exist already some interesting studies dealing with such local text processing mechanisms (e.g., Granger 1982).

The crucial question here is, how do the local thought processes of the understander develop; how does his reasoning proceed from one state to another under the influence of the incoming text. There should exist certain units by which these processes could be described and predicted on this local level, certain "packets of (local) thought processes."

We want to specify here one type of such a unit. For the lack of a better term, we call them "reasoning molecules" (RM). By this term we want to stress two characteristic features of these units. First, they are namely processing units, units of thought processes, not static knowledge structures (like frames). Secondly, they are not thought to represent elementary, indivisible steps in these processes. They represent certain complexes of such steps, but complexes that function as wholes, when triggered by text. Using a somewhat metaphorical way of speaking, we can

say that RMs embody certain agents that work as "experts" in certain types of problems. They make use of the data coming from the text and their built-in knowledge about the given problem they are specialists of. They may interact together, engaging one another for obtaining additional information and to solve certain subproblems of their particular problems. As such, RMs form a relatively loose, decentralized society of experts whose activity is chiefly directed by the immediate text structure. There is also a general, central "supervisor" in such a reasoning system (Litvak et al. 1982), but its role and influence appear more clearly on higher levels of reasoning and decision making. An RM is characterized by the basic properties described in the following four sections.

(1) It has a built-in goal. As RMs function as "experts," their task is to notice the problems they are experts for, and to solve them. The general end of any RM is to make sense of the situation to which it applies. But let us stress that this "making sense" does not necessarily amount to incorporating the corresponding event or situation into some goal-plan hierarchy. Instead, making sense may mean for the understander, for instance, recognizing what a particular feature of a situation or event was representing in the world described in the text. For instance, there exist RMs for determining such structural aspects of events as to what end something was done ("Goal-expert"), or at what time something was done ("Time-expert"), but there exist also RMs which are experts in such questions as what counts as a relevant motivation of a refusal (cf. the following). Further, making sense of a partner's response in a dialogue may mean to the other partner making a decision about how to react to this response. Especially on the basis of this latter example it may be said that in fact the primary interest of an understander is not just to make sense of a piece of text itself but, instead, to make sense of the situation in which he himself is the interpreter of the corresponding part of the text.

In general, it may be right that for the investigation of local reasoning mechanisms, texts are more suitable where global organizational structures are lacking, or are not so significant; interactions in face-to-face dialogue present an example of such texts.

(2) RMs make use of semantic categories and structures identified in text, as well as speech-act-type pragmatic structures. In an RM these structures function as "influence factors," i.e., as units that are characterized on the basis of their effect upon the understander. Influence factors are semantic and pragmatic situations in text that manipulate the attention of an understander: provoke or satisfy his interest, trigger him to pose questions and to seek answers to them, to choose between alternative possible evaluations, and so on. The task of RMs is just

to notice such "interest provoking situations" in text, to register their components and to provide the understander with "packets" of reasoning steps which may lead him to the needed decision (ultimately, to make sense of the corresponding situation). For instance, assume that someone is presented with the response:

"I am not coming. I do not want to take such a risk."

which is presented as an answer to his request (or order, or proposal). The "refusal reasoning molecule" identifies the latter sentence in the response as motivation for the refusal. "Not-wanting-to-take-risks" is an influence factor which provides the motive of the refusal. But at the same time it functions as an influence factor in another RM which leads the given participant of the dialogue to accept or to reject the refusal, and to react accordingly.

(3) RMs are characterized by a certain inner organization. Typically, an RM has three functional components. First it includes a "sensor mechanism" whose task is to notice in text the situations which are relevant to the given RM. Second, there is the "task formulator" which functions as the central monitor and "bookkeeper" of the corresponding RM; departing from the built-in task of the RM and the data provided by text (or by other RMs) it formulates the concrete problem to be solved, determines the method of its solution and keeps track of the course of its realization. Third, there is the processing unit of the RM which carries out the operations/processes determined by the task formulator.

Further, there apparently should exist definite empirical constraints concerning the size of the "working space" of an RM. It must be possible for the understander to hold the influence factors relevant to an RM simultaneously in his working memory and to take them all into account in making the resulting decision. Again, the face-to-face dialogue is a good example: in order to react adequately to a response in such a dialogue, the participant should take simultaneously into account all the relevant factors contained in the response of his partner. Because of this, it is not surprising that the length of the replies in face-to-face dialogue tends to remain in certain limits. It would be premature to try to determine here the exact nature of the given constraints, e.g., in terms of the allowed number of influence factors in a reasoning molecule (although the well known number 7 plus or minus 2 could be a good guess).

(4) There exist certain basic types of RMs. First of all, we can differentiate between thematic and textual RMs. Thematic RMs are experts concerning the contents of a text (the provided examples, such as "Goal-expert" or "Refusal-expert" belong to this type). Textual

RMs are experts concerning the organizational structure of various texts (e.g., stories, tales, scientific arguments). Ultimately, they should be able to answer the question: "Why is this particular utterance presented at this place in the text?"

### III CONCLUDING REMARKS

As empirical material we have analyzed the structure of interactions in directive dialogues, and still more concretely, the mechanisms needed to understand interactions which present requests and orders in such dialogues, on the one hand, and the possible reactions, e.g., refusals to fulfill these requests and orders, on the other. We have built a taxonomy of influence factors typical of these types of interactions, and constructed some basic types of reasoning molecules used in interpreting the replies.

The work is not yet implemented, but we have planned to implement it in the frames of our text understanding systems TARLUS (Litvak et al. 1981; Koit et al. 1983). TARLUS is a system whose main task is to interpret stories of a certain kind, in particular by recognizing so-called hyperevents implicitly described in text, (e.g., by recognizing that certain actions of a person described in text can be qualified as robbery or stealing).

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