ABSTRACT

We have written a system that analyzes and represents some texts. The basic idea which has guided us is that of "topic" knowledge. In following the evolution of the topic the system brings to the fore coherence relations. Therefore it permits us to understand the sentences by integrating them in a context (bottom-up process); at each step of the analysis, the existing context is a function of the previously developed topics (top-down process).

A frame network represents the topics. These frames are related by hierarchical and descriptive links. Thus, a text representation is the set of frames instantiated on the basis of either the sentences or the inferences made by the system.

1 INTRODUCTION

People produce texts in order to achieve certain goals and much of the comprehension process is a matter of deducing the author's goals (Allen and Perrault 1980). To achieve those goals, the author may decide to split the message into two or more utterances to give the information from several perspectives. He may develop a subject from a global perspective, or a detailed one ... Thus, to understand what the author has written, the reader must discover the chains of reasoning in retrieving the coherence relations because the author generally will not relate the sentences in any direct fashion. So the coherence relations are the elements that specify those links. When writing a text, its author assumes some kind of knowledge on the reader's part. If this assumption is not correct, the text will seem incoherent to the reader who will be unable to find any links between the sentences.

In attempting to take this point into account, our system deals with the text analysis from a new aspect. Whereas Grosz (Grosz 1977), Sidner (Sidner 1979), Schank (Schank and Abelson 1977) and Lehnert (Lehnert and al. 1983) favor top-down treatment of texts which are supposed as coherent ones, our system has both a top-down and a bottom-up tendency.

The system evaluates the relation between each sentence and that part of the text already analyzed. Its purpose is to follow the development of the discourse topic, and not to understand the meaning of the texts. Its mechanism analyzes texts which possess certain kinds of characteristics. We will describe these later.

A discourse, or a text, must be defined. For our purpose, it is a set of several written sentences. We assume that the text is about a central concept, the principal topic. However we take into account that the discourse may develop other topics because people often produce texts that meet this specification.

The following of the discourse topic permit us to find relations between the sentences of a text, and to detect the lack of relation.

EX1 : P1 Paul goes to the restaurant.
     P2 He chooses a prix fixe menu at 150F.

EX2 : P1 Paul goes to the restaurant.
     P2 I am on vacation next week.

In EX1, P2 is understood with regard to the first sentence, which introduces the topic "go to a restaurant". But, in EX2, the two sentences seem incoherent and will be so interpreted as one does not find an immediate link between P1 and P2 (it is always possible to imagine an adequate context). However a sentence is interpreted by our system only within the context generated by the preceding sentences. It does not create a context in order to understand a sentence, rather it constructs a context based on the text already analyzed and tries to relate a sentence to this context. If it fails, it considers that the text is incoherent with respect to its current knowledge.

Our system then permits us to discover what the different current topics are and so to define and circumscribe the text's reference domain.
1.1 Presentation of the System

Example 3: From Cesar by M. Pagnol.

Marius (M) is a mechanic. C is for Cesaricet.

Introduction of the Principal Topic

P1 Hello, I have a motor-boat in the harbour.
P2 and my motor is out.
P3 A kind of fisher-sailor-bowls-player on the quay told me to come and see you.

M. P4 That's nice of him.
P5 However I don't know if I can do anything.

Confirmation of the active topic

P6 I look after cars, more than anything else.
P7 I haven't been to any special schools.
P8 So, if it is a Diesel ...
P9 It's not a Diesel. It's a Beaudoin.

Return to the PT

M. P10 Hey! A Beaudoin, P11 I know a bit about them.
P12 I took care of one for three years.
P13 It was on Mr Frere's motor boat.
P14 He is the Country Judge.
P15 Do you know him?
P16 No, I'm not from these parts.

Deviation from PT

M. P17 Well, that's not important P18 Let's go look at your motor problem.
P19 Ficelle, if someone wants to see me, I'll be in the harbour on the ...
P20 What's the name of your boat?

Deviation

C. P21 The Pescadou.
P22 On the Pescadou. It's a fine name.

Return to the PT

P23 Wait a minute. I'm going to take a set of spanners.

As we have a syntactic-semantic parser (Rudy 1983) as the front-end to the system, our program uses an internal representation of the sentences where any pronoun ambiguity is resolved. We discuss this problem below. The concepts corresponding to the words of the sentence are recognized unless ambiguous, as we will see later. The concepts are found in a semantic net. So, the internal representation is made of a central concept (the predicate), which is related to some concepts by semantic cases in Fillmore's sense (Fillmore 1968), plus the concepts as time or place.

The system acts in two stages. First, it searches for the principal topic of the text. Then it analyzes each sentence in integrating it in a settled context. Analyzing a sentence means here to find the comprehension process that relates it to what is already known and to resolve ambiguities if the parser has failed.

To get a better picture of the system's possibilities, let's examine the Pagnol's dialogue where we have replaced the pronouns with their antecedent concepts as does our front-end parser.

1.1.1 Introduction of the Principal Topic: PT

P1 Cesaricet has a motor boat in the harbour.

The program makes the assumption that this phrase is treated as a complete sentence and introduces an element of a topic which will be discussed later in the discourse. The system does not know what is the matter with the motor boat. So it stores this knowledge.

P2 Cesaricet's motor is out.

At this step, the system makes the hypothesis that the text concerns the motor breakdown. We can notice that it is now able to integrate the concept "motor boat".

P3 A kind of fisher-sailor-bowls-player on the quay told me to come and see you.

This sentence introduces a new character Marius ("you"), and explains Cesaricet's arrival. Such a sentence can be handled by a character treatment module (Berthelín 1979) and does not now fit in our comprehension mechanism. Such a treatment would transmit to our system that Marius is introduced and that it knows that Marius is a mechanic.

So we assume the presence of this module and replace the sentence P3 by:

Marius is a mechanic.

The system finds a link, an inferential chain, between "be a mechanic" and the assumed topic "motor breakdown". Therefore the hypothesis is confirmed and the principal discourse topic is set. The PT is always the most representative topic of the text. For that, the system examines the inferential chain and selects here "repair a vehicle" as PT, while "be a mechanic" becomes the active topic: AT.

1.1.2 Topic confirmation and topic deviation

P6 confirms the active topic "be a mechanic". However, when the system finds a more remote connection between a sentence and the context it has constructed, as in P7, it opts for a topic deviation, and decides that the phrase concerns a particular point of one context's constituent.
1.1.3 Topic shift

Part 6 shows an example of a topic shift. This occurs when the discourse develops another subject, completely different from those which are part of the context. In that case, the system verifies that there is a coherent connection.

1.1.4 Metaphor and ambiguity

The metaphor in P12 is understood as "repair a motor". The ambiguity in P23 (spanner as tool or as structural element of a bridge) is also resolved; however we will not get back to this last matter because we have adopted a classical solution to it.

2 DEFINITION OF THE ANALYZED DISCOURSE

The first point concerns the structure of the texts. We analyze texts whose first sentences elaborate the P1. This topic is always in memory during the interpretation of the text. So it will always take place in the context.

The second point is about the nature of the discourse and of the coherence relations. Our definition for coherence retrieval differs from that of Hobbs (Hobbs 1979). He highlights pairs of sentences and describes their semantic relations as either elaboration, similarity, contrast or parallel structure.

We define coherence as the existence of semantic or pragmatic links between each sentence and the context. This is analogous to Searle's definition, but our procedures of context elaboration and research of links are considerably different.

We treat primarily texts which tell action stories. The relations for which the system searches are causal or descriptive ones. Causal relations pinpoint the conditions and the results of actions, while descriptive ones show the development of actions.

Before giving the details of the processes, we will describe our knowledge representation.

3 TOPIC REPRESENTATION

Topics are represented by frames. This kind of representation was inspired by FRL (Goldstein and Roberts 1979), however we have introduced some new wrinkles.

The frames are the description of situations. They are organized in precision levels, i.e. a given structure does not include all the details of one situation. The knowledge is distributed among several frames which are related by hierarchical links. Thus the system can tell if a topic is developed in a general or a detailed manner. The precision levels also permit us to limit the necessary number of inferences.

A frame is characterized by several elements:

- its name which is formed by a pair of concepts: a predicate and an object which are related by a semantic case. The predicate indicates the point of view in which the object is considered. Thanks to the name, the system can associate a sentence and a frame.

P1 I go to the restaurant

P2 I buy a restaurant

P1 leads the system to select the frame "go to a restaurant" while P2 leads it to select "buy a commercial premises". In P2 it is necessary to find a more general concept than the one used in the sentence. This is done by extending the sentence concept using the semantic net. However all sentences do not lead to a frame, i.e. when the predicate is too general to describe a situation.

- a list of slots

The name of these slots are DESCRIPTION, CONDITION, RESULT, TIME and PLACE, plus the name of the cases associated with the predicate. The values of the slots are in facets. These values can be "variables" or references to other frames. A "variable" is our name for the reference in the semantic net to a particular concept whose associated features are those specified by the situation described (the given context). The reference to other frames is used when the value is too complex to be represented by a single concept.

Example of frame:

NAME : repair a vehicle

AGENT : VALDEF: person (obl)

INSTR : VALDEF: tool

TRAIT(tool, number, x)

TRAIT(tool, possess, agent)

COND : NPDIST NORD

1 0 * vehicle is out of (obl)

2 0 * know mechanic (obl)

EGAL(agent, agent)

DESCR : NPDIST NORD

1 1 * find breakdown (obl)

EGAL(agent, agent)

2 2 * take off a part (opt)

EGAL(part, res)

EGAL(agent, agent)

EGAL(llie, llie)

3 3 * repair a part (obl)

EGAL(part, res)

EGAL(agent, agent)

4 4 * replace a part (opt)

EGAL(part, res)
We can draw attention to several particularities:

- each facet has two kinds of numerotation. NPDIST permits us to distinguish the facets in a given slot. NPORD specifies a chronological order.

- each facet is marked as optional (opt) or obligatory (obl). At a frame selection, the lack of precision or the negation of an optional facet does not interfere with the situation unfolding. In contrast the absence of an obligatory facet's value leads the program to infer it. Its negation signifies an abnormal development of the previous situation.

- some procedures are attached to the facets: TRAIT, EGAL, SIFAIT.

- one can also give default values to the variables: VALDEF.

In conclusion, we would like to underline the individuality of our knowledge representation. We construct a network of frames which are related by two kinds of links: hierarchical and descriptive. The latter relation comes from facets values. We have intended to represent three essential ideas:

- to give a representative name to the described situation
- to organize the knowledge in levels of comprehension
- to select the relevant information and to reduce the number of inferences

The first two points permit us to resolve the problem of frame selection. The association of a predicate with one of its objects and the repartition of the knowledge in small units, lead the system to select only the good frame.
The system assumes that this frame represents the principal topic and constructs the context with those frames which describe it (i.e. the frames which are values in its slots). In this example, there are no frame as values, so there is only one frame in the context.

Before dealing with P3, the program tries to relate the preceding variable (motor boat) to the selected frame. A link is found because a motor is known in the semantic net as a part of a motor boat. The program fills out the concept "motor" in the instantiated frame by addition of features.

P3 leads to the choice of "someone is a mechanic".

The system searches the frame net for a link between the most recently selected frame and the context. It finds the following path:

1-someone is a mechanic → 2-repair a vehicle → 3-vehicle is out of order → 4-mechanical object is out of order

This path means that (1) is described by (2), which has (3) as condition which is itself described by (4), the hypothetical P1. (2) and (3) are the inferences made by the system.

If there is at least one inference, the system opts for a topic deviation. The current phrase develops a particular aspect of one topic of the context.

We have already mentioned that the system tries to find the most representative PT. For that, it examines the kind of links in the inferential chain. Those links are divided in two classes. A frame can lead us to:

Class 1: - the link which relates the frame to its father,
- the links towards those frames which contain the present frame in one of their slots.
Class 2: - the links which relate the current frame to its slots,
- the links towards frames found in its slots.

Class 1 contains the links which lead to a more general topic, and Class 2 indicates a greater degree of precision.

The system starts from the assumed PT and will choose as PT that frame, other than most recent, which is the terminus of the path whose nodes are related by Class 1 links. Here "repair a vehicle" is chosen as the PT.

The topic evolution is represented by a tree, which the system can now construct.

PT: repair a vehicle, inference

vehicle is out, inference someone is, AT of order a mechanic

mechanical object is out of order

This representation permits us to know what points have been developed about a topic.

There are other kinds of links between a sentence and the context. Let us suppose that the system has made a hypothesizing about the choice of the PT and the next sentence must confirm or deny this PT.

- 1st possibility: case of a variable

The second sentence refers to a variable (we use Sidner's example):

Example 4:
P1: I want to organize a meeting.
P2: It will be at 6 pm.
P3: We will meet in my office.

The assumed PT and the context are:

context {organize a meeting : PT

description invite person

time

place

P2 is treated as a variable because the pair "be" and "time" is not an entry to a frame. Variable

value 4 pm

The variable is found in a PT's facet. So the PT is confirmed.
In the general case, the program tries to confirm the PT and looks for the variable in the frames of the context: both in the frames' name and in the facets.

Three cases may arise:
C1: the variable is in the PT (in its name or in one of its facets)
C2: the variable is in a facet of a frame other than that of the PT
C3: the variable is not found in the context.

In C1, this is a confirmation of the topic; the active topic is also the PT.
C2 is also a confirmation of the topic; however, there is a modulation and the active topic is provided by the frame which contains the variable. This is a way of further exploring one aspect of the PT.
C3: when the variable is not found in any frame, the program stores it and does not modify the current assumption. It may introduce a topic shift and the variable would be defined further on the text. It might also be a metaphor.

- 2nd possibility: no link has been found between two frames.

Example 5:
P1: I went to the market.
P2: I met Jean.
P3: He told me he had bought a car.

An assumption about PT is made from P1.

collection context
\{ go to the market: PT comparison prices buy food

From P2, the system selects the frame "meet someone".

meet someone place result

The system does not find a link between this frame and the current context. It recognizes that there has been topic shift. The latter frame represents the new hypothetical PT. However, the system verifies that this topic shift, between P1 and P2, has occurred in a coherent manner.

In this case, the coherence relation may come from a shared concept. See Grau (Grau 1983) for a detailed explanation.

In our example above, the program chooses the concept "market", because a place is required in the last frame, and market is linked to place in the semantic net.

4.2 Coherence and reference

The coherence relations are determined after the system has selected the significant elements from the sentences.

We have adopted this method because we think that the problem of anaphora resolution is different from that of coherence. That is, neither the use of pronouns nor definite noun phrases lead to text coherence, but rather derive from it.

According to Hobbs, the listener's strategy is to do the best he can to recognize coherence, then to make coreference assumptions that will allow coherence to be maintained.

Our strategy is similar to his: finding the coherence relations leads to a description of the reference domain.

We suppose in our system that the antecedents of the pronouns are found by syntactic and semantic criteria (Subah 1976). If these can't resolve some stubborn cases and if the sentence's object is still not identified, the system replaces that object by a default value. This has the effect of generalizing the meaning.

The following processes of the system are used to highlight the coherence relations in the rest of the text. They are applied to the sentences of the discourse which have already been parsed.

- context selection
- research of a link between a sentence and the context
- representation of the topic development
- active topic updating

4.3 Context selection

At each step of the text interpretation, there is a specified set of topics to which a connection may be made from the current sentence. This part of the analysis is the top-down process. However, the kinds of connections are so defined that the context constitutes neither an implicit nor an explicit forecast of an eventual topic, as for Sidner and Groz.

The context depends on the current state of the topic development. The system chooses the following topics in the tree to construct the context:
1 - the active topic: AT
2 - if no topic shift has occurred, that topic which was active just before the current AT
2a - otherwise, whichever topic was active just prior to the shift
3 - the PT

Why are the above choices relevant?
1 - It is evident to prefer the AT.
2 - We admit the possibility of a return to a
topic, after the development of a particu-
lar point. It is the second topic.
2a - If there has been a digression, the third
topic means the parenthesis closing.

These topics are classified in the above
order inside the context. Thus providing a se-
lection criterion if several paths are found
towards the context. Another criterion is the
path length. The system chooses the smaller
reasoning.

Let us consider the root of example 3,
the dialogue from Pagnol.

P4 and P5 are not interpreted by our sys-
tem, as they contribute nothing to our cohe-
rence control.
P6 : I look after cars, more than any-
thing else.

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assertion: affirmative
variable
  car
```

"look after" is too vague to provide an
entry to a frame. So we keep only the concept
'car'.

Here, the context before processing this
sentence is:
- person is a mechanic, AT
- mechanical object is out of order, AT before
  the actual one
- repair a vehicle, PT

The system can now search for a link be-
 tween the sentence and the context.

4.4 Search for a link

Above, we have shown the different kinds of
relation, here we will explain how the sys-
tem searches for them.

The program generates a tree during the
search. The root is the frame selected from
the analyzed sentence, and the nodes are all
the frames which are related to it. Then the
system compares those related frames with the
ones in the context. This comparison takes
place for all frames at an equal level. The
process is reiterated until at least one node
is a frame of the context

```
level 1
  1
   2
  level 2
  3
  level 3
  5 6 7 8 9 10
  level 4
  11 12 13 14 15
```

4.5 Representation of the topic evolution and
 updating of the AT

We explain here the types of topic evolu-
tion, namely a deviation, a shift, a level
shift or an inference.

At each step of the analysis, the system
updates the AT in accordance with the connec-
tion it has found.

If there has been a confirmation, no
change occurs. If it was a deviation or a
shift, the AT becomes the topic found from the
sentence.

If the system has detected a level chan-
ge, either a generalization or a precision,
the AT is also the current topic found from
the sentence.

Before applying all these processes, the
system may need to resolve some metaphors.

4.6 How to understand "Marius takes care of
a motor"?

This kind of metaphor is detected when
the parser does not succeed in relating the
predicates and a concept of the sentence be-
cause the semantic features of the two con-
cepts conflict with one another.

Such a situation can be explained in the
following manner:
- the predicate is so used because there does
  not exist another concept to translate it
  idea. Then it is a meaning unknown to the
  system, and one does not know how to find
  it.
- the author can use the predicate in a sur-
  extension way (Anglin 1976). This metaphor
  is usage from the author applying the predi-
  cate to a larger number of objects. The pre-
  dicate then has a meaning that the system
calls by the name of another predicate. This
denotes a partial synonymy in a special con-
text between two predicates.

How does the system deal with this latter
problem?

First it searches for all the meanings of
the predicate and of the word in conflict.
Then it selects the corresponding frames.

In our example, "I have taken care of one
(motor) for three years", the system knows two
meanings of "to take care of":
1- take care of : agent is a human being
    theme disease
    goal animate being,
    part of animate being
    instrument is a instrument
2. take care of: agent theme task

The system knows also the subgraph:

motor ----> mechanical object ----> object

So it can select the frames:
List 1 - take care of a task
- take care of an animate being
- ... 
List 2 - mechanical object is out of order
- repair a mechanical object
- sell an object
- ...

The system tries to construct pairs from frames, where each element is from a different list. Each pair must be in the same tree in the frame net. Thus the system searches those elements which derive from a common situation (are synonymous at a higher level). Then we have only to choose the pair which is related to the context.

In our example:
The chosen frame is underlined,

recondition someone or something

repair an object ----> take care of an animate being

repair a vehicle ----> repair a mechanical object

5 CONCLUSION

We have presented a work that "verifies" the coherence of some texts. Such a system does not generate a deep analysis of text.

How does this integrate itself in a complete process of text comprehension?

It is situated after a sentence parser. But the two processes are not independent and there are mutual interactions, in the case of ambiguities for example. Moreover, our system circumnavigates the field for the reference resolution. These two processes are also in interaction.

We have insisted on the bottom-up and top-down process. That leads to a system completely different from those of Schank (Schank 1977) and Lehnerd (Lehnerd et al. 1983). First, our system does not know a priori the studied domain. Second, at each step of the analysis, the system does not forecast the following topic. And third, we don't have one representation in one structure for a story. We possess elements of knowledge which are gathered dynamically by the following of the discourse topic.

REFERENCES


