STALKING "COHERENCE" IN THE TOPICAL JUNGLE

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ABSTRACT

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

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 perspecti-
ves. 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 sen-
tences in any direct fashion. So the coherence
relations are the elements that specify those
links. When writting a text, its author assu-
mes 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 ac-
count, our system deals with the text analysis
from a new aspect. Whereas Grosz (Grosz 1977),
Sidner (Sidner 1979), Schank (Schank and Abel-
son 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 alrea-
dy analyzed. Its purpose is to follow the de-
velopment of the discourse topic, and not to
understand the meaning of the texts. Its me-
chanism analyzes texts which possess certain
kinds of characteristics. We will describe the-
se later.

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

The following of the discourse topic per-
mit 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 to-
pic "go to a restaurant". But, in Ex2, the two
sentences seem incoherent and will be so in-
terpreted 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 or-
der to understand a sentence, rather it cons-
tructs 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 referen-
ce domain.

1.1 Presentation of the system

Example 3 : From Cesar by M. Pagnol.

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

```
                C. ┌P1  Hello, I have a motor-boat
Introduction    │      in the harbour,
of the PT     1 ┤ P2  and my motor is out.
(Principal      │ P3  A kind of fisher-sailor-
 Topic)         │      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
Confirmation           can do anything.
of the        2 {P6  I look after cars, more than
active topic           anything else.
Deviation        ┌P7  I haven't been to any spe-
from PT       3 ┤      cial schools.
                ┌P8  So, if it is a Diesel ...

Return to     C. │P9  It's not a Diesel. It's a
the PT        4 ┤      Beaudoin.

                M.│P10 Hey! A Beaudoin,
                  └P11 I know a bit about them.
                ┌P12 I took care of one for three
Deviation     5 ┤      years.
from PT         │ P13 It was on Mr Frere's motor
                └      boat.
                ┌P14 He is the Country Judge.
Topic           │ P15 Do you know him ?
shift         6 ┤
                C.│P16 No, I'm not from these parts

                M. P17 Well, that's not important
                ┌P18 Let's go look at your motor
Return to     7 ┤      problem.
the PT          │ P19 Ficelle, if someone wants to
                │      see me, I'll be in the har-
                └      bour on the ...
                ┌P20 What's the name of your
                │      boat ?
Deviation     8 ┤
                C.│P21 The Pescadou.

                M.│P22 On the Pescadou. It's a fine
                  └      name.
Return to     9 ┌P23 Wait a minute. I'm going to
PT               └      take a set of spanners.
```

As we have a syntactic-semantic parser
(Rady 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
searchs 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 fai-
led.

To get a better picture of the system's
possibilities, let's examine the Pagnol's dia-
logue 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 Césariot has a motor boat in the har-
bour.

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

P2 Césariot's motor is out.

At this step, the system makes the hypo-
thesis that the text concerns the motor break-
down. We can notice that it is now able to in-
tegrate 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 Césariot's arri-
val. Such a sentence can be handled by a cha-
racter treatment module (Berthelin 1979) and
does not now fit in our comprehension meca-
nism. Such a treatment would transmit to our
system that Marius is introduced and that it
knows that Marius is a mechanic.

So we assumes 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 hypo-
thesis is confirmed and the principal discour-
se 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 mecha-
nic". 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 con-
text's constituant.

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 PT. 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 analoguous to Sidner'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 searchs 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 characterised 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. That 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 "variable" 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                      (opt)
         TRAIT(tool,number,x)
         TRAIT(tool,possess,agent)

COND.  : N°DIST N°ORD
           1      0  *·vehicle is out of (obl)
                        order
                        EGAL(vehicle,compl)
           2      0  * know mechanic      (obl)
                        EGAL(agent,agent)

DESCR. : N°DIST N°ORD
           1      1  * find breakdown     (obl)
                        EGAL(agent,agent)
           2      2  * take off a part    (opt)
                        EGAL(part,1.res)
                        EGAL(agent,agent)
                        EGAL(lieu,lieu)
           3      3  * repair a part       (obl)
                        EGAL(part,1.res)
                        EGAL(agent,agent)
           4      4  * replace a part     (opt)
                        EGAL(part,1.res)
```

```
                    EGAL(agent,agent)
                    SIFAIT(2,obl)

RESULT : N°DIST N°ORD
              1     0  * vehicle run        (obl)
                        EGAL(vehicle,compl)

PLACE  : ISA premises                       (opt)
         VALDEF: garage
```

We can draw attention to several particularities:

- each facet has two kinds of numerotation.
  N°DIST permits us to distinguish the facets
  in a given slot.
  N°ORD 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 fa-
  cet's value leads the program to infer it.
  Its negation signifies an abnormal develop-
  ment of the previous situation.

- some procedures are attached to the facets:
  TRAIT, EGAL, SIFAIT.
  TRAIT precises some semantic features of a
  concept.
  EGAL permits the transmission of a concept
  from one frame to another.
  SIFAIT can force the value of a facultative
  facet.

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

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

- to give a representative name to the descri-
  bed situation
- to organize the knowledge in levels of com-
  prehension
- to select the relevant information and to
  reduce the number of inferences

The first two points permit us to resol-
ve the problem of frame selection. The asso-
ciation 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.
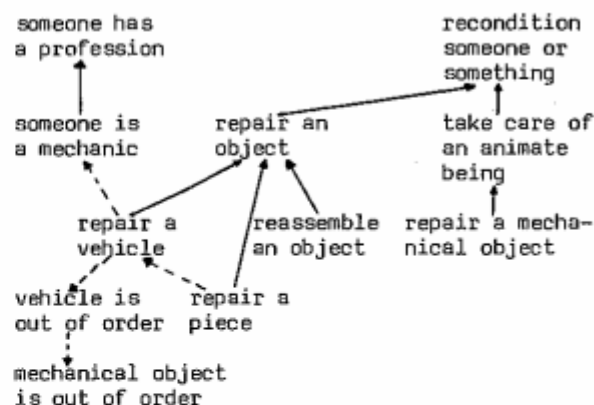
Relations between frames

4 TEXT PROCESSING

In this section, we will detail the pro-
cedures executed by the program.

4.1 The principal topic

A priori, our system does not know the
subject of the text which is to be analyzed.
It must find it.

Let us consider the above discourse of
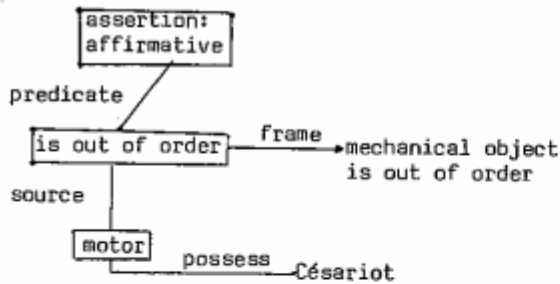Pagnol and the sentences that the system in-
terprets.

P1 : Césariot has a motor boat in the harbour.
P2 : Césariot's motor is out of order.
P3 : Marius is a mechanic (transformation by
     associated modules).

The internal representation of P1 refers
to the concept "motor boat".
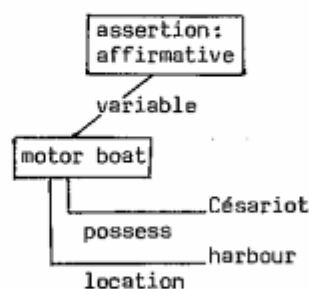
This sentence does not provide enough
knowledge to make an assumption about the PT.
So the system holds it in memory and will try
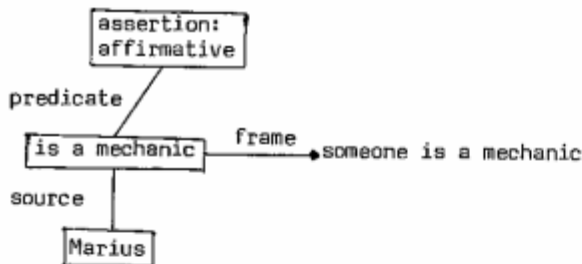to relate it to the first frame selected.

P2 causes the instanciation of the frame
"mechanical object is out of order".

```
        ┌─────────┐
        │assertion:│
        │affirmative│
        └─────────┘
predicate      /
        ┌──────────────┐  frame
        │is out of order├────────►mechanical object
        └──────────────┘         is out of order
source        │
        ┌─────┐
        │motor│  possess
        └─────┘────────Césariot
```

The system assumes that this frame re-presents 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 instanciated frame by addition of features.

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

```
        ┌─────────┐
        │assertion:│
        │affirmative│
        └─────────┘
predicate  /
        ┌────────────┐  frame
        │is a mechanic├────────►someone is a mechanic
        └────────────┘
source   │
        ┌──────┐
        │Marius│
        └──────┘
```

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 PT. (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 mentionned 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:

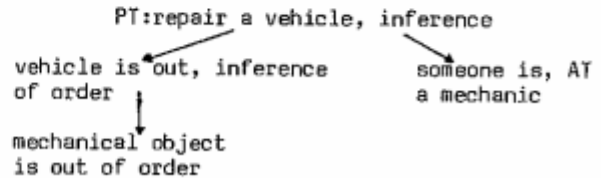Class 1 : - the link which relates the frame

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 sons,
- 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 hypothesis about the choice of the PT and the next sentence must confirm or deny this PT.

- 1st possibility: case of a variable

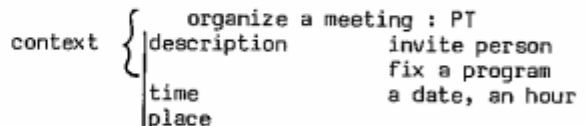The second sentence refers to a varia-ble (we use Sidner's example):

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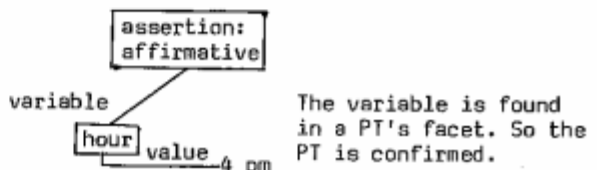P1 : I want to organize a meeting.
P2 : It will be at 4 pm.
P3 : We will meet in my office.

The assumed PT and the context are:

```
        ┌   organize a meeting : PT
context │  description        invite person
        │                     fix a program
        │  time               a date, an hour
        └  place
```

P2 is treated as a variable because the pair "be" and "time" is not an entry to a fra-me.

```
        ┌─────────┐
        │assertion:│
        │affirmative│
        └─────────┘
variable   /                The variable is found
        ┌────┐              in a PT's facet. So the
        │hour│ value        PT is confirmed.
        └────┘     4 pm
```

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.

Tree 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.

```
          ⎧ go to the market: PT
context   ⎨ description ──────►compare prices
          ⎩              ──────►buy food
```

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

```
          meet someone
          place
          result──────►the persons talk
```

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 circumscription of the reference domain.

We suppose in our system that the antecedents of the pronouns are found by syntactic and semantic criteria (Sabah 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 Grosz.

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 particular 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 selection criterion if several pathes are found towards the context. Another criterion is the path length. The system chooses the smaller reasoning.

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

P4 and P5 are not interpreted by our system, as they contribute nothing to our coherence control.

P6 : I look after cars, more than anything else.
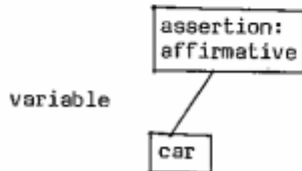
"look after" is too vague to provide an entry to a frame. So we keep only the concept "car".

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 between 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 system 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
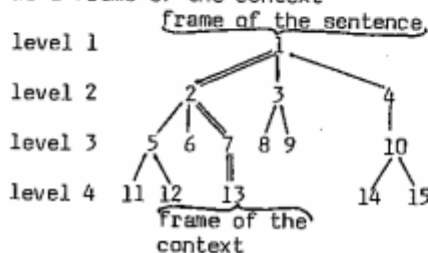
4.5 Representation of the topic evolution and updating of the AT

We explain here the types of topic evolution, 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 connection 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 change, 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 predicate and a concept of the sentence because the semantic features of the two concepts 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 an 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 predicate to a larger number of objects. The predicate then has a meaning that the system calls by the name of another predicate. This denotes a partial synonymy in a special context between two predicates.

How does the system deal with this latter problem?

First it searchs 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   isa human being
                  theme   desease
                  goal   animate being,
                             part of animate
                             being
             instrument isa instrument

2- take care of : agent   isa human being
              theme   task

     The system knows also the subgraph:

motor $\xrightarrow{\text{isa}}$ mechanical object $\xrightarrow{\text{isa}}$ 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 searchs 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
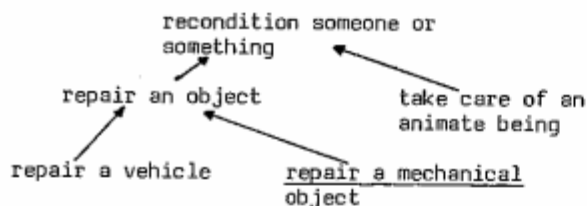
5 CONCLUSION

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

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

     It is situated after a sentence parser. But the two processes are not independant and there are mutual interactions, in the case of ambiguities for example. Moreover, our system circumscribe 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 Lehnert (Lehnert and 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.

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