A Processing Model for Redirection Clues in Discourse

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by

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Abstract

This essay examines the processing of interruptions in discourse based on the model proposed by Grosz and Sidner. Three types of interruptions with redirection clue words or phrases are proposed in the Grosz and Sidner model - flashbacks, digressions and semantic returns. We develop an interruption processing model (IPM) and present an implementation, which takes as input discourse that includes interruptions and produces as output an interpretation of the structure of that discourse.

The design of algorithms for the processing model is guided by the high-level mechanisms suggested by Grosz and Sidner. The algorithms present low-level descriptions of the updates required for the representation of the discourse, as stored in the intentional structure and attentional state. Several examples are provided to illustrate the structures of discourse at any given instance. The examples also help to explain the behavior of clues in discourse.

The processing model also forms part of the realization of the computational argument analysis system by Cohen. Together with the implementation of connective clues by Smedley, they establish the clue interpreter in the system.

Acknowledgements

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Chapter 1

Introduction

The aim of this essay is to address the problem of processing discourse with redirection clues. Discourse is a sequence of utterances by the conversants of a conversation. The redirection clues are words or phrases that specifically indicate the transition of the focus of attention of the discourse. The presence of redirection clues usually indicates a break of the main flow of the discourse (called interruption).

A model for processing interruption[1] is presented in the essay. This processing model will take discourse as input and output a representation of the discourse structure, which will help us analyze and understand discourse.

The main contribution of IPM is that it translates the descriptive processing algorithm proposed by [Grosz85] to a working model and clarifies some points in [Grosz85], and therefore gives a more precise and clear view of the discourse structure. In addition, the IPM can also be integrated into the clue interpreter for the implementation of AUS, the argument understanding system proposed by [Cohen83]

[1]The processing model presented in the essay will be called Interruption Processing Model, and abbreviated as IPM.

(See also [Cohen87a]).

In this chapter background information to understand the Interruption Processing Model (IPM) will be provided and common confusions between discourse and argument, as well as between interruptions and redirections, will be clarified.

1.1 The Interruption Processing Model

The Interruption Processing Model (IPM) proposed in this essay processes discourse with redirection clues embedded in it. The input of the processing mechanism is discourse, which is processed with the clues as signals of the transition of discourse intentions and attentions. The output of the IPM will be a representation of discourse structure. The representation will give the intentional structure and the attentional state of the discourse. The notions of discourse intentions and attentions shall be introduced and detailed in later chapters.

Clues are words or phrases which a speaker introduces into an argument or discourse to help the hearer in understanding the specific argument or discourse ([Cohen84]). They provide an argument or discourse with a functional interpretation ([Cohen83]). The function of clues can be analyzed to make processing easier and faster. Prevalence of clues in actual discourse suggests that clues facilitate understanding of discourse or convincing of arguments.

The IPM, in processing the discourse, captures the clues and with their help recognizes a redirection of discourse intentions and attentions. The IPM then treats the discourse fragments (called *discourse segments*) following the clue as redirectional segments, which either provide the discourse segments preceding the clues with more background information for the discourse to be carried out coherently or have no direct relevance with them.

Depending on what types of clues are detected, the model processes the discourse distinctly. The functions of a clue therefore are twofold: first, it signals the transitions of discourse , and secondly the type of clue sometimes gives insight into what the relationship of the segments just before and after it is and thus how these segments should be interpreted.

The IPM is available for any *user* who is given a discourse and would like to know more about the structure of the discourse. The user of the processing model will be able to query at any instance about what the structure of the discourse is. It will be clear that the structure of discourse is a useful tool in understanding discourse when the computational discourse theory proposed by [Grosz85] and [Grosz86] is introduced in later sections.

Examples are drawn from everyday discourse to illustrate how the processing model works, especially how, after the detection of clue and recognization of clue type, the discourse is treated in each different case of redirection.

There are of course redirections within redirections. Return from a redirection requires another redirection, which in fact is a special case of redirection within redirection. The process of redirection could, at least in theory, continue on and on. The processing model as designed only handles a limited number of redirections. This point will be further explained in the section where limitations and constraints of the implementation is discussed.

On one hand, the processing model in itself provides a limited mechanism for discourse processing. On the other hand, it makes the structure of discourse more clear by realizing what has been hypothesized in the computational theory of discourse structure proposed by [Grosz85]. Also, the processing model as a working model clarifies some of the points [Grosz85] fails to specify.

1.2 Discourse versus Arguments

Argument is defined to be a one way communication in a dialogue situation ([Cohen83]). Therefore an argument in fact is a one person *monologue*, the purpose of which is to *convince* the hearer of a particular point.

From [Copi86], argument is defined to be "any group of propositions of which one is claimed to follow from the others, which are regarded as providing support or grounds for the truth of that one." From the definitions, an argument consists of propositions, or statements, and the relationships between the propositions are those of claim-evidence (or conclusion-premiss).

An immediate question is then in order: given that an argument contains the claim-evidence relationship, how are the claim and evidence recognized?

The definition and the question together clearly illustrate the role clue words or phrases play in the argument understanding problem. This is not to say that without clues, the claim-evidence relationship between propositions will not be able to be determined (See [Young87]). But just that it could be very difficult if the clues are not present.

An intuitive approach is to use the *position* of the propositions or statements as a means to determine the claim-evidence relationship. The following example from [Copi86] says how it is possible to first state the claim, and then followed by three premisses that are claimed to support the conclusion.

> A little neglect may breed great mischief ... for want of a nail the shoe was lost; for want of a shoe the horse was lost; and for want of a horse the rider was lost.[2]

[2]Benjamin Franklin, *Poor Richard's Almanac*, 1758.

The next example illustrates how valuable and time-saving a clue is in recognizing the claim and evidence relationship. The presence of the clue *for* immediately signals that whatever follows is the evidence for the claim before the clue.

> Neither a borrower, nor a lender be;
> For loan oft loses both itself and friend.[3]

It should at least be very difficult, if not impossible, to tell evidence apart from claim if clues are not existent. At the minimum, clues provide a *hint* to the relationships between statements. But usually clues are more useful than that.

In the case of argument, there is a person arguing against another. In the case of discourse, there could be more than one speaker (writer) and more than one hearer (reader). The utterances produced by the *conversational participants* (CP) influence the way the discourse is understood and the direction of the discourse. Sometimes, during the discussion, it might be necessary to distinguish between the *initiating conversational participants* (ICP), the person who launches the conversation and *other conversational participants* (OCP), the other partners of the conversation (see [Grosz85]).

From the definitions, we can conclude that Discourse is more general in the sense that there may be more than one speaker and more than one hearer. An Argument, in essence, is only a special case of a discourse.

As stated in [Cohen83], the hearer of an argument eventually would want to challenge the particular points being made or particular connections between statements, or even the credibility of the speaker. But first, before all that, a hearer would have

[3]William Shakespeare, *Hamlet*, I, iii.

to know what is being told. Therefore, argument understanding is a precursor problem to understanding discourse where the goals of the conversants are to argue for particular points (the goal-oriented discourse). Understanding argument would be a first step to the understanding of discourse problems.

1.3 Interruption versus Redirections

Redirection is a transition from the main flow of discourse. It may suggest a new beginning of another discourse or may be a brief interruption from which the original course is quickly resumed. Most redirections are in between the two extremes.

Interruption, on the other hand, is abrupt change of the flow of discourse. It may or may not be a transition from the discourse flow. The *true interruption* introduced in [Grosz85], for instance, is a case of non-redirection. It is only an interleaving of discourse. This point will be further explored in the chapter where classification of clues are discussed.

From the definitions, we know that there are interruptions that are not redirections. If we accept the definition that an interruption is a break of current flow in a discourse, then we can conclude that interruption is a superset of redirection. IPM will limit its processing to redirection for its implementation.

Chapter 2

Classification of Clues

Since clue words and phrases are keys signalling transitions in discourse, it is obvious that recognization of clue types is important in the sense that distinct types of clues should flag distinct kind of transitions and thus should be treated distinctly.

The issue of classifying clues has been the topic of much research for the reason just stated. [Hobbs76], [Reichman81], and [Cohen84] are some of the examples representing the efforts in classification of clue words. The classification in [Cohen84] bears relevance to discourse processing and hence will be discussed in detail.

The first phase of developing the IPM involves classifying clues, which is then followed by the design and analysis of the algorithm for processing discourse with each of the clue types. This chapter will mainly discuss the research that is most relevant to the purpose of our processing model.

2.1 Grosz & Sidner's Classification

The issues of classification of clues is addressed as a test to the validity of the theory of discourse structure proposed in [Grosz85] and later reinforced in [Grosz86]. They did not engage directly in the classification of clues. They classified interruptions only. Their classification is useful when the classification of clues is explored.

From an intuitive view, an interruption is any break from the normal flow of discourse. Interruptions fall into four categories:

- Type1: True interruptions
- Type2: Flashbacks
- Type3: Digressions
- type4: Non-interruptions:"Semantic Returns"

The following examples from [Grosz85] are used to illustrate each type of interruption.

The first type of interruption is called true interruption, in which a discourse segment has a distinct purpose from that of the segment embedded in it. In other words, both segments have unrelated discourse segment purposes. In the example below, an instance of *true interruptions* is shown. D1 indicates the normal discourse and D2 represents a break away from the course of D1 (D2 is in italics):

D1: John came by
and left the groceries
D2: *Stop that*

you kids

D1: and I put them away

after he left

D1 and D2 are both distinct and do not relate to each other. We discard this type of interruption from our classification because we limit our discussion to the one-turn one-conversant situation. In the true interruption case, two sets of audience are intended, which is outside the scope of our discussion. Also, not all the parties of the discourse (if it can be called one) may be engaging in conversation. The essence of discourse is perhaps lost in the case of true interruptions.

The next example shows the case of *flashbacks.* Again, the flashbacked segments are shown in italics.

Ok. Now how do I say that Bill is

Woops I forgot about ABC.

I need an individual concept for the company ABC

... [remainder of discourse segment on ABC]...

Now back to Bill. How do I say that Bill is an employee of ABC?

Here, the ICP breaks the flow of discourse for the purpose of bringing some necessary information to the discourse in order to continue the present flow.

In the example, the ICP intends to talk about Bill's relationship with the company he works for but forgets to introduce the background information needed to continue. The flow of discourse is then broken to talk about company ABC. After, the flow of discourse is returned and continued.

The case in *flashbacks* is distinguished from the case in *digressions* mainly in the "reason" for interruptions. We'll pick up this point after *digressions* are introduced.

If, in the last example, when ICP is talking about Bill and his relationship with ABC, one OCP cuts in and say:

Speaking of Bill, that reminds me,
he came to dinner last week

Bill remains the subject but the flow of the discourse changes. This is a case of *digressions.* We observe that the "reason" for interruption in *digression* is distinct from that in *flashbacks.* In the case of flashbacks, the CP needs to redirect because new information has to be brought in to fill in the missing pieces needed to understand the current discourse segment. This reason is not necessary for digressional redirections to happen. And that tells them apart.

In next chapter, where the issue of processing is addressed, it will be clear that owing to the reason of interruption, the processing will be different.

The last type of interruption is called *semantic return*, which in the strict sense, is not an interruption because normal flow of discourse is not interrupted. Some point that was salient once but is perhaps no longer in focus is specifically *reintroduced.*

One typical example would be the case when one CP refers to an object or scene in the discourse that took place some time before with another CP:

Remember our discussion about Jack at the party?
Well, a lot of other people thought he acted just as badly
as we thought he did.

Any point that was salient once could become salient again by reintroducing it. This suggests that there must be some mechanism to keep track of the points that were talked about before. This is considered during the development of the IPM.

It is important that distinctions between the four types of interruptions are made. These distinctions form the core of the algorithm for processing discourse and are therefore needed in the design of algorithms for IPM.

2.2 Cohen's Classification

In [Cohen84], a taxonomy of clues is proposed. Clues are basically categorized into two types: *connective clues* and *redirection clues.* The dividing line for this dichotomy is that the connective clues specify the type of relation between propositions, whereas the redirection clues help determine which prior proposition is related to the current one.

The two type of clues together help to reduce the processing complexity. [Cohen81] hypothesizes a general reduction on processing complexity from linear to real-time should clues be consistently used throughout the discourse by CPs. From intuition and experience, clues at the very least, make a discourse or an argument easy to follow and understand,

The connective clues are further categorized into five classes, with common interpretation rules for clues in same category of the taxonomy. This is in fact an important feature. The interpretation rules form the backbone for algorithms when a processing model is to be developed.

Five classes are called *parallel, inference, detail, summary,* and *reformulation.* See table 2.1 for the relations between the proposition P prior to the proposition S (the clue is in S) and examples of clue words. See [Cohen84] for a more extensive list of clue words for each class of connective clues.

Notice that the five categories are mutually exclusive from each other. This makes

Category	Relation:P to S	Example
parallel	brother	in addition
detail	father	in particular
inference	son	as a result
summary	multiple sons	in sum
reformulation	father and son	in other words
contrast	father or brother	conversely

Table 2.1: The classification of connective clues

processing for each class more convenient in the sense that by detecting the specific clues, the processing algorithm could be determined. In exploring the redirection clues, we found no such convenience. The next chapter will detail this point.

[Cohen84] mainly concentrates on the connective clues. The model was later expanded in [Cohen87b] and partially realized by [Smedley87]. The work of this essay contributes to the grand scheme of Argument Understanding System (AUS) in [Cohen83] by augmenting it with the redirection part of clues, which together with [Smedley87] form the clue interpreter in the AUS (See [Song88]).

2.3 Copi's Classification

[Copi86] demonstrates that in an argument premisses could precede the conclusion or vice versa or the conclusion may be sandwiched between premisses offered in its support, as shown in the following example[1]:

[1]A.B. Webb, United Press International report, *Honolulu Advertiser*, October 2, 1980.

> Iran's charge d'affaires in Beirut Mehdi Amer Rajai, said, "If America enters the war, all hostages in Iran will be killed. Therefore, America will not do any such thing, especially now that the American elections are close and the death of the hostages will not be to Cater's advantage."

Here, the conclusion is *America will not enter the war* and is supported by two premisses, one before and one after it.

From [Copi86], position in an argument or discourse is not able to decide the claim-evidence relations. However, they are two types of clues that could serve the purpose of determining the claim-evidence relations: *conclusion-indicators* and *premiss-indicators.*

What follows the *conclusion-indicator* is the conclusion in an argument and what follows the *premiss-indicator* is the premiss of an argument. The rules, however, have to be applied with caution because there could be counter-examples. The rules serve as guideline and in fact, they work well in general cases.

Some examples of the *conclusion-indicators* from [Copi86] are in table 2.2 and Some examples of the *premiss-indicators* are in table 2.3. Notice these lists are not exhaustive.

The examination into the work of [Copi86] is not only educative (other discipline of linguistic studies also recognize the benefit of clues) but one that has contribution to IPM. The division of clues into two types in [Copi86] provides inspiration for the classification of clues for IPM. In the next section, we show how the classification of clues was based on the proposal by [Grosz85], tailored by [Cohen83] and further influenced by [Copi86].

Indicator	Meaning
therefore	it follows that
hence	we may infer
thus	I conclude that
so	which shows that
accordingly	which means that
consequently	which implies that
as a result	which points to the conclusion that

Table 2.2: A list of conclusion-indicators

Indicator	Meaning
since	as indicated by
because	the reason is that
for	for the reason that
as	may be inferred from
as shown by	may be deduced from

Table 2.3: A list of premiss-indicators

Category	Typical Example
flashback	that reminds me
digression	speaking of
semantic return	remember that

Table 2.4: The classification of redirection clues

2.4 Classifications Proposed

With the backgrounds from the previous sections of this chapter, we are now ready to propose the classification which was initiated by [Cohen84] and guided by [Grosz85].

The classification adopted in this paper is to follow the taxonomy from [Cohen83] and deals specifically with the *redirection clues*. The redirection clues are further classified according to the classification of interruptions by [Grosz85] to: ***flashbacks***, ***digressions***, and ***semantic returns***. Table 2.4 lists the types of redirection clues and some examples of them. Notice that the example listed in each class is only representative. Clues in each class could as well be used in other classes. It is not possible to tell the type of redirection simply from the specific phrase used.

The reason for using a taxonomy in [Cohen84] is clear: the two sets of clues are disjunctive and redirection clues could then be treated independently. Again, the reason for adopting the three classes of interruptions for the classification of redirection clues is that they suggest naturally distinct algorithms for processing, so the same processing could be used for each class of clues. Here we don't deal with the *true interruptions* case for the reasons stated above.

We used the conclusion-premiss-indicator model proposed by [Copi86]. Banks of return-indicators and redirection-indicators are kept. When clue is detected, the clue

Category	Function	Example
redirection	signal redir	speaking of, remember, that reminds me, woops
return	return from redir	returning to, back to

Table 2.5: The classification of redirection according to function

will be tested against the banks to determined the nature of the clue and therefore determine the the processing algorithms.

Return-indicators are clues such as "returning to" and redirection-indicators are clues like "remember", "speaking of", or "that reminds". The clues are processed after they are captured and before being dispatched for comparison to the bank. Table 2.5 lists some of the redirection clues and classification of them according to [Copi86] model.

Chapter 3

Algorithms for the Processing Model

This chapter focuses on the algorithms for IPM, which are conceived following the guidelines from the computational theory of discourse proposed by [Grosz85]. Employing the *intentional structure* and *attentional state* it proposes, the algorithms are designed.

IPM is basically a realization of the high-level descriptions of how the intentional structure and attentional state should be updated as the discourse evolves. The basic framework is provided in [Grosz85].

We therefore first introduce the discourse theory before presenting the algorithm for each of the interruption type. And because the description in [Grosz85] and the more detailed [Grosz86] is still vague, assumptions must be made and constraints have to be set. Although actual discourse may be quite complex, the examples introduced in each section will be simplified to illustrate the proposed solution.

3.1 Background from Grosz & Sidner

[Grosz85] proposes a computational theory of discourse structure. The main thesis of it and subsequently of [Grosz86] is that discourse structure is composed of three separate but interrelated components: the structure of the sequence of utterances (this is called the *linguistic structure*), the structure of discourse intentions or purposes (this is called *intentional structure*), and the state of the focus of attention (this is called *attentional state*).

These components are separate because each one of them exists to provide interpretation of the structure of discourse. Lacking one of them, the discourse can not be adequately and accurately represented. They are interrelated because none of the three components can exist independently. The focus space stack, for instance, stores the discourse segment purposes, which are the basic components of the intentional structure.

3.1.1 Linguistic Structure

The basic element of linguistic structure is the utterance. The linguistic structure is composed of *discourse segments*, each of which is the natural aggregation of utterances. The recognition of the boundaries of segments is important so that the intention of each segment can be uniquely identified and the intentional structure of the discourse established.

The discourse segment boundaries could be detected through the help of clues, which are special words or phrases that indicate redirection in discourse. Without clues, segment boundaries could still be concluded but it might take much more complex processing algorithm and time [1]. The change of tense as a means to determine

[1] [Cohen87a] postulates that clues are in fact necessary in order to recognize certain discourse

discourse segment boundaries as suggested in [Grosz85], for example, is a device to signal that the boundary of segment is encountered or crossed, even without the help of clues.

Notice that the linear position of utterances need not be relevant to the segmentation of discourse. That is, two neighbouring utterances may belong to distinct discourse segments and two physically distributed utterances may in fact be in one discourse segment. This makes the problem of processing discourse without clues all the more complex.

3.1.2 Intentional Structure

The basic element of the intentional structure is, quite intuitively, the intention. The intentional structure is the structure of the discourse segment purposes. It answers the question: what is the speaker trying to say? According to [Grosz85], it helps define if a discourse is coherent — i.e. that there are certain structural relationships between the discourse segments. [Hobbs78] defines that a discourse is coherent if it exhibits structural relationships between various segments, which depend on propositional content of segments. ([Hobbs78]). This *propositional content of segment* is represented in our model as the discourse segment purpose.

It is straightforward that a discourse may have an overall purpose. The property turns out to be of significance because it is this overall purpose (called *the discourse purpose*, DP) that distinguishes one discourse from another. Of course it can be argued that sometimes there are multiple purposes for engaging in a conversation. Yet for the purpose of processing discourse, one of the purposes has to be announced as the DP.

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configurations. Some discourse without clues may therefore be incoherent.

The same reasoning applies to discourse segments. Each segment will have one *discourse segment purpose*, DSP. Each DSP contributes to the total DP.

In intentional structure, the structural relationships among DSPs are important. Two of the structural relationships are indicated in [Grosz85]: *dominance* and *satisfaction precedence.*

DSP2 *dominates* DSP1 if DSP1 *contributes* to the satisfaction of DSP2. DSP1 contributes to DSP2 if one action that satisfies DSP1, also provides part of the satisfaction to DSP2. If DSP2 has to be satisfied before DSP1, we have DSP2 *satisfaction precedes* DSP1.

One purpose of introducing the structural relationships is to provide a source for distinguishing DSPs and the DP. If a purpose dominates all other purposes, then it is the DP. Conversely, if a purpose contributes to the satisfaction of another purpose, it is a DSP. All DSPs must contribute in some way to another DSP or to DP ([Grosz85]).

3.1.3 Attentional State

Finally, there is the attentional state, which is composed of the discourse segment intentions, objects, and properties of objects that are prominent at any given point of instance. It is an *abstraction* of the focus of attention of the CPs (*conversational participants*) at an instance of time. The attentional state,therefore, is dynamic.

The attentional state is modeled by a set of *focus spaces.* As the discourse unfolds, the focus space structure changes according to the transitions of focusing. The data structure used to simulate the focusing transition is a stack called the *focus space stack.* Each space corresponds to one discourse segment.

A push onto the stack happens when a new DSP contributes to the DSP of immediately preceding segment. When a new DSP contributes to some DSP higher in

the intentional hierarchy, some number of the focus spaces have to be popped before pushing the new DSP onto the stack ([Grosz85]). This stack updating, however, does not apply to the case where there are interruptions. When interruption occurs, the rule of updating the stack will depend on the type of interruption being detected.

The focus space for a discourse segment may or may not be in the focus space stack, depending on whether the segment is salient or not. The focus space also includes the DSP for each segment, which indicates the reason why the discourse is engaged.

3.1.4 Summary

With the intentional structure and attentional state as the basic structures, the algorithm for processing discourse with interruption is conceived and is presented in the following section.

One other component of the discourse theory, the linguistic structure, is not left out as it may seem to be. The linguistic structure indicates where the discourse segments lie; the algorithms assume a certain discourse segmentation and then show the processing.

3.2 Design of Algorithms

The algorithm emerges from the [Grosz85] model by processing the intentional structure and attentional state of a discourse. A tree is chosen to be the data structure to build the intentional structure as the dominance-contribution relationship model naturally suggests. Suppose DSP_i dominates DSP_j then DSP_i is father to DSP_j in the tree. A stack is chosen to be the data structure to implement the attentional state.

Again, intuitively, it is the most suitable data structure for recording the dynamic attentional state.

The general algorithm is presented below:

```
while (discourse continues) do
   get the input line;
   reformat the line read;
   read input until redirection clue is detected;
   check the kind of the redirection clue;
      if (kind = redirection indicator)
         if (type = flashback)
            level of redirection updated;
            update the discourse structure according to
                                        flashback module ;
         endif;
         if (type = digression)
            level of redirection updated;
            update the discourse structure according to
                                      digression module ;
         endif;
         if (type = semantic return)
            level of redirection updated;
            update the discourse structure according to
                                 semantic return module ;
         endif;
       endif;
       if (kind = return indicator)
         if (type = flashback)
            return from redirection signalled;
            update the discourse structure according to
                                        flashback module ;
         endif;
         if (type = digression)
            return from redirection signalled;
            update the discourse structure according to
                                      digression module ;
         endif;
```

```
            if (type = semantic return)
               return from redirection signalled;
               update the discourse structure according to
                                    semantic return module ;
            endif;
          endif;
endwhile;
```

The input read in is first processed by a formatter to basically rid all leading empty spaces and capital letters. The reason for doing this is that input line is first checked against the banks of clues. This way, all the *lexical equivalents* of a certain clue need not to be stored. For example, only one of "that reminds me" and "that reminded me" has to be kept in the clue banks.

According to the type of the redirection, IPM will dispatch the processing to different modules. For instance, the flashback intentional module will update the intentional structure for a flashback type of redirection.

The first clue detected is always recognized as the clue for redirection. After that, any clue detected will have to be checked to see if it is a return-indicator or a further redirection. The method for checking is primitive. Two banks, one for return-indicators and one for redirection-indicators, will be maintained and a successful comparison will tell what *kind* of clue is detected.

Depending on the kind of clue, IPM will again dispatch the processing to the appropriate module. The process goes on until all input is consumed and the intentional structure and attentional state are finally completed.

3.3 Flashbacks

3.3.1 Flashbacks: Definition

Flashback is also called *filling in missing pieces* by [Grosz85]. It is the case where additional information must be brought in, in order to continue with the discourse. So the flashback brings in a *filler segment* that has a DSP that is *satisfaction precedes* some DSPs in the discourse.

3.3.2 Flashbacks: Intentional Structure

In the following example, the DP could be some discussion of rare experiences each of the CP wishes to share with the OCP. The first segment has a DSP about the experience the ICP has, which is flashbacked to DSP-FB1, in which the ICP goes to talk about some other information necessary for carrying on. The DSP-FB1 satisfaction precedes DSP-MAIN (the DSP of the outer segment), and both DSP-MAIN and DSP-FB1 are dominated by DP.

> Something very similar has happened to me before.
> **that reminds me**, seven years ago...
> ...goes on about his old experience...

Figure 3.1 is the structure of the intentions. Notice the relative positions of DSP-FB1 and DSP-MAIN show that they are *ordered* siblings, which means that DSP-FB1 has to be satisfied before the satisfaction of DSP-MAIN. This is where flashbacks differ from digressions.

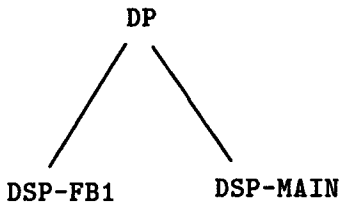


Figure 3.1: The intentional structure for flashbacks

[Grosz85] doesn't discuss what happens when interruptions are nested. For instance, there can be a flashback within a segment which is already acting as a flashback to the main segment. This case is shown in the example below.

The example involves a person retrospecting on one of his experiences, and that experience leads to the retrospection of another experience related to rainbows. This is a typical case of double flashback. Figure 3.2 shows the intentional structure.

Something very similar has happened to me before.
That reminds me seven years ago...
...goes on about his old experience
...then talks about rainbow
Speaking of rainbow...
...goes on about rainbow

DSP-FB1 satisfaction precedes DSP-MAIN. Now DSP-FB2 is interpreted as being dominated by DSP-FB1. This is the assumption we make for the interpretation of nested flashbacks. (The exact solution to this deserves more study. DSP-FB2 should satisfaction precede DSP-FB1 as well, in some sense. Perhaps there is a hidden

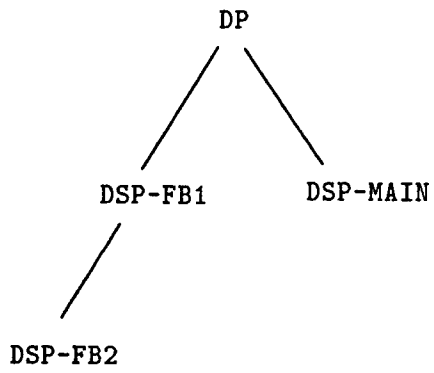


Figure 3.2: The intentional structure for two level flashbacks

dominance relation between all flashbacks and the segment they interrupt. Whether both relations can hold at once should be studied.)

3.3.3 Flashbacks: Attentional State

For the simple example shown in the previous subsection, the focus space for the flashback, FS-FB1 is pushed onto the focus space for FS-MAIN. The result is shown in Figure 3.3.

For the more complex example where two levels of redirection is involved, the focus space of FS-FB2 is again pushed onto to the focus space of FS-FB1, which is stacked upon FS-MAIN. Figure 3.4 is what the attentional state looks like with two-fold flashbacks.

In both cases, when return from a flashback is signalled, the focus space on top of the stack is popped. Further details will be provided in appendix A, where sample outputs of IPM are presented.

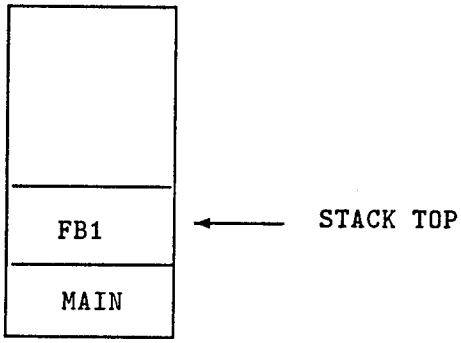


Figure 3.3: The attentional state for flashback

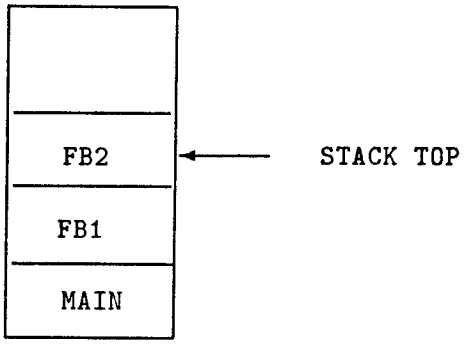


Figure 3.4: The attentional state for double flashback

3.4 Digressions

3.4.1 Digressions: Definition

Digression is a type of interruption that establishes a new segment which is related to and communicates with the segment it digressed from through one or more objects that are salient in both segments.

The major difference between digression and flashback is in the intentional structure of the discourse. The fact that the digressed segment has a distinct DSP of its own suggests the establishment of a separate tree. This is shown below.

3.4.2 Digressions: Intentional Structure

In the following example, the DP could be some discussion of the cost of house renovation. The first segment has a DSP about the expense of the prime minister's official residence, which is digressed to DSP-DG1. DSP-DG1 is unrelated to DSP-MAIN.

> The renovation of the prime minister's mansion costs a lot.
> **Speaking of** his residence, is it the one by the lake?

Notice that the digression could come from the same speaker or from different speaker. This is also true in other type of redirections. Figure 3.5 is the structure of the intentions.

The next example involves two levels of digressions. As could be inferred from the previous example, DSP-DG2 just establishes a new tree as in figure 3.6

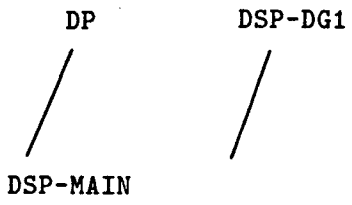


Figure 3.5: The intentional structure for digressions

The Japanese prime minister just resigned.

Speaking of Japan, it has a powerful economy.

Since you the mention economy,...

Figure 3.6: The intentional structure for double digressions

3.4.3 Digressions: Attentional State

For the simple example shown in the previous subsection, the focus space for the digression, FS-DG1 is pushed onto the focus space for FS-MAIN. The result is shown in figure 3.7.

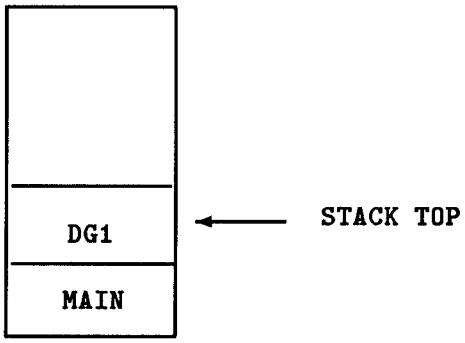


Figure 3.7: The attentional state for digressions

For the more complex example where two levels of redirection is involved, the focus space of FS-DG2 is again pushed onto to the focus space of FS-DG1, which is stacked upon FS-MAIN. Figure 3.8 is what the attentional state looks like with two-fold flashbacks.

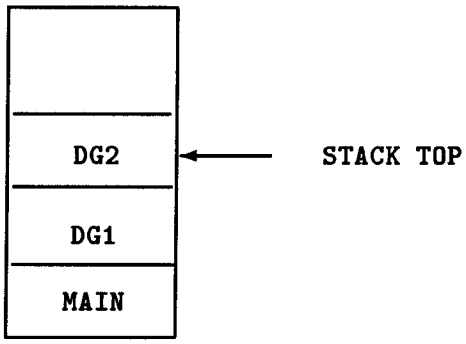


Figure 3.8: The attentional state for double digressions

In both cases, when return from digression is signalled, the focus space on top of the stack is popped. Further details will be provided in appendix A, where sample

outputs of IPM are presented.

3.5 Semantic Returns

3.5.1 Semantic Returns: Definition

Semantic return is the situation where some DSPs and objects which once were in focus but are no longer in focus at present, are taken up again by *reintroducing* them.

Semantic return is different from the previous cases of interruptions we discussed, where there is a need to pop the stack when the interruption is closed. Also, in the case of semantic return, the focus space for the segment being reintroduced may not be in the focus space stack, and will have to be brought back.

In [Grosz85], semantic returns are also dubbed *non-interruptions* because the interrupted segment is not maintained in the focus space stack. It is not an interruption in the most common sense. But it is definitely a case of redirection, which we want to handle in the IPM. In the process of developing IPM, semantic returns also require distinct treatment.

3.5.2 Semantic Returns: Intentional Structure

The following example is drawn from [Cohen84]. In AUS, the argument tree (intentional structure we called it here) should be like figure 3.9. The argument trees of [Cohen83] show claim-evidence relations between statements of the argument (claim is father to its evidence sons).

Note that the claim-evidence relations in the argument case is analogous to the dominance-contribution relations in the discourse case. Therefore the intentional

structure representation we derived in flashbacks and digressions still holds.

1)The city is a mess

2)The parks are disaster

3)The playground area is all run down

4)The swings are broken

5)The highway system also needs revamping

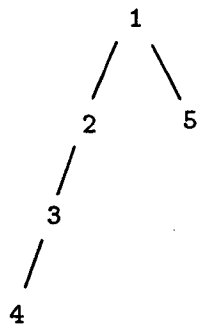


Figure 3.9: The intentional structure of the city example

3.5.3 Semantic Returns: Attentional State

The following figure is a snapshot for the attentional states after each statement in the previous example is introduced. In the figure the numbers stand for the intention of that statement (i.e. the DSP of each segment is what's stored). Figure 3.10 (1) is first established when *the city is a mess* is read. Figure 3.10 (2) is the tree structure when the statment (1) and (2) are read. Figure 3.10 (5)is the final structure when the five statements are completely introduced.

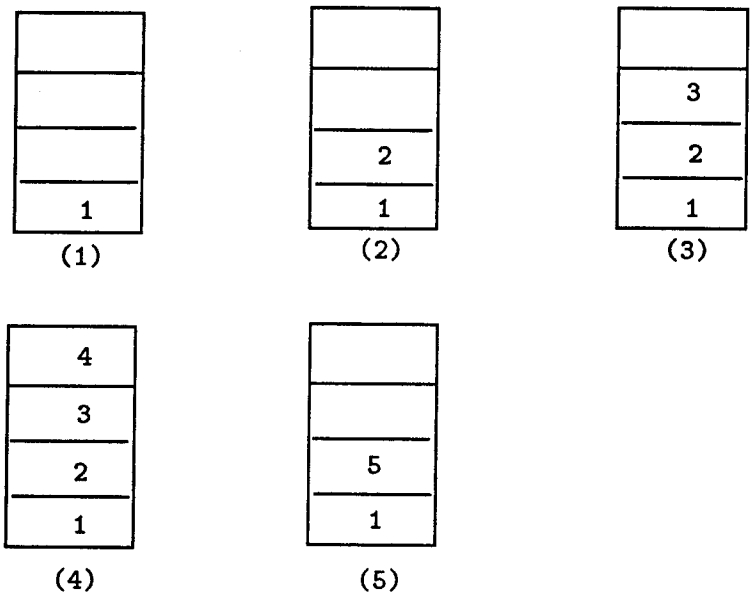


Figure 3.10: The focus space stack (1)

If one of the CPs now adds "returning to the park...", the example becomes the following:

1)The city is a mess
2)The parks are disaster
3)The playground area is all run down
4)The swings are broken
5)The highway system also needs revamping
6)**Returning to** the park, ...

The algorithm involving updating the focus space stack in the case of semantic return is: find the segment to which the semantic return is intended (DSP-SR), and then check the top of stack for parentage relation (if the stack top is father?); if true then push and if false, pop the top of stack and keep checking until true.

The attentional state should become figure 3.11, in which statement 5 was popped out and when the father of statement 2, which is statement 1, is on top of the stack, statement 2 is then pushed back to the focus space stack and completes a semantic return.

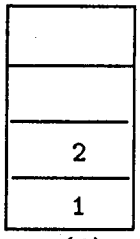


Figure 3.11: The focus space stack (6)

In order to process semantic returns, therefore, it is first necessary to identify the prior segment which is referred to. Note that this is not necessary for flashbacks and digressions since the old information in those cases is not brought back into focus. After a flashback or digression, the interrupted segment comes back into focus; for semantic returns, in some sense the "interrupting" segment remains in focus.

In fact, semantic returns cause old information to be brought back into focus. Since the old information may no longer be in the focus space stack, there must be some way to bring this back. One idea is to have a pointer from the DSPs in the intentional structure (which persists) to old focus space stack contents. In the next chapter, we discuss how our implementation deals only with re-introducing the old DSP, and show how this is done.

In processing semantic returns, we must decide what the focus stack looks like after the return (this is not adequately described in [Grosz85]). Our decision, described above, is to retain the normal push and pop rules for the focus space stack (where the DSP on top of the stack is dominated by the DSP below it in the stack, and so on). The old DSP can be brought back into focus, together with DSPs in its dominance hierarchy (and intervening focus spaces have been popped).

Chapter 4

The Interruption Processing Model

This chapter mainly addresses the specific problems encountered when the actual implementation is attempted. The problems include decisions about what assumptions should be made and the processing limitations of the working prototype.

In the last chapter some examples were given for each type of redirection (We used redirection interchangeably with interruption because the *true interruptions* case has been removed from consideration.) Given a sample discourse as input, a user of IPM should be able to traverse it and query at any point the following :

- What is the intentional structure of the discourse at this point?
- What part of the input discourse has been processed?
- What is the state of the focus space stack at this point?

The reply to the first query provides the first component of the discourse structure: the intentional structure of the discourse. The answer to the second query informs the

user of the position of the input which has been processed by IPM. This gives the user an opportunity to check the intentional structure and later the dynamic attentional state. And the response to the last query allows the user to verify what the focus of attention is at this very instance.

The satisfaction of the three queries gives a comprehensive view of the meaning of the discourse, mainly by telling the user what the purposes are for the discourse segments, and what the focus of attention is at whatever point the user chooses to ask.

The three questions dictate the output of our interruption processing system. The output from the system after processing a discourse input would correspond to answers for the three questions. It will first show the tree structure of the discourse segment purposes, and followed by the indication of the part of input that has been read; each discourse segment is represented by the opening line of it. Last, the state of focus space stack will be shown with the freshly pushed-in focus space at the top. The top of the focus space stack would then be the focus of attention of the discourse at that point.

The following sections discuss the implementation details for each of the redirection types. The IPM was implemented in C. Examples of the IPM at work are in appendix A.

4.1 Flashbacks

Consider the following example. The discourse involves a parent asking the teacher how her child performed in the summer camp and the teacher has to describe the activities and other issues about the summer camp in order to say how Jack did in some of these activities.

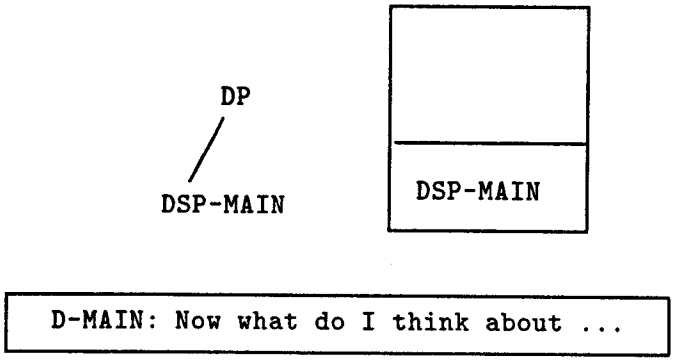


Figure 4.1: The structure before the redirection

Now what do I think about Jack in the summer camp?

Woops, I have to tell you about the summer camp first.

...goes on about the summer camp ...

Returning to Jack, he did very well in the Be-A-Leader game.

The IPM reads the input line by line until a redirection clue is encountered. The algorithm is when each input line is read, the IPM checks the banks of redirection clues against the line of input and if any of the redirection clues is present in the input line, it will flag the fact.

For this particular example, the behaviour of IPM is to read the first line of the input, establish the intentional structure, the attentional state, and the focus space stack. Figure 4.1 shows the output if the user is to request the output at this point.

IPM goes on to read the next line, which is *Woops, I have to tell you about the summer camp first.* Because this input line contains a redirection clue, the flag becomes true and a redirection has been recognized. The redirection clue is captured

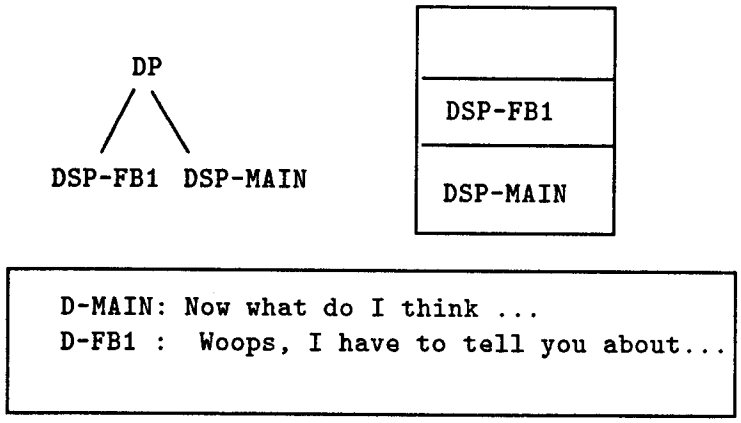


Figure 4.2: The structure after redirection

and displayed as the clue of redirection level one. Figure 4.2 shows the three structures after the flashback redirection.

IPM continues to read the last line, which is *Returning to Jack, he did very well in the Be-A-Leader game.* Again, another redirection is signalled by *returning to* and this clue is a *return-indicator*, so the IPM will return to the point where the flashback took place. Figure 4.3 shows the structure after the return.

Because the intentional structure records information about all segments of discourse, whether in focus or not, it persists. The intentional structure is the same as figure 4.2, which in fact is very useful if the situation necessitates bringing back one of the focus spaces not currently active and not in focus space stack (as in the case of semantic returns).

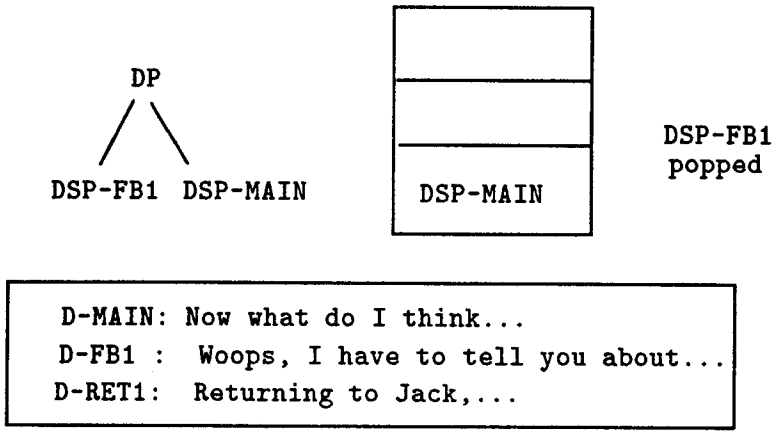


Figure 4.3: The structure after return

4.2 Digressions

The changes made for the digression case are mostly in the part of codes that deal with the intentional structure. That's exactly the difference between flashbacks and digressions. This point is repeatedly emphasized in [Grosz85] as the reason why the intentional structure has to be separate from the attentional state.

For flashbacks, the DSP of the flashback[i] becomes the son of the DSP of the flashback[i-1]. For digressions, each digression builds a new intentional structure simply because the DSP of the digressed segment is unrelated to the DSP of the digression segment.

Consider the following example. This example is slightly different from the one for flashbacks in that the teacher, after been asked by the parent about her child's

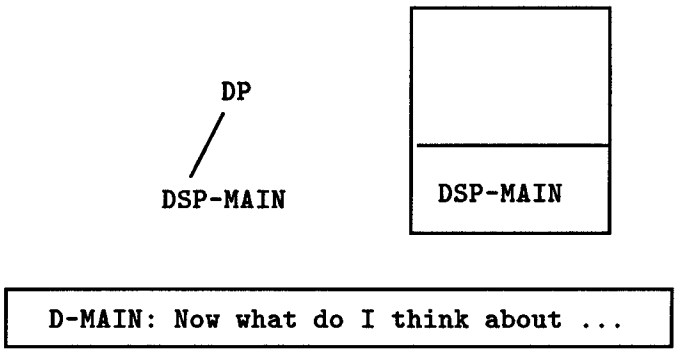


Figure 4.4: The structure before the digression

performance in the summer camp, doesn't immediately reply to the question but engages in the description of how badly he behaved in school today.

> Now what do I think about Jack in the summer camp?
> **Speaking of** Jack, I have to tell you what he did in school today.
> ...goes on about description about Jack in school ...
> Now **back to** your question, what did you ask?

The processing algorithm is the same as that of flashback except the part for intentional structure we just mentioned. Figure 4.4 shows the structure before the digression, figure 4.5 shows the structure after the recognition of digression, and figure 4.6 the structure after the return from digression is signalled.

4.3 Semantic Returns

The code for *semantic returns* is quite different from those of flashbacks and digressions, which explains the fundamental uniqueness of semantic returns.

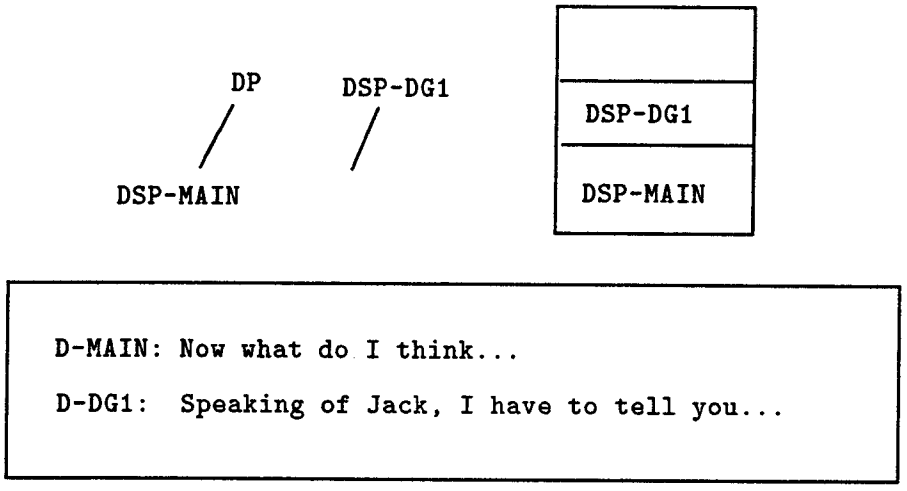


Figure 4.5: The structure after the digression

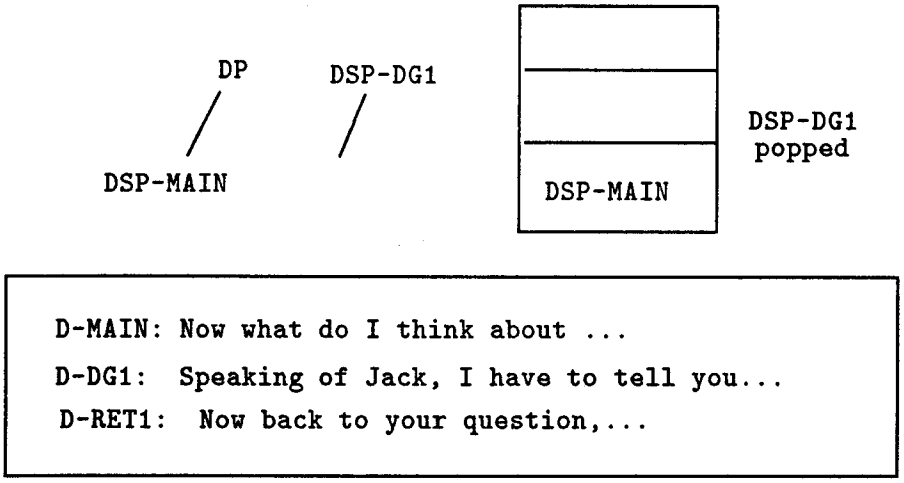


Figure 4.6: The structure after the return from digression

During discussion of semantic returns, we will look at the argument case only for the sake of simplicity of processing. In actual implementation, the claim and evidence relationship of each segment is given as part of the input. This is to factor out the problem of determining evidence relations. A number, *i*, is attached to the beginning of each segment to signal that this segment is evidence for segment *i*. Also, the segment to which the redirection is intended is assumed to be given. That is recognized by the number before the segment too. For implementation convenience, a caret precedes the segment of semantic returns. Another simplifying assumption is that each segment is confined to be one sentence. The processing problems which are factored out of the implementation are critical to the development of a full discourse analyzer. This is discussed in the next section.

The implementation for semantic returns now involves keeping track of claim-evidence relationships for the purpose of updating the focus space structure.

Consider the following example. The scene could be in a board meeting of a company. The ICP is introducing Peter as the ideal candidate for a certain position. The ICP gave some evidence to support the claim and the discourse comes to an end. Some time later, the topic is brought up again by the ICP and because the point he wishes to return to is no longer in focus (not on the focus space stack), it has to be specifically reintroduced. This is a case of semantic return.

1)I found Peter is quite a good candidate for the position.

2)His management skill is what the company needs.

3)He has extensive administrative experience.

4)He served for ten years on the board.

5)He also has been vice-president for five years.

...some time elapsed ...

6)Remember I talked about Peter's management skill the other day?

The behavior of the IPM is as follows: it first reads in the first sentence and establishes the structure in (1) of figure 4.7, and then processes the succeeding sentences and establishes the structure. The growing intentional structure and the updating of the focus space stack is shown in the rest of figure 4.7. Note that we still only retain DSPs in the focus space stack.

In this example, after the last input line is read: a semantic return case is signalled by the presence of the redirection clue. The updating algorithm of the attentional state (the focus space stack) comes into play (the updating algorithm is described in last chapter). It will pop the focus space stack until the father of the segment being reintroduced is found and then pushes the focus space of the semantic return segment into the stack.

The resulting structure is shown in figure 4.8. In figure 4.8, 5 and 3 in (5) of figure 4.7 are popped out, and 2 is pushed onto the stack. If 3, which is still in focus, is the intended segment of semantic return, only 5 will be popped. This also shows that returning to the segment not is focus requires more processing than returning to some segment still in focus.

4.4 Limitations of IPM

In developing the working model of IPM, assumptions have to be made to reduce the complexity of the problem. Some limitations are set for the reason of avoiding the issue of overly-complex inputs.

The first assumption is that the type of redirection is given when the input is processed. Therefore IPM is relieved of the responsibility of deciding the *type* of

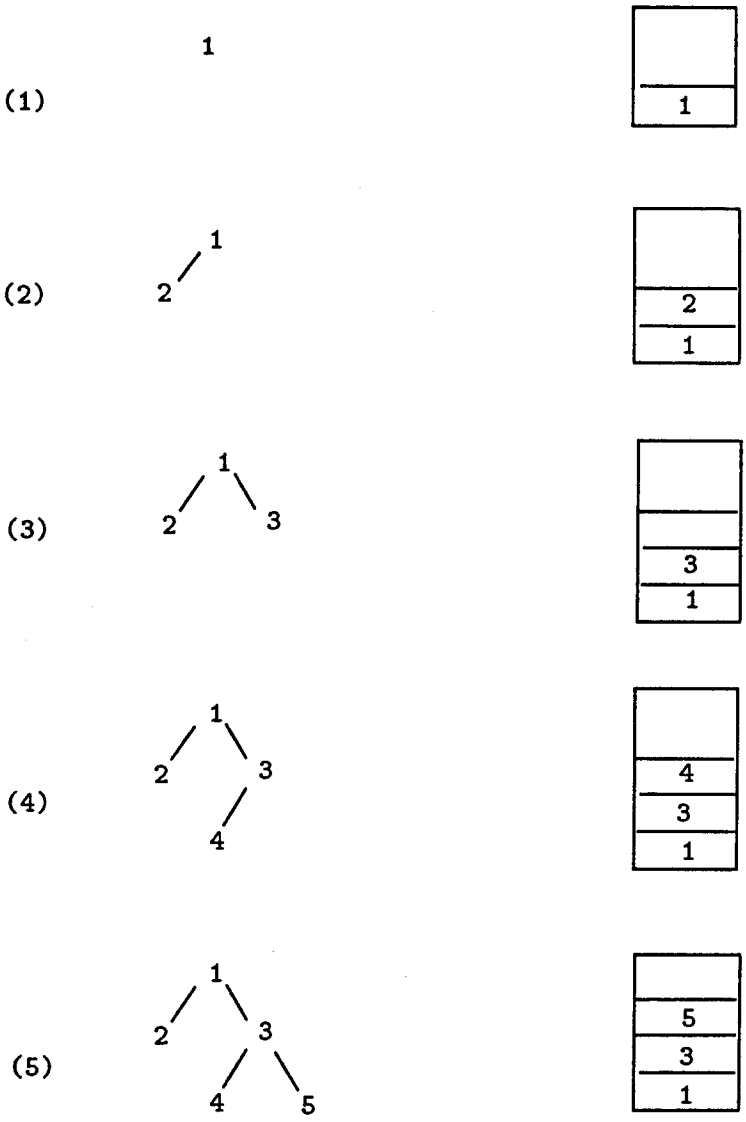
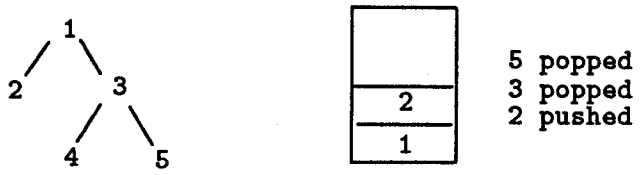


Figure 4.7: The structure from (1) to (5)



(6)

Figure 4.8: The structure after (6)

redirection it is processing and can hence go directly to the specific algorithm for that type of redirection. In a full discourse analysis system, determining the type of redirection is dependent on the type of clues and the semantic content of the interrupting segment. This is factored out of our solution at present.

In the process of implementation, we found that detecting the type of redirection isn't a trivial issue. The utterance-level (speech acts) intentional structure has to be understood to solve the problem. The utterance-level intentional structure is cited as a difficult problem in [Grosz85].

To reduce the complexity, the size of the input IPM could process is also restricted. We show only small example discourse to clearly illustrate the processing of the IPM. Also, the segment boundaries would be hard to be detected if clues are not present. In the examples given above, the return from redirection, be it flashback or digression, all have to be signalled by one of the return-indicators; otherwise, IPM will treat it

as part of the redirection and continue until another return-indicator is met.

Therefore, IPM is unable to handle, for example, a two-level redirection for which the return from level two isn't signalled by a return-indicator.

Also, only the DSP is stored in the focus space. The objects and the properties related to the objects should also be stored in the focus space according to [Grosz85]. Determining the salient objects and their properties requires more processing which is avoided in IPM.

Chapter 5

Conclusion and Future Work

Although the IPM is developed under the high-level description of [Grosz85], it has made some revisions to the rough algorithm provided by them, mainly because more details are needed.

Some examples of the IPM processing a certain number of examples are included in appendix A. One or two examples are given for each type of redirection.

This chapter comments on the work of the IPM, both its merits and its problems. The difficulties will also be pointed out and possible future work will be suggested.

5.1 Contributions

The IPM realizes the processing description given in [Grosz85], except for the part of *true interruptions*. True interruptions are eliminated from consideration because in fact the true interruptions might be viewed as interleaving of two or more unrelated discourse.

The IPM is still not the full-fledged discourse-processing system that[Grosz85] says their theory of discourse structure could be based upon. It is, however, a subset of the discourse-processing system. A complete discourse processing model should be able to process discourse with or without interruptions.

For interruptions, it should have the power to recognize the type of redirection with or without the help of redirection clue. The IPM lacks both of these features. It processes redirection with the type of redirection being supplied to it and the redirection clues have to be present to signal both redirection and return from redirection.

Nevertheless, there are some contributions from the IPM. A side effect of developing the IPM is to clarify some of the vague points mentioned in [Grosz85]. The updating of the focus space stack in the case of flashbacks and digressions should be sightly different according to [Grosz85] but exactly how should they be different is not mentioned. For the purpose of our implementation, the difference in their attentional state is of a trivial nature.

Also, cases of nested interruptions are not discussed in [Grosz85]. We propose an updating of the intentional structure and attentional state for these cases.

One other unclear point in [Grosz85] is that exactly what should be put onto the focus space stack. [Grosz85] suggests that in addition to the DSP of the segment, the objects and the properties of the objects should be placed on the stack. How the objects are chosen and once the objects are selected, what are the relevant properties and how are these properties acquired are not specified. Again, for simplicity, the IPM only puts the intentional structure of the discourse segment onto the stack.

For the case of semantic returns, [Grosz85] fails to mention how the focus space stack should be updated. They cited [Polanyi83] by saying in semantic returns, there is no popping of the stack. The IPM follows the [Cohen83] model by popping out

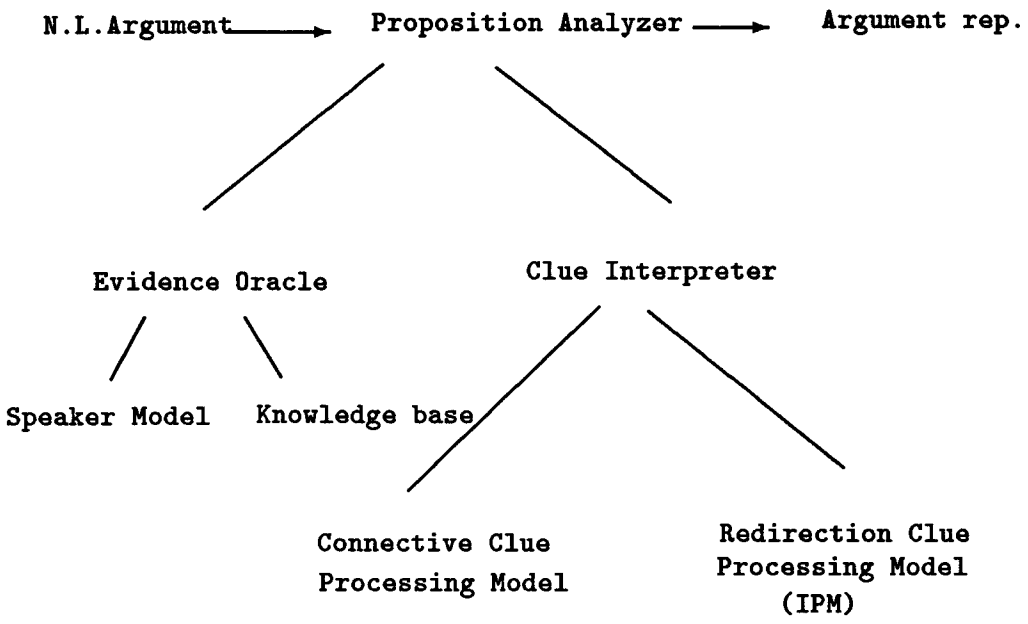


Figure 5.1: The contribution of the IPM to AUS

the non-father element of the focus space stack and pushing back the segment being discussed further. The stack thus contains only the DSP of the focus of attention and its ancestor DSPs.

The IPM also contributes to the AUS model presented in [Cohen83] by augmenting the *clue interpreter* part of the *proposition analyzer* ([Smedley87] and [Cohen87a]), which is the core of the whole AUS. Figure 5.1 shows the specific part the IPM contributes to.

The part of the *evidence oracle* in the figure is implemented in [Young87], which when given two propositions, will be able to decide the claim-evidence (or conclusion-premiss) relations between them. Before the integrating work by [Song88], the propo-

sition analyzer with clue interpreter by [Smedley86] and [Smedley87] had to ask the user to decide the claim-evidence relations.

The work of the IPM falls into the clue interpreter part of the AUS. However, integrating work has to be done to combine the IPM and the work of [Smedley87], which deals only with connective clues.

5.2 The Unsolved Problems

The IPM processes interruptions with the assumption that the type of redirection is given. Because the problem of utterance-level intentions is not explored and no deep semantic processing is going on, the IPM lacks the power of recognizing the redirection type. The input will have to be treated utterance by utterance in order to begin to solve the problem. Then the utterance-level intentions will have to be examined. [Grosz85] has cited that to be one of the difficult research problems.

The IPM will not check if the discourse is coherent or incoherent to reduce the complexity of the problem. The IPM at this point, could handle redirection within redirection only in the same type of redirection. Across different types of redirection, it would treat them as if they are the same type of redirection.

Also, the discourse segment boundary is still, in the IPM, indicated by the clues. Without clues, the IPM will treat everything as in one segment. This is of course not accurate. For a more complete processing, a better understanding of how to determine segment boundaries is needed.

5.3 Possible Future Work

One other restriction of the IPM is that it relies solely on the redirection clues for the separation of discourse segments. It would treat the part of the discourse after the last redirection clue and before the next clue as one discourse segment.

This, of course, severely restricts its applicability in the sense that if the directions are not provided, it would wrongly process the input. The recognition of discourse boundaries is, of course, not an easy task. It concerns determining of discourse purpose and discourse segment purposes.

To make the IPM complete, the problem of nested redirection of different type of redirections would have to be solved as the first step.

To complete the scheme in figure 5.1, the integration of connective clues and redirection clues, for example, to form a general clue processing model, is the first step. To accomplish this, a preprocessor which parses the input of the IPM to be the form used in the working model by [Smedley87] has to be written first. With this part completed, the work of [Song88] which combines [Young87] can be updated with the new clue interpreter to form the complete AUS.

Another direction for future work is to remove many of the assumptions made for the implementation of the IPM, and deal with basic discourse processing problems. For instance, if the input may include cases where clues do not exist to signal redirection, a more thorough investigation of the types of redirection phrases and whether they signal redirection or return will be necessary. But it has been useful to construct the implementation merely to identify which discourse problems are difficult and worthy of future research.

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Appendix A

Sample Examples

The examples in appendix A show the behavior of the IPM with different types of redirections. In each of the examples, the input discourse is first shown, followed by the discourse structure — the intentional structure, the attentional state and the focus space stack.

Also, before the discourse structure is output, the type of redirection, the redirection clue captured, and the level of redirections will be listed.

A global discourse purpose (DP) is assumed in the examples. In the focus space stack, DSP is led by a stock phrase: S wants H to believe that... This might not be suitable in every case. Rather, it points out that the CP intends to achieve some intentions. Following the stock phrase is the first sentence of the discourse segment. Again, this is just a representation of the discourse segment purpose. It happens that in some examples, the DSP is not accurately described.

A.1 Flashbacks

A.1.1 Flashbacks: Example One

```
You know, something very similar has happened to me before.


"Flashback" is the type of redirection


The structure of the discourse is:

The Intentional Structure

              DP
             /
            /
           /
      DSP-MAIN


Attentional State

------------------------------------------------------------------------
D-MAIN
   you know, something very similar has happened to me before.
------------------------------------------------------------------------


FS stack

FS-MAIN
------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   you know, something very similar has happened to me before.
------------------------------------------------------------------------

************************************************************************



You know, something very similar has happened to me before.

   That reminds me that 7 years ago, I was boating in Lake Simcoe.
```

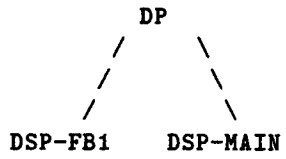
I saw exactly the same kind of rainbow arching over the whole lake.

"Flashback" is the type of redirection

"That reminds me" is the redirection clue of level 1

The structure of the discourse is:

The Intentional Structure



Attentional State

D-MAIN
you know, something very similar has happened to me before.
D-FB1
that reminds me that 7 years ago, i was boating in lake simcoe.

FS stack

FS-FB1

FB1
DSP-FB1: S wants H to believe that...
that reminds me that 7 years ago, i was boating in lake simcoe.

FS-MAIN

MAIN
DSP-MAIN: S wants H to believe that...
you know, something very similar has happened to me before.

****

You know, something very similar has happened to me before.

   That reminds me that 7 years ago, I was boating in Lake Simcoe.
   I saw exactly the same kind of rainbow arching over the whole lake.

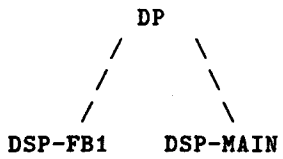
Returning to where I left off just now, this explained why I was so amazed
when I saw the rainbow again today.

"Flashback" is the type of redirection

"That reminds me" is the redirection clue of level 1
"Returning to" is the clue signalling return of level 1

The structure of the discourse is:

The Intentional Structure



Attentional State

D-MAIN
   you know, something very similar has happened to me before.
D-FB1
   that reminds me that 7 years ago, i was boating in lake simcoe.
D-RET1
   returning to where i left off just now, this explained why i was so amazed

---

FS stack

FS-MAIN

MAIN

```
DSP-MAIN: S wants H to believe that...
   you know, something very similar has happened to me before.
-------------------------------------------------------------------------------

*******************************************************************************
```

A.1.2 Flashbacks: Example Two

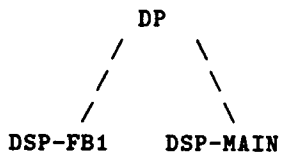
```
You know, something very similar has happened to me before.

"Flashback" is the type of redirection

The structure of the discourse is:

The Intentional Structure

              DP
             /
            /
           /
      DSP-MAIN

Attentional State

------------------------------------------------------------------------
D-MAIN
   you know, something very similar has happened to me before.
------------------------------------------------------------------------

FS stack

FS-MAIN
------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   you know, something very similar has happened to me before.
------------------------------------------------------------------------

************************************************************************

You know, something very similar has happened to me before.

   That reminds me that 7 years ago, I was boating in Lake Simcoe.
   I saw exactly the same kind of rainbow arching over the whole lake.
```

"Flashback" is the type of redirection

"That reminds me" is the redirection clue of level 1

The structure of the discourse is:

The Intentional Structure



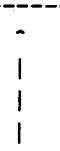
Attentional State

D-MAIN
you know, something very similar has happened to me before.
D-FB1
that reminds me that 7 years ago, i was boating in lake simcoe.

FS stack

FS-FB1

FB1
DSP-FB1: S wants H to believe that...
that reminds me that 7 years ago, i was boating in lake simcoe.



FS-MAIN

MAIN
DSP-MAIN: S wants H to believe that...
you know, something very similar has happened to me before.

****

You know, something very similar has happened to me before.

That reminds me that 7 years ago, I was boating in Lake Simcoe.
I saw exactly the same kind of rainbow arching over the whole lake.

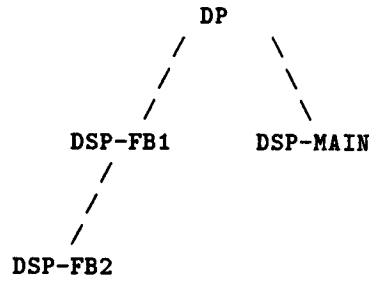
Speaking of rainbow, I should add that that is one of the
fascinating miracles of nature.

"Flashback" is the type of redirection

"That reminds me" is the redirection clue of level 1
"Speaking of" is the redirection clue of level 2

The structure of the discourse is:

The Intentional Structure



Attentional State

D-MAIN
you know, something very similar has happened to me before.
D-FB1
that reminds me that 7 years ago, i was boating in lake simcoe.
D-FB2
speaking of rainbow, i should add that that is one of the

FS stack

```
FS-FB2
-------------------------------------------------------------------------
FB2
DSP-FB2: S wants H to believe that...
   speaking of rainbow, i should add that that is one of the
-------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
FS-FB1
-------------------------------------------------------------------------
FB1
DSP-FB1: S wants H to believe that...
   that reminds me that 7 years ago, i was boating in lake simcoe.
-------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
FS-MAIN
-------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   you know, something very similar has happened to me before.
-------------------------------------------------------------------------

*************************************************************************
```

You know, something very similar has happened to me before.

That reminds me that 7 years ago, I was boating in Lake Simcoe.
I saw exactly the same kind of rainbow arching over the whole lake.

Speaking of rainbow, I should add that that is one of the
fascinating miracles of nature.

Back to the rainbow over Lake Simco that I saw 7 years ago.
It was one of the most gigantic rainbow ever recorded in Canadian history.

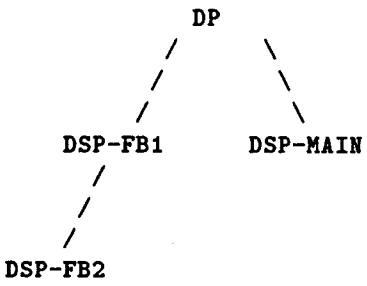
"Flashback" is the type of redirection

"That reminds me" is the redirection clue of level 1

"Speaking of" is the redirection clue of level 2
"Back to" is the clue signalling return of level 2

The structure of the discourse is:

The Intentional Structure



Attentional State

D-MAIN
you know, something very similar has happened to me before.
D-FB1
that reminds me that 7 years ago, i was boating in lake simcoe.
D-FB2
speaking of rainbow, i should add that that is one of the
D-RET2
back to the rainbow over lake simco that i saw 7 years ago.

FS stack

FS-FB1

FB1
DSP-FB1: S wants H to believe that...
that reminds me that 7 years ago, i was boating in lake simcoe.

FS-MAIN

MAIN

```
DSP-MAIN: S wants H to believe that...
   you know, something very similar has happened to me before.
-------------------------------------------------------------------------------

*******************************************************************************
```

You know, something very similar has happened to me before.

   That reminds me that 7 years ago, I was boating in Lake Simcoe.
   I saw exactly the same kind of rainbow arching over the whole lake.

      Speaking of rainbow, I should add that that is one of the
      fascinating miracles of nature.

   Back to the rainbow over Lake Simco that I saw 7 years ago.
   It was one of the most gigantic rainbow ever recorded in Canadian history.

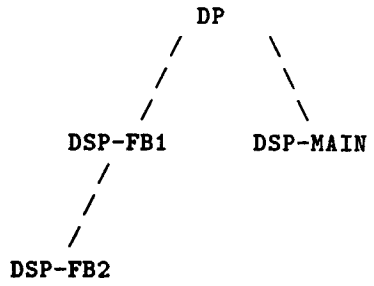
Returning to where I left off just now, this explained why I was so amazed when I saw the rainbow again today.

"Flashback" is the type of redirection

"That reminds me" is the redirection clue of level 1
"Speaking of" is the redirection clue of level 2
"Back to" is the clue signalling return of level 2
"Returning to" is the clue signalling return of level 1

The structure of the discourse is:

The Intentional Structure



Attentional State

```
---------------------------------------------------------------------------
D-MAIN
   you know, something very similar has happened to me before.
D-FB1
   that reminds me that 7 years ago, i was boating in lake simcoe.
D-FB2
   speaking of rainbow, i should add that that is one of the
D-RET2
   back to the rainbow over lake simco that i saw 7 years ago.
D-RET1
   returning to where i left off just now, this explained why i was so amazed
---------------------------------------------------------------------------


FS stack

FS-MAIN
---------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   you know, something very similar has happened to me before.
---------------------------------------------------------------------------

***************************************************************************
```

A.2 Digressions

A.2.1 Digressions: Example One

```
The renovation of the prime minister's official residence cost a lot.

"Digression" is the type of redirection

The structure of the discourse is:

The Intentional Structure

              DP
             /
            /
           /
      DSP-MAIN

Attentional State

------------------------------------------------------------------------
D-MAIN
   the renovation of the prime minister's official residence cost a lot.
------------------------------------------------------------------------

FS stack

FS-MAIN
------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   the renovation of the prime minister's official residence cost a lot.
------------------------------------------------------------------------

************************************************************************


The renovation of the prime minister's official residence cost a lot.
```

Speaking of his residence, is it one of the mansions by the lake?
I do hope I can live there some day.

"Digression" is the type of redirection

"Speaking of" is the redirection clue of level 1

The structure of the discourse is:

The Intentional Structure

Attentional State

D-MAIN
the renovation of the prime minister's official residence cost a lot.
D-DG1
speaking of his residence, is it one of the mansions by the lake?

FS stack

FS-DG1

DG1
DSP-DG1: S wants H to believe that...
speaking of his residence, is it one of the mansions by the lake?

FS-MAIN

MAIN
DSP-MAIN: S wants H to believe that...
the renovation of the prime minister's official residence cost a lot.

****

The renovation of the prime minister's official residence cost a lot.

   Speaking of his residence, is it one of the mansions by the lake?
   I do hope I can live there some day.

Getting back to the renovation, it even cost fifteen thousand dollars
of the tax payer's money just for the planning of it.

"Digression" is the type of redirection

"Speaking of" is the redirection clue of level 1
"Back to" is the clue signalling return of level 1

The structure of the discourse is:

The Intentional Structure

Attentional State

D-MAIN
   the renovation of the prime minister's official residence cost a lot.
D-DG1
   speaking of his residence, is it one of the mansions by the lake?
D-RET1
   getting back to the renovation, it even cost fifteen thousand dollars

---

FS stack

FS-MAIN

```
MAIN
DSP-MAIN: S wants H to believe that...
   the renovation of the prime minister's official residence cost a lot.
-------------------------------------------------------------------------

*************************************************************************
```

A.2.2 Digressions: Example Two

```
The Japanese prime minister just resigned due to his failure in election.

"Digression" is the type of redirection

The structure of the discourse is:

The Intentional Structure

              DP
             /
            /
           /
      DSP-MAIN

Attentional State

------------------------------------------------------------------------
D-MAIN
   the japanese prime minister just resigned due to his failure in election.
------------------------------------------------------------------------

FS stack

FS-MAIN
------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   the japanese prime minister just resigned due to his failure in election.
------------------------------------------------------------------------

************************************************************************


The Japanese prime minister just resigned due to his failure in election.

   Speaking of Japan, it has the most powerful economy in the world.
   We should learn from Japan.
```

```
"Digression" is the type of redirection

"Speaking of" is the redirection clue of level 1

The structure of the discourse is:

The Intentional Structure

              DP                DSP-DG1
               /                   /
              /                   /
             /                   /
      DSP-MAIN

Attentional State

------------------------------------------------------------------------
D-MAIN
   the japanese prime minister just resigned due to his failure in election.
D-DG1
   speaking of japan, it has the most powerful economy in the world.
------------------------------------------------------------------------


FS stack

FS-DG1
------------------------------------------------------------------------
DG1
DSP-DG1: S wants H to believe that...
   speaking of japan, it has the most powerful economy in the world.
------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
FS-MAIN
------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   the japanese prime minister just resigned due to his failure in election.
------------------------------------------------------------------------

************************************************************************
```

```
The Japanese prime minister just resigned due to his failure in election.

   Speaking of Japan, it has the most powerful economy in the world.
   We should learn from Japan.

        Since you mention the economy, that reminds me of something.
        Can you compare the economic power of Japan with that of ours?


"Digression" is the type of redirection

"Speaking of" is the redirection clue of level 1
"That reminds me" is the redirection clue of level 2

The structure of the discourse is:

The Intentional Structure

          DP            DSP-DG1       DSP-DG2
          /               /             /
         /               /             /
        /               /             /
   DSP-MAIN

Attentional State

------------------------------------------------------------------------
D-MAIN
   the japanese prime minister just resigned due to his failure in election.
D-DG1
   speaking of japan, it has the most powerful economy in the world.
D-DG2
   since you mention the economy, that reminds me of something.
------------------------------------------------------------------------


FS stack

FS-DG2
------------------------------------------------------------------------
DG2
DSP-DG2: S wants H to believe that...
```

```
   since you mention the economy, that reminds me of something.
-------------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
FS-DG1
-------------------------------------------------------------------------------
DG1
DSP-DG1: S wants H to believe that...
   speaking of japan, it has the most powerful economy in the world.
-------------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
FS-MAIN
-------------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   the japanese prime minister just resigned due to his failure in election.
-------------------------------------------------------------------------------

*******************************************************************************
```

The Japanese prime minister just resigned due to his failure in election.

Speaking of Japan, it has the most powerful economy in the world.
We should learn from Japan.

> Since you mention the economy, that reminds me of something.
> Can you compare the economic power of Japan with that of ours?

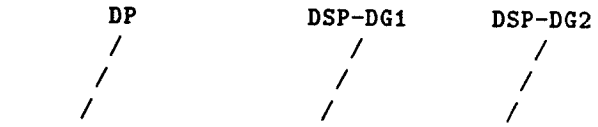
Now go back to the economy. I was talking about what we can learn from Japan...

"Digression" is the type of redirection

"Speaking of" is the redirection clue of level 1
"That reminds me" is the redirection clue of level 2
"Back to" is the clue signalling return of level 2

The structure of the discourse is:

The Intentional Structure



Attentional State

```
----------------------------------------------------------------------------
D-MAIN
   the japanese prime minister just resigned due to his failure in election.
D-DG1
   speaking of japan, it has the most powerful economy in the world.
D-DG2
   since you mention the economy, that reminds me of something.
D-RET2
   now go back to the economy.  i was talking about what we can learn
----------------------------------------------------------------------------
```

FS stack

```
FS-DG1
----------------------------------------------------------------------------
DG1
DSP-DG1: S wants H to believe that...
   speaking of japan, it has the most powerful economy in the world.
----------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
FS-MAIN
----------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   the japanese prime minister just resigned due to his failure in election.
----------------------------------------------------------------------------
```

****

```
The Japanese prime minister just resigned due to his failure in election.

   Speaking of Japan, it has the most powerful economy in the world.
   We should learn from Japan.

        Since you mention the economy, that reminds me of something.
        Can you compare the economic power of Japan with that of ours?

   Now go back to the economy.  I was talking about what we can learn
   from Japan...

Let me return to the election. The most influential party in Japan is led
for the first time by a female leader.


"Digression" is the type of redirection

"Speaking of" is the redirection clue of level 1
"That reminds me" is the redirection clue of level 2
"Back to" is the clue signalling return of level 2
"Return to" is the clue signalling return of level 1

The structure of the discourse is:

The Intentional Structure

          DP            DSP-DG1       DSP-DG2
          /               /             /
         /               /             /
        /               /             /
   DSP-MAIN

Attentional State

-------------------------------------------------------------------------
D-MAIN
   the japanese prime minister just resigned due to his failure in election.
D-DG1
   speaking of japan, it has the most powerful economy in the world.
D-DG2
   since you mention the economy, that reminds me of something.
D-RET2
   now go back to the economy.  i was talking about what we can learn
D-RET1
   let me return to the election. the most influential party in japan is led
```

```
------------------------------------------------------------------------------


FS stack

FS-MAIN
------------------------------------------------------------------------------
MAIN
DSP-MAIN: S wants H to believe that...
   the japanese prime minister just resigned due to his failure in election.
------------------------------------------------------------------------------

******************************************************************************
```

A.3 Semantic Returns

A.3.1 Semantic Returns: Example One

```
I found that Peter is quite a good candidate for the position.

"Semantic Return" is the type of redirection

The structure of the discourse is:

Intentional Structure

                S1



Attentional State

------------------------------------------------------------------------
S1:    Main Claim
  i found that peter is quite a good candidate for the position.
------------------------------------------------------------------------


Focus Space Stack

------------------------------------------------------------------------
S1
DSP-S1:   S wants H to believe that ...
  i found that peter is quite a good candidate for the position.
------------------------------------------------------------------------



************************************************************************



I found that Peter is quite a good candidate for the position.
```

1His management skill is what the company needs.

"Semantic Return" is the type of redirection

The structure of the discourse is:

Intentional Structure

Attentional State

S1: Main Claim
i found that peter is quite a good candidate for the position.
S2: Evidence for S1
his management skill is what the company needs.

Focus Space Stack

S2
DSP-S2: S wants H to believe that ...
his management skill is what the company needs.

S1
DSP-S1: S wants H to believe that ...
i found that peter is quite a good candidate for the position.

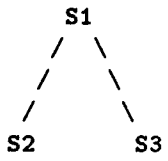
****

I found that Peter is quite a good candidate for the position.
1His management skill is what the company needs.
1He has extensive adminstrative experience.

"Semantic Return" is the type of redirection

The structure of the discourse is:

Intentional Structure



Attentional State

S1: Main Claim
i found that peter is quite a good candidate for the position.
S2: Evidence for S1
his management skill is what the company needs.
S3: Evidence for S1
he has extensive adminstrative experience.

Focus Space Stack

S3
DSP-S3: S wants H to believe that ...
he has extensive adminstrative experience.

```
------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
------------------------------------------------------------------------
S1
DSP-S1:   S wants H to believe that ...
  i found that peter is quite a good candidate for the position.
------------------------------------------------------------------------
```

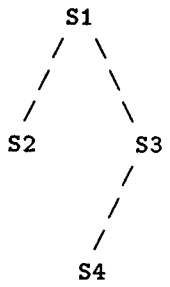
****

I found that Peter is quite a good candidate for the position.
1His management skill is what the company needs.
1He has extensive adminstrative experience.
3He served for ten years on the board.

"Semantic Return" is the type of redirection

The structure of the discourse is:

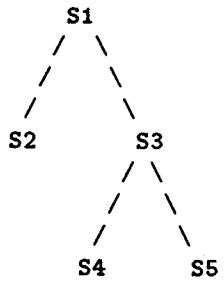
Intentional Structure



Attentional State

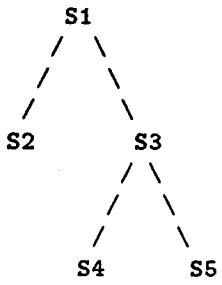
```
------------------------------------------------------------------------------
S1:     Main Claim
  i found that peter is quite a good candidate for the position.
S2:     Evidence for S1
   his management skill is what the company needs.
S3:     Evidence for S1
   he has extensive adminstrative experience.
S4:     Evidence for S3
   he served for ten years on the board.
------------------------------------------------------------------------------


Focus Space Stack

------------------------------------------------------------------------------
S4
DSP-S4:   S wants H to believe that ...
   he served for ten years on the board.
------------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
------------------------------------------------------------------------------
S3
DSP-S3:   S wants H to believe that ...
   he has extensive adminstrative experience.
------------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
------------------------------------------------------------------------------
S1
DSP-S1:   S wants H to believe that ...
  i found that peter is quite a good candidate for the position.
------------------------------------------------------------------------------



******************************************************************************
```

```
I found that Peter is quite a good candidate for the position.
   1His management skill is what the company needs.
   1He has extensive adminstrative experience.
       3He served for ten years on the board.
       3He also has been vice-president for five years.


"Semantic Return" is the type of redirection


The structure of the discourse is:


Intentional Structure
```




```
Attentional State

------------------------------------------------------------------------
S1:    Main Claim
  i found that peter is quite a good candidate for the position.
S2:    Evidence for S1
   his management skill is what the company needs.
S3:    Evidence for S1
   he has extensive adminstrative experience.
S4:    Evidence for S3
   he served for ten years on the board.
S5:    Evidence for S3
   he also has been vice-president for five years.
------------------------------------------------------------------------


Focus Space Stack

------------------------------------------------------------------------
```

```
S5
DSP-S5:   S wants H to believe that ...
   he also has been vice-president for five years.
-------------------------------------------------------------------------
                                    -
                                    |
                                    |
                                    |
-------------------------------------------------------------------------
S3
DSP-S3:   S wants H to believe that ...
   he has extensive adminstrative experience.
-------------------------------------------------------------------------
                                    -
                                    |
                                    |
                                    |
-------------------------------------------------------------------------
S1
DSP-S1:   S wants H to believe that ...
  i found that peter is quite a good candidate for the position.
-------------------------------------------------------------------------

*************************************************************************


I found Peter is quite a good candidate for the position.
   1His management skill is what the company needs.
   1He has extensive adminstrative experience.
       3He served for ten years on the board.
       3He also has been vice-president for five years.
^2Now, remember I was talking about Peter's management skill the other day? ...


"Semantic Return" is the type of redirection


The structure of the discourse is:


Intentional Structure
```



Attentional State

```
--------------------------------------------------------------------------
S1:    Main Claim
  i found peter is quite a good candidate for the position.
S2:    Evidence for S1
   his management skill is what the company needs.
S3:    Evidence for S1
   he has extensive adminstrative experience.
S4:    Evidence for S3
   he served for ten years on the board.
S5:    Evidence for S3
   he also has been vice-president for five years.
S6:    Return to S2
  now, remember i was talking about peter's management skill the other day? ...
--------------------------------------------------------------------------
```

Focus Space Stack

```
--------------------------------------------------------------------------
S2
DSP-S2:   S wants H to believe that ...
   his management skill is what the company needs.
--------------------------------------------------------------------------
                                    |
                                    |
                                    |
--------------------------------------------------------------------------
S1
DSP-S1:   S wants H to believe that ...
  i found peter is quite a good candidate for the position.
```

****

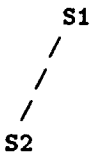
A.3.2 Semantic Returns: Example Two

```
The deficit problem is getting out of control.

"Semantic Return" is the type of redirection

The structure of the discourse is:

Intentional Structure

                S1



Attentional State

------------------------------------------------------------------------
S1:    Main Claim
  the deficit problem is getting out of control.
------------------------------------------------------------------------

Focus Space Stack

------------------------------------------------------------------------
S1
DSP-S1:   S wants H to believe that ...
  the deficit problem is getting out of control.
------------------------------------------------------------------------

**************************************************************************


The deficit problem is getting out of control.
  1The prime minister just announced a stringent policy for social welfare.
```

"Semantic Return" is the type of redirection

The structure of the discourse is:

Intentional Structure



Attentional State

S1: Main Claim
the deficit problem is getting out of control.
S2: Evidence for S1
the prime minister just announced a stringent policy for social welfare.

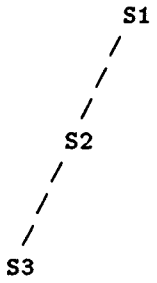
Focus Space Stack

S2
DSP-S2: S wants H to believe that ...
the prime minister just announced a stringent policy for social welfare.

S1
DSP-S1: S wants H to believe that ...
the deficit problem is getting out of control.

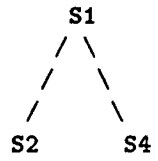
****

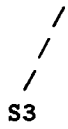
```
The deficit problem is getting out of control.
  1The prime minister just announced a stringent policy for social welfare.
     2The budget for social welfare has been cut in half.


"Semantic Return" is the type of redirection


The structure of the discourse is:


Intentional Structure
```




```
Attentional State

------------------------------------------------------------------------
S1:    Main Claim
  the deficit problem is getting out of control.
S2:    Evidence for S1
   the prime minister just announced a stringent policy for social welfare.
S3:    Evidence for S2
   the budget for social welfare has been cut in half.
------------------------------------------------------------------------


Focus Space Stack

------------------------------------------------------------------------
S3
DSP-S3:   S wants H to believe that ...
```

```
   the budget for social welfare has been cut in half.
-------------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
-------------------------------------------------------------------------------
S2
DSP-S2:   S wants H to believe that ...
   the prime minister just announced a stringent policy for social welfare.
-------------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
-------------------------------------------------------------------------------
S1
DSP-S1:   S wants H to believe that ...
  the deficit problem is getting out of control.
-------------------------------------------------------------------------------


*******************************************************************************


The deficit problem is getting out of control.
  1The prime minister just announced a stringent policy for social welfare.
     2The budget for social wellfare has been cut in half.
  1The minister of finance was booed by the congressmen for his proposal.


"Semantic Return" is the type of redirection


The structure of the discourse is:


Intentional Structure
```





Attentional State

S1: Main Claim
the deficit problem is getting out of control.
S2: Evidence for S1
the prime minister just announced a stringent policy for social welfare.
S3: Evidence for S2
the budget for social wellfare has been cut in half.
S4: Evidence for S1
the minister of finance was booed by the congressmen for his proposal.

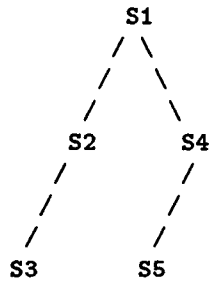
Focus Space Stack

S4
DSP-S4: S wants H to believe that ...
the minister of finance was booed by the congressmen for his proposal.

S1
DSP-S1: S wants H to believe that ...
the deficit problem is getting out of control.

****

```
The deficit problem is getting out of control.
  1The prime minister just announced a stringent policy for social welfare.
     2The budget for social wellfare has been cut in half.
  1The minister of finance was booed by the congressmen for his proposal.
     4He proposed to cancel the travel allowances for congressmen.


"Semantic Return" is the type of redirection


The structure of the discourse is:


Intentional Structure
```



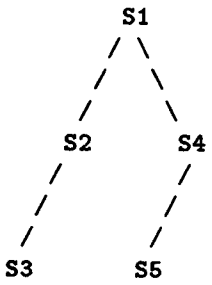

```
Attentional State

------------------------------------------------------------------------
S1:    Main Claim
  the deficit problem is getting out of control.
S2:    Evidence for S1
   the prime minister just announced a stringent policy for social welfare.
S3:    Evidence for S2
   the budget for social wellfare has been cut in half.
S4:    Evidence for S1
   the minister of finance was booed by the congressmen for his proposal.
S5:    Evidence for S4
   he proposed to cancel the travel allowances for congressmen.
------------------------------------------------------------------------


Focus Space Stack
```

```
-------------------------------------------------------------------------
S5
DSP-S5:   S wants H to believe that ...
   he proposed to cancel the travel allowances for congressmen.
-------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
-------------------------------------------------------------------------
S4
DSP-S4:   S wants H to believe that ...
   the minister of finance was booed by the congressmen for his proposal.
-------------------------------------------------------------------------
                                    ^
                                    |
                                    |
                                    |
-------------------------------------------------------------------------
S1
DSP-S1:   S wants H to believe that ...
  the deficit problem is getting out of control.
-------------------------------------------------------------------------
```

****

```
The deficit problem is getting out of control.
  1The prime minister just announced a stringent policy for social welfare.
     2The budget for social wellfare has been cut in half.
  1The minister of finance was booed by the congressmen for his proposal.
     4He proposed to cancel the travel allowances for congressmen.
^2Remember I was talking about the prime minister's policy for social welfare?


"Semantic Return" is the type of redirection


The structure of the discourse is:
```

Intentional Structure



Attentional State

```
------------------------------------------------------------------------
S1:    Main Claim
  the deficit problem is getting out of control.
S2:    Evidence for S1
   the prime minister just announced a stringent policy for social welfare.
S3:    Evidence for S2
   the budget for social wellfare has been cut in half.
S4:    Evidence for S1
   the minister of finance was booed by the congressmen for his proposal.
S5:    Evidence for S4
   he proposed to cancel the travel allowances for congressmen.
S6:    Return to S2
  remember i was talking about the prime minister's policy for social welfare?
------------------------------------------------------------------------
```

Focus Space Stack

```
------------------------------------------------------------------------
S2
DSP-S2:   S wants H to believe that ...
   the prime minister just announced a stringent policy for social welfare.
------------------------------------------------------------------------
                                    |
                                    |
                                    |
------------------------------------------------------------------------
S1
DSP-S1:   S wants H to believe that ...
```

```
  the deficit problem is getting out of control.
--------------------------------------------------------------------------------
```

```
********************************************************************************
```