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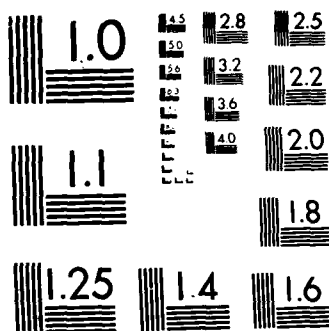
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October 1986

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Rhetorical Structure Theory: Description and Construction of Text Structures

Presented at the Third International Workshop on Text Generation,
held August 19-23, 1986 in Nijmegen, The Netherlands

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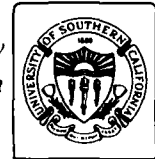
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Rhetorical Structure Theory: Description and Construction of Text Structures

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Presented
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Abstract

Rhetorical Structure Theory (RST) is a theory of text structure that is being extended to serve as a theoretical basis for computational text planning. Text structures in RST are hierarchic, built on small patterns called schemas. The schemas which compose the structural hierarchy of a text describe the functions of the parts rather than their form characteristics. Relations between text parts, comparable to conjunctive relations, are a prominent part of RST's definitional machinery.

Recent work has put RST onto a new definitional basis. This paper details the current status of descriptive RST, along with efforts to create a constructive version for use as a basis for programming a text planner.

1 The Roots of Rhetorical Structure Theory

Rhetorical Structure Theory (RST) has been developed as a basis for text generation, specifically for planning large texts of diverse kinds. It currently exists in a well elaborated form as a descriptive theory, and in a more rudimentary form as a constructive theory based on the descriptive theory.¹ This paper, designed as a workshop paper, presents an overview and status report, showing the predominant general cases and passing over some of the details and exceptions. (Other papers attempt a much more precise account.)

¹Rhetorical Structure Theory was initially defined by the authors and Christian Matthiessen : Barbara Fox, Cecilia Ford, and others have made important contributions. It has been influenced significantly by [Grimes 75] and [McKeown 85]. [Mann & Thompson 86], [Mann 84] and [Mann & Thompson 85] are our principal earlier papers on RST. [Mann & Thompson 87] describes its relations to other theories in some detail. The support of the National Science Foundation and the Air Force Office of Scientific Research are gratefully acknowledged; the opinions in this paper are solely the authors'.

2 Principal Mechanisms of Descriptive RST

RST describes a text by assigning a *structure* to it. Prior to analysis, a text is broken into *units* of a size that is convenient for the analyst's purposes. (Independent clauses are normally the smallest units; however, larger units may be chosen for larger texts.) These units function as terminal nodes in an RST structure -- which is a tree that covers the entire text. In this way an RST structure resembles a conventional sentence structure, but the resemblance is superficial.

The RST analysis is built out of instances of *schemas*, diagrammed in Figure 1. Each schema indicates how a particular unit of text structure is decomposed into other units. The vertical line points to one of the *text spans* which the schema covers, called the *nucleus*. The other spans are linked to the nucleus by *relations*, represented by labelled curved lines; these spans are called *satellites*. The schema definitions do not constrain the order of spans; the analysis of a particular text is drawn using the left-to-right order of the text whenever possible.

Generic RST Schema

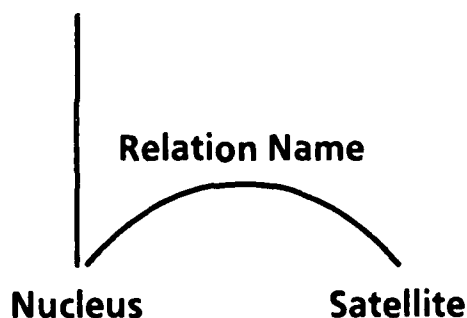


Figure 1: The Generic RST Schema

A schema is defined in terms of one (occasionally two) relations. For example, the *Evidence schema* is defined as a schema of applications of the *Evidence relation*.

Figure 2 shows an analysis that we have published elsewhere [Mann 84]. The text is a 9 sentence article from a political magazine. The analysis contains 12 applications of 8 different schemas: Evidence, Antithesis, Justify, Elaboration, Concessive, Conditional, Circumstance and Motivation/Enablement.

Two particular regions are highlighted: the applications of the Evidence schema. Note that there are two Evidence satellites in the upper region: Multiple satellites are allowed in schema applications. This schema covers (*decomposes*) the text span consisting of units 1 through 13. The nucleus is the span consisting of unit 1, and the two satellites are the spans of units 2 through 9 and 10 through 13.

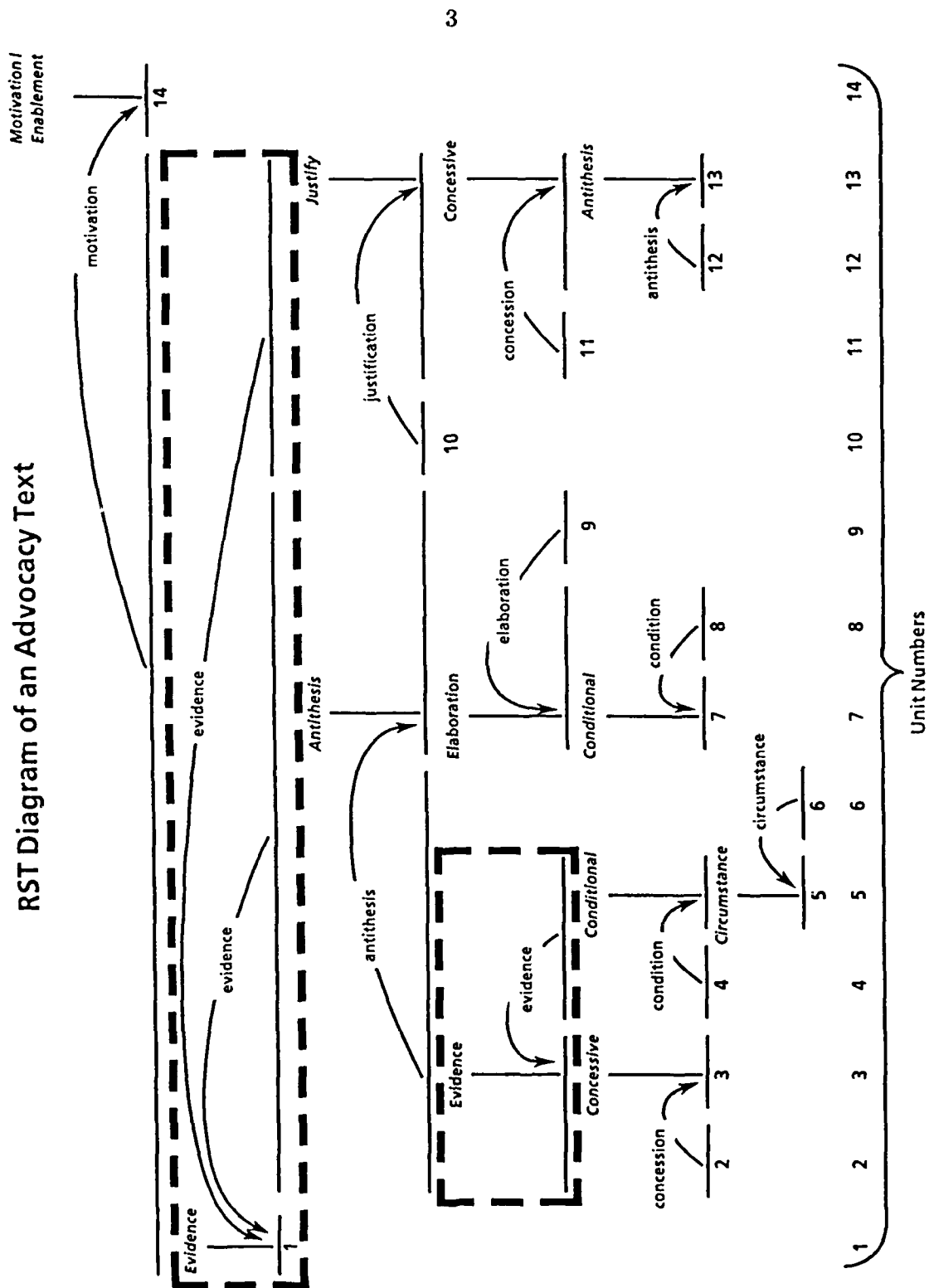


Figure 2: RST Diagram of an Advocacy Text

A schema application is valid if the relation definitions of which it is composed all apply to the appropriate text spans, with the same nucleus span in every case. An analysis of a text consists of a set of schema applications which collectively decompose the text into either terminal units or spans further decomposed in the analysis.²

The heart of RST is the relation definitions. In past work we have relied on open descriptive relation definitions [Mann 84]. More recently we have developed a new style, in which a relation definition consists of four fields:

1. **Constraints on the Nucleus**
2. **Constraints on the Satellite**
3. **Constraints on the combination of Nucleus and Satellite**
4. **The Effect**

We can see how it works in the definition of the Evidence relation used above. Informally, these are the values of the fields in the definition of the Evidence relation:

1. **Constraints on the Nucleus (the *claim*):**

The reader possibly does not already believe the claim.

2. **Constraints on the Satellite (the *evidence*):**

3. The reader either already believes the satellite or will find it credible.

4. **Constraints on the combination of Nucleus and Satellite:**

Comprehending the evidence will increase the reader's belief in the claim.³

5. **The Effect:** The reader's belief in the claim is increased.

Each of the fields specifies particular judgments that the text analyst must make in building the RST structure. Given the nature of text analysis, these are judgments of plausibility rather than of any sort of certainty. In the case of the Effect field, the

²There is no absolute requirement that the spans covered by a schema application be adjacent, but in practice it is virtually always so.

³Belief is treated as a degree concept. This is not a central feature of the definitions, but it helps explain certain text features, e.g. why people provide multiple lines of evidence. All of the judgments of the reader's states and reactions are necessarily from the analyst's view of the writer's view, since they are based on the text.

analyst is judging whether it is plausible that the writer desires the specified condition.⁴

This is a more explicit form of definition than we had used before. It is still based on judgments, necessarily, but since it provides a checklist of affirmations it makes it easy to identify the claims underlying a particular analysis.

An RST analysis is simply a set of schema applications for which:

1. one schema application decomposes the text as a whole, yielding smaller spans,
2. the others decompose the spans yielded by other applications, and
3. the analyst affirms the judgments involved in the relation definitions of the schema applications.

Note that since every definition has an Effect field, the analyst is effectively providing an account for the whole text of a plausible reason the writer might have had for including each part.

3 An Account of a Text

To see how this works, we analyze the text of the second highlighted Evidence schema from Figure 2. The text is:

2. Tempting as it may be,
3. we shouldn't embrace every popular issue that comes along.
4. When we do so
5. we use precious, limited resources
6. where other players with superior resources are already doing an adequate job.

The first constraint says that the reader possibly does not already believe the claim, units 2 and 3. This is plausible, since the reader may have a popularity-contest view of how to choose what to support.

The second constraint says that it is plausible that the reader believes units 4 and 5 or will find them credible.

⁴Plausibility is a threshold concept, based on a degree scale and a conventional way of dividing the scale to provide a binary judgment.

The third and most crucial constraint is that (in the writer's view) comprehending the evidence (in this case an apparent waste of resources) will increase the reader's belief in the claim (that we should not support every popular issue.)

The final constraint, based on the Effect field, is that the writer wants it to be the case that the reader's belief in the claim is increased.

Since in the role of analyst we affirm that all of these constraints are fulfilled, the Evidence relation holds between these two spans. The analysis of the entire text is constructed similarly.

4 Nuclearity

What is nuclearity? Why is the terminology of nucleus and satellite appropriate for consistent use with a variety of relations? The discussion of nuclearity so far simply uses "nucleus" and "satellite" as span labels in definitions. But they represent a much more pervasive and significant regularity.

As RST was being developed, a pattern in the way relations appear in text became evident. The principal features of the pattern are these:

1. Relations are nearly all asymmetric. (For example, if A is serving as evidence for B, B is not at the same place serving as evidence for A.)
2. There is a characteristic difference across relations in how the two spans function:
 - a. One span is more prominent than the other.
 - b. One span is more essential to the text than the other.
 - c. For schemas with multiple relations, there is a single core span that all of the other spans are related to.
 - d. The identity of the prominent and essential span can be predicted from the relation itself. It is not conditional on the content of the spans or their context.

The prominent and essential core span is called the *nucleus*, and the remaining spans the *satellites*. The identity of the nucleus is part of the relation definition. The use of the terminology reflects the fact that the pattern described above is predominant in texts.

5 Other Relations

The set of relations is not closed. Depending on one's purposes and the kind of text in view, relations can be added, subdivided and otherwise manipulated. Still, they are not an open category like Noun, subject to unconstrained overt invention. The set of rhetorical relations is more like the set of conjunctions (than like the set of nouns) in that it is reasonably stable for any particular purpose, yet flexible enough to bend to a new task. They seem to be somewhat language-specific and culture-specific, certainly in frequency if not in occurrence.

We are currently developing a reasonably precise exposition of descriptive RST [Mann & Thompson 87]. It will include definitions (in the style illustrated above) for the following relations:

Circumstance	Solutionhood
Elaboration	Background
Enablement	Motivation
Evidence	Justify
Volitional Cause	Non-Volitional Cause
Volitional Result	Non-Volitional Result
Antithesis	Concession
Condition	Otherwise
Interpretation	Evaluation
Restatement	Summary
Sequence	Contrast

Other definitions which are not fully developed are: Means, Comparison, Contribution, and Disjunction.

6 Relational Propositions: the Phenomenon

In a previous paper we identified a phenomenon called Relational Propositions [Mann & Thompson 86]. It is an assertion-like effect in which the assertions are not expressed explicitly in clauses. Often there is no explicit signal at all, yet the assertion is effectively communicated by the text.

For example, here is an extract from a letter to the editor of BYTE magazine (diagrammed in Figure 3). The writer is praising a program which computes federal income tax, published in a previous issue of the magazine:

1. The program as published for calendar year 1980 really works.
2. In only a few minutes, I entered all the figures from my 1980 tax return
3. and got a result which agreed with my hand calculations to the penny.

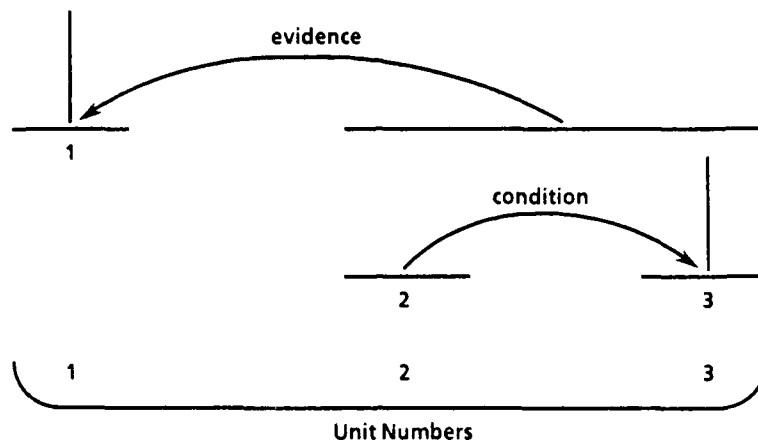


Figure 3: RST Diagram of the Program Testimonial

We would posit an Evidence relation with unit 1 as nucleus and units 2 through 3 as satellite.

The relational proposition of this text says that this experience, (entering the figures and getting a result which agreed with hand calculations), is a suitable basis for believing that the program really works. The text conveys this idea of evidence, but does not express it explicitly. (The previous examples did not express it explicitly either. Evidence is one of several relations for which explicit expression is rare.)

In fact, this proposition is essential to the coherence of the text. Suppose we alter the text by adding another sentence so that the proposition about evidence is not affirmed:

"The program as published for calendar year 1980 really works. In only a few minutes, I entered all the figures from my 1980 tax return and got a result which agreed with my hand calculations to the penny. But that doesn't suggest in any way that the program works."

The resulting text is obviously incoherent: we no longer know what the writer is saying. This supports our view that the natural (coherent) text crucially relied on and conveyed the proposition of evidence. Several other kinds of support for this view are described in [Mann & Thompson 86].

More generally, we find that *every relation in an RST structure conveys some*

relational proposition. The conveyed propositions are essential to the coherence of the texts in which they arise.

There is an interesting and complex relationship between the relational propositions and the various forms that express such information, especially the conjunctions. Unfortunately, it has not yet been well studied. This raises a point that is important for discourse theory as a whole. *Expression of implicit propositions is not an occasional side-effect that accompanies the clausal propositions of a text. Rather, it is an inevitable and essential component of text communication.*⁵

How can we know what relational proposition arises from any particular relation in the structure of a text? This is a problem on which we are currently working. The preliminary answer is that the relational proposition can be identified generically at the time that the corresponding relation is defined. Furthermore, the relational proposition does not constrain the definition; rather it is derivable from the other parts of the definition. We are not yet confident that this is the complete story, but it is at least approximately correct.

We should note that the phenomenon of relational propositions has significant added consequences for text generation:

1. Relational propositions are an expressive resource, a means for achieving brevity.
2. Explicit clausal expression of a proposition which is also conveyed as a relational proposition produces an excessively repetitive text.
3. Since relational propositions can be conveyed without clausal material, a text generator must be specially designed to control what propositions are conveyed.

7 Consequences of Descriptive RST

The most important finding in RST-based studies of text is that virtually all small published texts in our culture have RST analyses. Since the definitions and conventions of RST are restrictive enough that there is no a priori reason why so many texts should have analyses, so this is a genuine finding. This is an advance in that it shows what relations are essential in composing text, and how they can be arranged. And it demonstrates that relational linking is comprehensive, spanning the whole text, and pervasive, linking on every scale down to small units.

⁵ Mann & Thompson 85 develops the idea that the relational propositions described in [Mann & Thompson 86] do in fact arise from the RST discourse structure of the texts in which they occur.

A companion study, [Thompson & Mann 87], provides strong evidence that the relations of RST structure and the relations of clause combining are one and the same set. Thus RST is informative about phenomena of clause combining, conjunction and related issues of form and function. In the clause combining area, another companion study shows the close relationship between RST and hypotaxis [Matthiessen & Thompson 86].

RST also yields guidance for work in knowledge representation. The relations of RST reflect a set of distinct kinds of knowledge that are given special treatment in text organization. It is therefore essential to represent these in the knowledge notations underlying a general text comprehender or generator.

8 Constructive RST

RST was created so that it could be the basis of an autonomous computational text planner. Satisfying this goal requires more than just a descriptive theory; it also requires an approach to synthesis of structures, i.e. constructive RST. Constructive RST is in a much more rudimentary state than the descriptive theory, but enough has been done to be described.

We have chosen not to work with stored fixed combinations of RST schemas. We do not have genre-specific or task-specific text structures as a starting point. In this way our work is very different from McKeown's work [McKeown 85], and so some of the strengths of her system are more difficult for us to achieve.⁶ Instead, we are developing a text planner that uses the individual RST schemas as its building blocks.

One of the principal problems in developing a general approach to text planning is to manage the complexity of the task. It is necessary to factor the task into manageable parts so that, to a close approximation, independent issues are treated independently, and issues which are not of central interest are distinguished from those which are primary.

One approach to creating a factoring of issues is the "method of oracles" described below.

There are very many intellectual problems that come up in text planning. Some of these are not essentially problems of text planning, but nevertheless they are of a kind which must be solved if one is to plan text. These problems must be factored out in order to make progress on text planning.

For example, the following sorts of questions come up inside our text planner:

⁶See [Mann 86] and [Mann 84] for comparisons of the two lines of work.

1. If I say X, will the reader believe it?
2. What do I know that is evidence for X?
3. Does the reader have the prerequisite knowledge to comprehend a straightforward statement of X?
4. If the reader wants to do X, will he be able to do it?
5. If X is suggested as an action for the reader to perform, will he want to do it?
6. Do I have the right to present X at this point in the text?
7. Does the reader know of a particular apparent refutation for X, which I believe is not a genuine refutation of X?

These are not centrally questions about methods for structuring text. Rather they are concerned with the information resources used by a text structuring method. Answering them (and many others like them) is essential to creating certain kinds of texts.

To factor such questions out of the text planning algorithm we use the method of oracles, familiar to many through Robin Cohen's thesis on argument recognition [Cohen 83]. Each such question is assigned to an opaque "black box," called an Oracle, which is responsible for answering it. Nothing is claimed about how the answers are produced. The claim for the non-Oracle portion of the algorithm is that if the Oracles answer their assigned questions correctly, the algorithm will function correctly.

Many of the Oracles' questions are very difficult. For some there are no programs that even come close to implementing an answering process. Is this sort of text generation therefore hopeless? Not at all. Even though the general case is unapproachable, many of the Oracles have restricted forms that are suitable for implementation. For example, in a system with internalized proofs, the question "What do I know that is evidence for X?" might be approached by searching in the proof of X.

Currently, text generation is severely limited by the state of the art of knowledge representation. For many kinds of knowledge there are no strong precedents for how to represent them. Such kinds of knowledge cannot yet be expressed in computer-produced text. The Oracles that appear particularly difficult to implement are generally those for which there are unsolved problems of knowledge representation. From one point of view this is fortunate: the kinds of texts we cannot plan are the kinds for which our machines have little to say.

9 A Structured Text Planning Procedure

We have a draft procedure which is able to plan many varieties of texts. It is entirely a human-executed procedure. We test it by simulating the process of generating small natural texts. With ourselves representing the Oracles (about 30 of them), we can reliably produce structures which are identical to, or acceptable for, structures of actual texts. We have identified an unmarked ordering for all of the relations; we use it exclusively.

The "input" for this procedure is a statement of the writer's goal, in terms of the intended effect of the text, which is a description of the state to be achieved. For example, an intended effect might be: "The reader wants to buy our disks" or "The reader knows what kind of object a Response Unit is."⁷ The "output" for this procedure is an RST structure, with propositions identified with each of the terminal nodes of the structure, and underlying speech acts to be performed relative to those propositions. This information is chosen so that, with minor supplementation, it is sufficient to specify sentences to be generated by a functional grammar. In a more complex system, some clause combining methods external to the RST planning (but relying on it) may be used before the information reaches the grammar.

The method is a top-down, goal-pursuit method.

Much of the complexity of texts, and thus much of the action in text planning, comes because the reader is not ready to receive and accept what the speaker wants to convey. A large part of the method is devoted to consulting a model of the reader (hidden under the Oracles) and providing the support, such as evidence, background, concessions and motivation, to make the pursuit of the text goal effective. The method as it stands reflects the need for an elaborate model of the reader and many kinds of processes that manipulate it.

The method is not yet sufficiently to justify documenting it publicly. However, to give an indication of the sorts of issues being considered, Figure 4 shows a fragment of it, about 5% of the whole. The figure shows 3 oracles, with the Belief Oracle being used twice. This fragment encodes essentially the same commitments about the writer's viewpoint that are represented in the definition of the Evidence relation.⁸

Several kinds of text planning activity are not included in the structure planning method. We have not yet incorporated provisions for skilled use of clause combining,

⁷The goals are not in terms of intended actions by the speaker, e.g. "Tell the superclass and part composition of a Response Unit." Such goals might be appropriate as part of a process control mechanism, but they do not relate directly to the function of the text.

⁸The emphasis on evidence in this paper is presentational. The work is in fact much more evenly distributed.

A Portion of the RST Construction Method

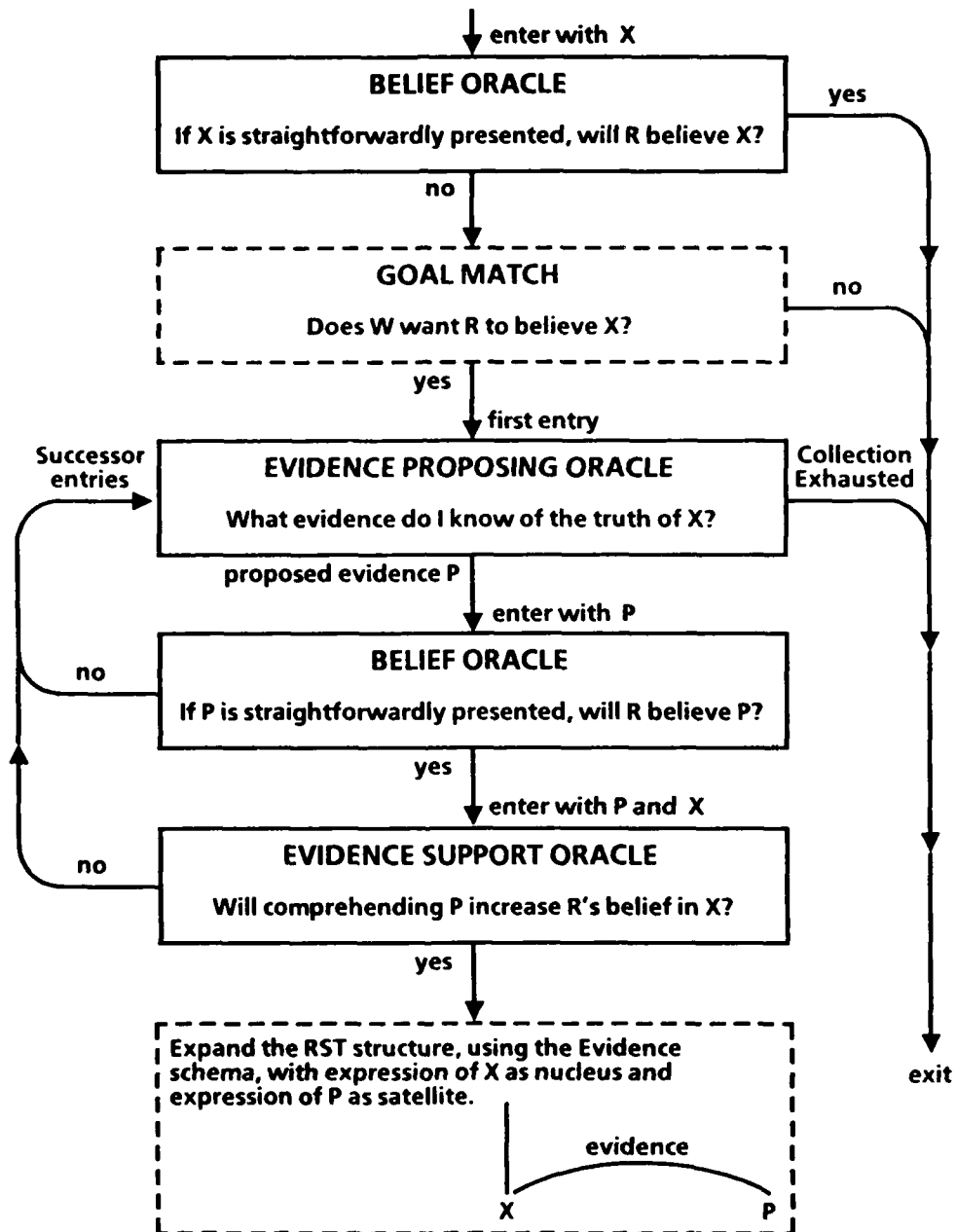


Figure 4: A Portion of the RST Structure Construction Method

manipulation of thematic structures or the interactions of text structure with lexical choice.

Both descriptive and constructive RST are being extended and refined. Constructive RST is being readied for application in a paragraph planner.

10 Summary

The status of RST has advanced beyond the level indicated by available papers and reports.

Descriptive RST has been developed to the point at which it can raise interesting issues about discourse and communication. The nature of coherence, the communicative potential of multisentential texts, the functions of conjunctions and the nature of clause combining are some of these areas. Given the current definition methods, an RST structure for a text is necessarily a declaration of a functional account of every part of the text, a plausible effect of each part and its role in the text as a whole.

Since so many texts have RST structures, descriptive RST is an interesting new tool for text analysis.

Constructive RST has been developed enough to pass rudimentary tests of effectiveness. It can mimic part of the generation of natural texts, producing appropriate structures given suitable extra-textual information. However, it is definitely only a partial solution to the problem of designing an implementable text planner for large innovative texts.

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