Rhetorical Structure Theory in Natural Language Generation

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1 Introduction

This paper is a survey of some literature on the use of Rhetorical Structure Theory (RST) (Mann and Thompson, 1988) for text generation, some of which can also be of use for building RST trees from texts for summarisation purposes.

1.1 Motivation

Several researchers have suggested the use of RST trees for summarisation, e.g. Sparck Jones (1993), Ono et al. (1994), Marcu (1997a). The organisation of the RST trees, then, depends on the input. If the input is a text, the organisation is signalled by the author and interpreted by the analyser. If the input is a knowledge base, the organisation is guided by the relations present in the knowledge base and the communicative goal guiding the analysis.

Although many of the methods in RST summarisation deals with text as input, they could equally well be applied to RST trees generated from a knowledge base. This technique could be used for situations where the same text base has to be displayed in many ways, and the generation process is requiring a lot of resources. The processes of parsing and generating RST trees also have much in common, and therefore can profit from each other, sharing theories, resources and techniques.

1.2 Outline

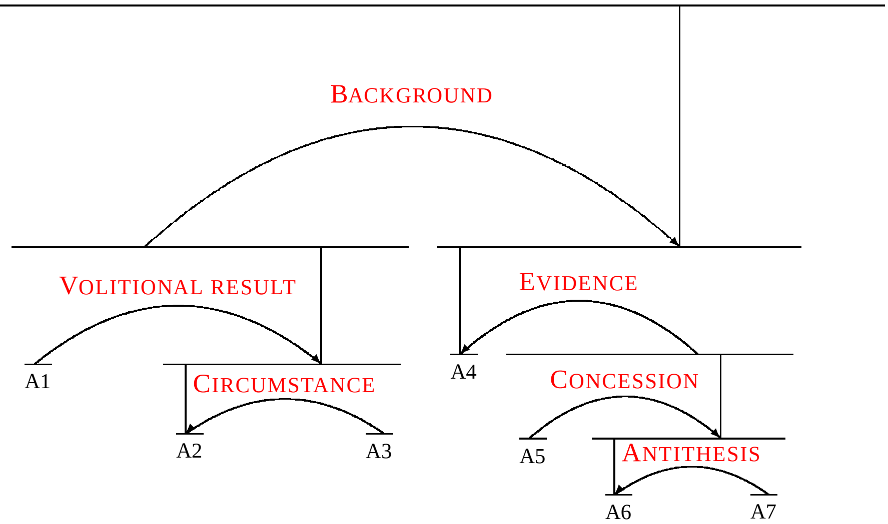
The paper is organised as follows: Section 2 gives a short introduction to RST. Section 3 focuses on the position of RST in the architecture of generation systems. In Section 4, some issues concerning the top-level organisation of texts are discussed, and in Section 5, the more detailed planning, such as choice of discourse markers and clause ordering, is under scrutiny.

2 Rhetorical Structure Theory (RST)

Rhetorical Structure Theory (RST) (Mann and Thompson, 1987, 1988) is based on the analyses of over hundred texts. Mann and Thompson claim that it is possible to analyse the majority of text types in terms of a hierarchical tree of rhetorical relations (see, for example, Figure 1).

The analysis is based on the assumption that some text units are more central (salient) to the text than others, and that the other units are given to support the reader's belief in them. The central units are named *nuclei*, and the supporting units are named *satellites*. Rhetorical relations are described in terms of *schemas*, i.e. the way in which one or more satellites (or nuclei) are related to the current nucleus. It is also assumed that a relation that holds between two text spans also holds between the nuclei of those text spans.

The application of a particular schema to a couple of text units is restricted by a number of constraints (see, for example, Figure 2).



[Farmington police had to help control traffic recently][A1] [when hundreds of people lined up to be among the first applying for jobs at the yet-to-open Marriott Hotel.][A2] [The hotel's help-wanted announcement – for 300 openings – was a rare opportunity for many unemployed.][A3] [The people waiting in line carried a message, a refutation, of claims that the jobless could be employed if only they showed enough moxie.][A4] [Every rule has exceptions,][A5] [but the tragic and too-common tableaux of hundreds or even thousands of people snake-lining up for any task with a paycheck illustrates a lack of jobs,][A6] [not laziness.][A7]

(*The Hartford Courant*, editorial)

Figure 1: An RST analysis from Mann and Thompson (1988).

RST has been used extensively for manual analyses, for automatic generation, and, recently, for automatic analyses. Although it seems like a plausible theory, it is not without criticism, mainly because of some vague statements and definitions in the 1988 article, but also because it has been used for novel text types and applications. The criticism concerns the granularity of the minimal text units: should it be clauses, sentences (Ono et al., 1994), event propositions (Miltsakaki et al., 2004), prepositional phrases (Schauer and Hahn, 2000)? It also concerns the number and nature of the relations: could every researcher invent and use a set of relations that suits her purposes, and are all relations really rhetorical? In Maier and Hovy (1993), an attempt has been made to taxonomise the relations hitherto used in three levels: ideational, interpersonal and textual (see also the discussion on grouping of discourse markers in Section 5.1).

Despite the criticism, RST is very much still in use, most of the time with the original set of relation possibly interspersed with one or two application-specific relations.

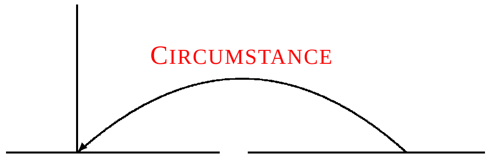
relation name	CIRCUMSTANCE
constraints on N	–
constraints on S	S presents a situation (not unrealized)
constraints on N+S combination	S sets a framework in the subject matter within which R is intended to interpret the situation present in N
effect	R regognizes that the situation presented in S provides the framework for interpreting N
locus of effect	N and S
example	 Hundreds of people lined up to be among the first applying for jobs at the yet-to-open Marriott Hotel. / The hotel's help-wanted announcement – for 300 openings – was a rare opportunity for many unemployed.

Figure 2: An RST definition of CIRCUMSTANCE from Mann and Thompson (1988) (N=nucleus, S=satellite, R=Reader).

3 RST's position in text generation

As is evident from the RST definitions (cf. Figure 2), the relations are one way for writers to express their intentions, thus closely reflecting the communicative goals of a text. Therefore, it is not surprising that many generation systems use RST to plan their output. According to Reiter and Dale (2000), most systems using RST first specify the relations in the macro-planning stage (i.e. planning the overall document plan), and postpone the actual ordering of text segments and the realisation of any discourse markers until the micro-planning stage (i.e. planning the more detailed text specification).

Reiter and Dale (2000) describe a three-stage generation architecture which they claim is a kind of consensus architecture for generation systems. The three stages (modules) are connected in a pipeline: document planning, micro-planning, and realisation (see Table 1). The output from the first module is a document plan, the output from the second module is a text specification, and the output from the third is the generated text (see Figure 3).

Module	Content task	Structure task
Document planning	Content determination	Document structuring
Microplanning	Lexicalisation	Aggregation
	Referring expression generation	
Realisation	Linguistic realisation	Structure realisation

Table 1: Modules and tasks in the consensus architecture (from Reiter and Dale (2000)).

Although this architecture might be illustrative for many systems, the surveys of Paiva (1998) and Cahill and Reape (1999) showed that it is not representative

Communicative goal
↓
Document planner
↓
Document plan
↓
Microplanner
↓
Text specification
↓
Surface realiser
↓
Surface text

Figure 3: Modules, input and output in the consensus architecture (from Reiter and Dale (2000)).

for all systems. They went through 19 applied systems where texts were generated from scratch to see how they fitted into the consensus architecture and found that the borders between the three modules were not that clear, and that the tasks were actually performed in more than one module and not always in a particular order.

For systems with input from a database or knowledge base, rhetorical structuring was mostly done in the first stage, but could also be performed in the microplanning stage. For systems which accepted input from a user, rhetorical structuring was mostly done either by the user or in the first stage.

However, the tasks tended to come in groups, where the order of processing might differ (Cahill and Reape, 1999):

- rhetorical structuring, centering/salience/theme, ordering
- aggregation, segmentation
- lexical choice, referring expression generation.

The surveys were part of the RAGS (Reference Architecture for Generation Systems), a joint project of the universities of Brighton and Edinburgh. As a result of the surveys and other considerations, an abstract data model has been defined (RAGS, 2002) to cater for all information needed, and a generic reference system, RICHES, has been built (Cahill et al., 2001) to show how the data model can be applied in a generation system.

The abstract data model has six principal levels of representations, although the instantiated representations can be mixed or partial:

Conceptual non-linguistic representations constructed by external agents in accordance with their own purposes

Rhetorical structures organised for a rhetorical purpose

Document structures pertaining to layout and function of a text as a document

Semantic linguistically oriented representations of meaning

Syntactic representations corresponding to conventional syntactic structures

Quote fixed output for some medium that can be incorporated into a generated document

In RICHES, the data model is represented as an event-driven whiteboard, where modules can subscribe to messages that an event has occurred, e.g. that a rhetoric relation has been added. Modules can update the whiteboard, but not change already added information. This means that the modules do not necessarily have to be pipelined, although they can be. The data model and whiteboard construct also mean that modules are more possible to reuse, since they can be made to answer for smaller and more defined areas of responsibilities.

However, some systems do not use abstract relations at all, but simply represent the relation with an appropriate discourse marker, such as *but* for CONTRAST. This can be more efficient, since the computation of what discourse marker to use is not trivial (cf. Section 5), but it also limits the organisation of the text severely, since no micro-planning, e.g. aggregation, can take place afterwards, and may also result in stereotypic formulations.

4 RST for macro-planning

4.1 Schemas

In the TEXT system, which was developed to generate text in response to a limited class of questions about the structure of a military database, four top-level schemas are used to drive text planning. The system allows three kind of questions (McKeown, 1985, p. 40f):

Define Provide a definition. Schemas: identification, constituency.

Describe Describe available information. Schemas: attributive, constituency.

Compare Compare differences. Schema: compare and contrast.

The schemas correspond to rhetorical predicates, predecessors to those in RST, and are based on a corpus study of samples from 10 expository texts, not in the domain of the application. The system is one of the pioneers in which rhetorical structuring was implemented.

A sample schema with an example classification from the corpus is shown in Figure 4. During text planning, the schema chosen according to the type of question is filled by activating subschemas on the basis of the information in the knowledge base. Subschemas listed in the top-level schema can be obligatory, optional or alternative. Optional subschemas are shown within curly brackets, and alternatives are delimited by a slash.

Attributive schema

Attributive
{Amplifi cation; restriction}
Particular illustration*
{Representative}
{Question; problem
Answer} /
{Comparison; contrast
Adversative}
Amplifi cation/Explanation/Inference/Comparison

Example

[This book, being about work, is, by its very nature, about violence -]^{B1} [to the spirit as well as to the body.]^{B2} [It is about ulcers as well as accidents, about shouting matches as well as fistfights, about nervous breakdowns as well as kicking the dog around.]^{B3} [It is, above all (or beneath all), about daily humiliations.]^{B4} [To survive the day is triumph enough for the walking wounded among the great many of us.]^{B5}

(*Working*, Terkel 72)

Example classification

B1 Attributive

B2 Amplifi cation

B3 Particular illustration

B4 Representative

B5 Amplifi cation; explanation

Figure 4: The Attributive schema (adapted from McKeown (1985, p. 27)).

Although the schemas are recursive in principal, it is not implemented in TEXT. Even if they were, the rhetorical structure is somewhat stereotyped. However, later generalisations of the schemas have been adapted to fit other knowledge bases and text types, so the basic principles of at least some of the schemas are that they can be reused.

4.2 Planning

Hovy (Hovy, 1988) was the first to formalise the RST relations of Mann and Thompson, using a set of modal operators used previously in the formal theory of rational interaction:

(BEL x p**)** — p follows from x's beliefs.

(BMB x y p**)** — p follows from x's beliefs about what x and y mutually believe.

(GOAL x p**)** — p follows from x's goals.

(AFTER a p) — p is true in all courses of events after action a.

Nucleus and satellite requirements are treated as semantic preconditions on the material to be conveyed, while so-called growth points are introduced for subgoals permitted by coherence. For example, the plan in Figure 5, when used successfully, guarantees that both speaker and hearer will mutually believe that the relationship SEOUENCE-0F (temporal, ordinal, or spatial) holds between two input entities.

Name: SEQUENCE

Results:
((BMB SPEAKER HEARER (SEQUENCE-0F ?PART ?NEXT)))

Nucleus requirements/subgoals:
((BMB SPEAKER HEARER (TOPIC ?PART)))

Satellite requirements/subgoals:
((BMB SPEAKER HEARER (TOPIC ?NEXT)))

Nucleus+Satellite requirements/subgoals:
((NEXT-ACTION ?PART ?NEXT))

Nucleus growth points:
((BMB SPEAKER HEARER (CIRCUMSTANCE-0F ?PART ?CIR))
(BMB SPEAKER HEARER (ATTRIBUTE-0F ?PART ?VAL))
(BMB SPEAKER HEARER (PURPDSE-0F ?PART ?PURP)))

Satellite growth points:
((BMB SPEAKER HEARER (ATTRIBUTE-0F ?NEXT ?VAL))
(BMB SPEAKER NEARER (DETAILS-0F ?NEXT ?DETS))
(BMB SPEAKER NEARER (SEQUENCE-0F ?NEXT ?FOLL)))

Order: (NUCLEUS SATELLITE)

Relation-phrases: ("" "then" "next")

Activation-question:
"Could ˜A be presented as start-point, mid-point, or end-point of some succession of items along some dimension? – that is, should the hearer know that ˜A is part of a sequence?"

Figure 5: Formalisation of the SEQUENCE relation (adapted from Hovy (1993)).

4.3 Constraint satisfaction

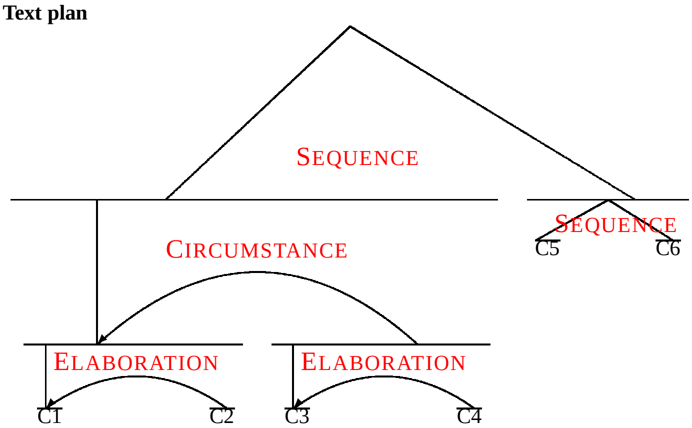
Although top-down approaches to text planning can be efficient, there are situations where they can be inadequate. For example, if the communicative goal is *Tell all that is known about X*, there might not be subgoals enough to cover all facts in the knowledge pool, so that those facts are not told.

A solution to this could be to use a data-driven method instead. Marcu (1997b) uses a formalisation of the rhetorical relations in RST. The text planner is given a set of elementary discourse units, U, and the set of relations that hold between

Knowledge pool

(GOAL (BMB SPEAKER HEARER (SEQUENCE-OF E1 ?NEXT))
((ENROUTE E1) (ACTOR E1 K1) (DESTINATION E1 S1) (NEXT-ACTION E1 A1) (LOCATION E1 P1))
((ARRIVE A1) (ACTOR A1 K1) (TIME A1 T1)) (NEXT-ACTION A1 L1))
((READINESS-STATUS C1) (NAME C1 C4))
((POSITION P1) (HEADING P1 H1) (LATITUDE P1 79) (LONGITUDE P1 18))
((HEADING H1) (COURSE H1 195))
((LOAD L1) (ACTOR L1 K1) (STARTTIME L1 T2) (ENDTIME L1 T3))
((SHIP K1) (NAME K1 KNOX) (READINESS K1 C1))
((PORT S1) (NAME S1 SASEBO))
((DATE T1) (DAY T1 24) (MONTH T1 4))
((DATE T2) (DAY T2 25) (MONTH T2 4))
((DATE T3) (DAY T3 28) (MONTH T3 4))

Text plan



Generated text

[Knox, [which is C4,]^{C2} is en route to Sasebo.]^{C2}[It is at 79N 18E]^{C3} [heading SSW.]^{C4} [It will arrive on 4/24,]^{C5} [and will load for four days.]^{C6}

Figure 6: An example text plan and the generated text given the SEQUENCE definition in Figure 5 (adapted from Hovy (1993)).

them, R (cf. Figure 7). The elementary units could be facts from a knowledge base (or text segments). The relations could be derived from the relations defined in the knowledge base (or hypothesised from discourse features in the text).

Although several relations can hold between text units, the assignment of relations between text spans is restricted by the constraints given in Mann and Thompson (1988):

- Completedness—the tree should be a full, “rooted”, tree.
- Connectedness—all units should either be a minimal unit or a constituent.
- Uniqueness—a unit can only be in one relation.
- Adjacency—there should be no overlapping units.

$$R = \begin{cases} rhet\_rel(\text{VOLITIONAL RESULT}, D3, D2) \\ rhet\_rel(\text{CIRCUMSTANCE}, D1, D2) \\ rhet\_rel(\text{BACKGROUND}, D2, D4) \\ rhet\_rel(\text{EVIDENCE}, D7, D4) \\ rhet\_rel(\text{CONCESSION}, D6, D7) \\ rhet\_rel(\text{ANTITHESIS}, D5, D7) \end{cases}$$

Maximal-score text plan = D1 $<$ D2 $<$ D3 $<$ D4 $<$ D5 $<$ D6 $<$ D7

[The ~~h~~Marriot Hotel's help-wanted announcement – for 300 openings – was a rare opportunity for many unemployed.]^{D1} [~~w~~When hundreds of people lined up to be among the first applying for jobs at the yet-to-open ~~Marriott H~~hotel~~.~~,]^{D2} [Farmington police had to help control traffic~~ recently~~.]^{D3} [The people waiting in line carried a message, a refutation, of claims that the jobless could be employed if only they showed enough moxie.]^{D4} [~~but t~~The tragic and too-common tableaux of hundreds or even thousands of people snake-lining up for any task with a paycheck does not illustrate~~s a lack of jobs, not~~ laziness.]^{D5} [Every rule has exceptions,]^{D6} [but the ~~tragic and too-common tableaux of hundreds or even thousands of~~ people's snake-lining ~~up for any task with a paycheck~~ definitely illustrates a lack of jobs~~,~~.]^{D7}

Figure 7: A paraphrase realisation of the maximal-score text plan of the Hartford Courier text in Figure 1 (adapted from Marcu (1997b, p. 249)).

The assignment is also restricted by local coherence constraints, i.e. the fact that most relations seem to have a canonical order, and that semantically and rhetorically related units often cluster into text spans. A corpus analysis was done based on 450 discourse markers and an average of 19 text fragments each. The result was an expected strength of having the nucleus precede the satellite for each relation and discourse marker given as a value from 0 to 1. An expected preference for clustering was also given as a value from 0 to 1, where a value close to 0.5 means a preference for realising the units as adjacent sentences, and a value close to 1 as clauses in the same sentence.

The strength values are combined into weights which are used to compute the maximally preferred text plan as concerns the order of units (cf. Figure 7). The ordered set of units is then given to a compilation algorithm which turns the set into Chomsky normal form grammar. The grammar describes all valid RST trees over the ordered set of units (Marcu, 1997b, p. 99ff).

4.4 Strategy mix

In ILEX, a system which generates texts on museum artefacts, a mixture of strategies for building the RST tree is used (O'Donnell, 2000). Knowledge about the artefacts is connected via relations in what is called the *ideational potential* (see Figure 8).

The texts are then planned and structured via a mixture of composition strategies, based on a corpus study of museum artefact descriptions and recordings of a museum curator giving a tour. Here are some of the repeatedly used strategies:

List the basic structure of the genre, which provides a list of the facts available

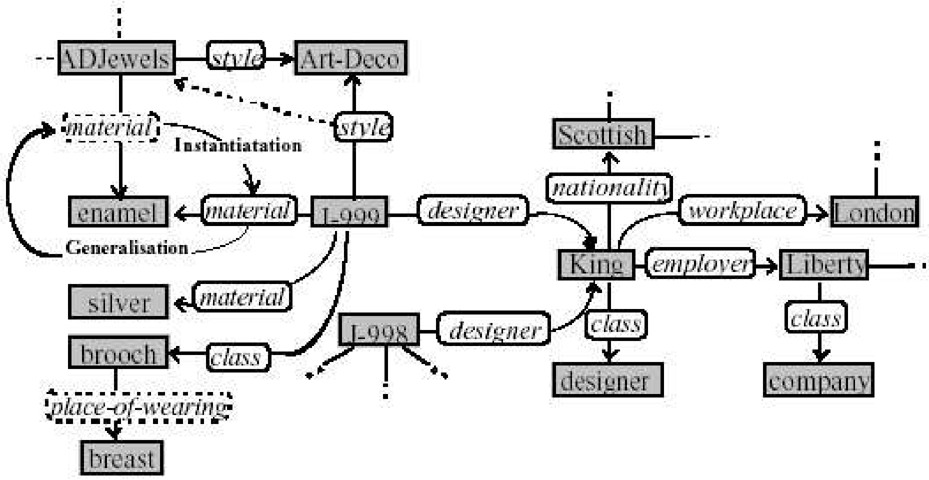


Figure 8: A subnet of the ideational potential (from O'Donnell (2000)).

about the entity being described.

Classify a fact providing the class of the entity, e.g. *This item is a brooch*.

Define a fact providing details which uniquely distinguish the entity, e.g. *A Communion Token is a simple metal ticket which permitted the holder to partake of Communion in the Church of Scotland and other Presbyterian Churches*.

Describe a fact providing details of the physical appearance of the entity, or its materials, etc. *This 98.6 carat gem is exceptionally large and well coloured.*

Digress a focus shift to an entity introduced in one of the facts in a list, e.g. *This item is a brooch. It was designed by Jessie King. King was British*.

Aggregate expression of multiple elements of a list as a single sentence, e.g. *It is made of silver and ~~it is made of~~ enamel*.

Generalise a shift from the current focus to discussing the class of entities which the current fact somehow introduces, e.g. *This item is a brooch. Brooches are ....*

Compare comparing and contrasting the artefact with other similar artefacts, e.g. *This pendant-cross resembles the previous item in that, like the previous item, it identifies the wearer as a Christian*.

When a description of an artefact is to be generated, the *List* strategy is the basic strategy. Starting from the artefact node in the ideational potential, facts are gathered and structured according to the relations between them into a topic tree (see Figure 9). Since the whole text has to fit on a single page, the selection is constrained by ideational and interpersonal relevance. Each relation type is given a weight, and the ideational relevance for a fact is the multiplication of the relation weights of the shortest path to the artefact node. Interpersonal relevance is computed as a multiplication of weights on how interesting the fact is assumed to be, how (educationally) important it is, and how assimilated it is in the reader's world knowledge.

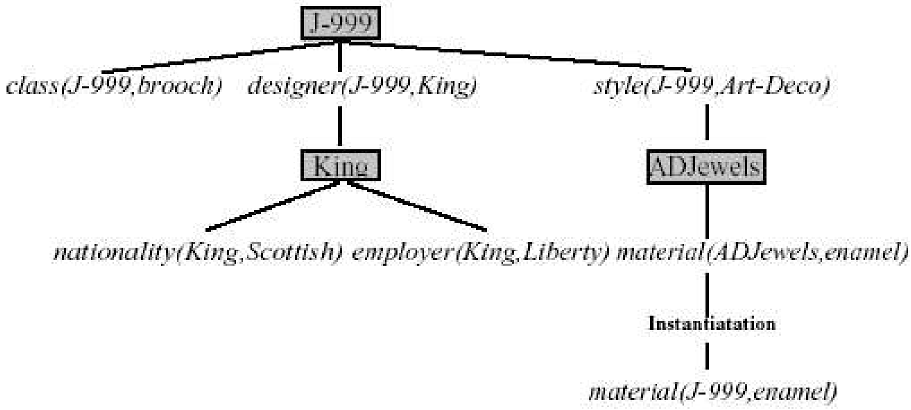


Figure 9: The resulting topic tree (from O'Donnell (2000)).

The n most relevant facts are selected and arranged in the topic tree, which is turned into an RST tree by mapping the strategies used onto RST relations. The *List* strategy, for example, is mapped onto a JOINT relation, and *Digress* onto ELABORATION (see Figure 10). The RST tree is then realised by an RST-aware module in ILEX.

Although the strategies used are based on museum artefact descriptions, most of them are rather general and can be found in other text types too. Therefore it seems plausible that they have reusability potential.

5 RST for micro-planning

When the text planner has come up with an RST textplan, the work is not finished. The subtrees and individual nodes have to be segmented and ordered into paragraphs, sentences, clauses or single words. Furthermore, since the generated text will be linear, the hierarchical and intentional structure has to be signalled, e.g. by discourse markers in order to guide the reader through the text.

Several researchers have dealt with these questions. Vander Linden and Martin (1995), for example, built a system, IMAGENE, which ordered and realised procedural text spans (propositional units) in purpose relations according to the communicative context. The study was concerned with the range of expressional

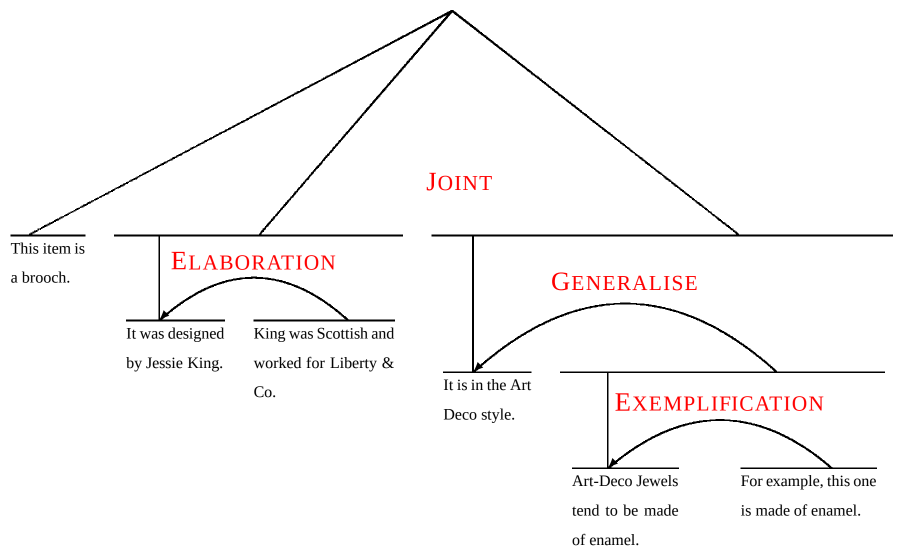


Figure 10: The resulting RST analysis from mixed strategy structuring (adapted from O'Donnell (2000)).

form of the relation, and how to determine what form to use. For the form part, four issues were studied:

- Slot (position of purpose span before or after related actions)
- Form (grammatical form of purpose span, e.g. clause/nominalisation)
- Linker (discourse marker)
- Clause combining (possibility of forming a single sentence)

For the determination part, systemic-functional communicative features (ideational, textual and interpersonal) were hypothesised to explain the various form features, and then checked for covariance. For example, it turned out that purpose spans that had more than one related action were nearly always positioned in the first slot: *To do A, do B and C*.

The corpus study resulted in a form of decision trees, which were implemented in the system. At each node, the text plan was updated to reflect the choice.

Others have also concentrated in particular on what features predict the choice of discourse markers (Grote and Stede, 1998; Stede and Umbach, 1998). A lexicon of discourse markers for German and English, DiMLex is developed, in which syntactic, semantic, and pragmatic features are noted for each discourse marker (see Table 2).

The lexicon has been used both for rhetorical parsing (Reitter, 2003) and generation. For parsing, the object is to hypothesise a relation given a discourse marker

Feature	*unless*	*for*	*however*	*even though*	*notwithstanding*
Syntactic					
PoS	subordinator	subordinator	adverb	subordinator	preposition
connection type	hypotaxis	hypotaxis	intersentential	hypotaxis	intraclausal
scope of marker	S simple	any	any	S simple	N and S simple
position	front	front	front/mid/end	front	front
linear ordering	N S	N S	S N	any	any
Semantic					
sematic relation	condition	cause	concession	concession	concession
polarity	act negated	any	any	any	any
functional order	any	effect-cause	conceding-conceded	any	any
nuclearity	N: act	N: effect	N: conceded	N: conceded	N: conceded
Pragmatic					
formality	standard	standard	standard	standard	formal
emphasis	none	none	none	intensified	none
discourse relation	PRECOND.	VOL. CAUSE	CONCESSION	CONCESSION	CONCESSION

Table 2: Sample lexicon entries in DiMLex (adapted from Grote and Stede (1998)).

and information on its surroundings. For generation purposes, the problem is reversed: to select a discourse marker given the constraints in the lexicon:

Applicability: The necessary conditions applying to the input representation, e.g. semantic and pragmatic relation and presuppositional and intentional features.

Combinability: The constraints the marker puts on the syntagmatic dimension, e.g. on subcategorisation and semantic type. These constraints interact with other realisation decisions.

Distinguishability: The features, if any, pertaining to the paradigmatic dimension, e.g. style and length.

5.1 Taxonomies of discourse markers

In an attempt to find out what rhetorical relations can be derived from the discourse marker we use, Knott (1996) performed a substitutionality test on sets of discourse markers in the same context. If two discourse markers could be used in the same context, they were assigned to the same group of discourse markers:

Grease is the time, is the place, is the motion;	<u>and</u>/ <u>moreover</u>/ <u>furthermore</u>	*Grease is the way you are feeling.*

If one of the discourse markers in a group could be used in a context, but not the other discourse marker, then the first discourse marker was considered to be a hyperonym to the second.

The resulting taxonomy has in turn been used as a starting point for several other investigations. Hutchinson (2004), for example, is trying to automatically find features that predict the meaning of discourse markers by collecting large samples from the British National Corpus (BNC), and the Internet, checking various features against Knott's taxonomy as a gold standard.

Oates (2001a,b) also used Knott's set of dicourse markers to study the ordering of multiple discourse marker occurrence, based on their occurrence in BNC. Two types of multiple marker occurrence were identified: simple, i.e. representing one RST relation, and complex, representing more than one relation. The results, covering more than 300 markers, were used to create hierarchies of weak and strong discourse markers for related groups of relations:

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

The corpus study suggested that weak markers, that could cue many relations, often preceded strong markers, that could cue few relations. This hypothesis was tested on a subset of the markers (contrastive group), and it was found to correlate well for simple markers, but not so well for complex markers. Both grammatical category and degree of strength were tested, and although grammatical category was a bit more accurate than degree of strength, the hierarchies provided additional contextual and relational information which is not available when using grammatical category alone.

The hierarchies are used in the RAGS project, and could potentially also be a valuable asset for rhetorical parsing.

6 Concluding remarks

This paper has shown some examples of the use of Rhetorical Structure Theory (RST) (Mann and Thompson, 1988) for text generation: its position in the loop, its use for top-level and sentence-level planning, and some useful resources for facilitating this planning.

Some correspondences with the reversed process, rhetorical parsing, has also been brought to the fore. The processes of parsing and generating RST trees have much in common, and hopefully the two related areas of research can profit from each other, sharing theories, resources and techniques.

References

Lynne Cahill, John Carroll, Roger Evans, Daniel Paiva, Richard Power, Donia Scott, and Kees van Deemter. From RAGS to RICHES: exploiting the potential of a flexible generation architecture. Technical Report ITRI-01-07, Information Technology Research Institute, University of Brighton, 2001. URL `ftp://ftp.itri.bton.ac.uk/reports/ITRI-01-07.pdf`. Also published in Proceedings of ACL/EACL 2001, pages 98–105.

Lynne Cahill and Mike Reape. Component tasks in applied NLG systems. Technical Report ITRI-99-05, Information Technology Research Institute, University of Brighton, 1999. URL `ftp://ftp.itri.bton.ac.uk/reports/ITRI-99-05.ps`.

Brigitte Grote and Manfred Stede. Discourse marker choice in sentence planning. In Proceedings of the 9th International Workshop on Natural Language Generation (INLG'98), Niagara-on-the-Lake/Ontario, Canada, August 1998. URL `http://flp.cs.tu-berlin.de/inlg98.ps`.

Eduard H. Hovy. Planning coherent multisentential text. In Proceedings of the 26th Annual Conference of the Association for Computational Linguistics, pages 163–169, Buffalo, NY, 1988.

Eduard H. Hovy. Automated discourse generation using discourse structure relations. Artificial Intelligence, (63):341–385, 1993.

Ben Hutchinson. Acquiring the meaning of discourse markers. In Proceedings of the 42nd Meeting of the Association for Computational Linguistics (ACL'04), Main Volume, pages 684–691, Barcelona, Spain, July 2004. URL `http://acl.eldoc.ub.rug.nl/mirror/acl2004/main/64_pdf_2-col.pdf`.

Alistair Knott. A Data-Driven Methodology for Motivating a Set of Coherence Relations. PhD thesis, Department of Artificial Intelligence, University of Edinburgh, 1996. URL `http://www.cs.otago.ac.nz/staffpriv/alik/papers/thesis.ps.gz`.

Elisabeth Maier and Eduard Hovy. Organizing discourse structure relations using metafunctions. In Helmut Horacek and Michael Zock, editors, New Concepts in Natural Language Generation: Planning, Realization, and Systems, pages 69–86. Pinter, London, 1993.

William C. Mann and Sandra A. Thompson. Rhetorical structure theory: A theory of text organization. ISI Reprint Series ISI/RS-87-190, Information Sciences Institute, Marina del Rey, California, USA, June 1987. URL `http://www-rcf.usc.edu/~billmann/WMlinguistic/oldfull.htm`.

William C. Mann and Sandra A. Thompson. Rhetorical structure theory: Toward a functional theory of text organization. Text, 8(3):243–281, 1988.

Daniel Marcu. From discourse structures to text summaries. In Inderjeet Mani and Mark T. Maybury, editors, Proceedings of ACL'97/EACL'97 Workshop on Intelligent Scalable Text Summarization, pages 82–88, Madrid, Spain, July 1997a. URL `http://www.isi.edu/~marcu/papers/summary97.ps`.

Daniel Marcu. The Rhetorical Parsing, Summarization, and Generation of Natural Language Texts. PhD thesis, Department of Computer Science, University of Toronto, December 1997b. URL `http://www.isi.edu/~marcu/papers/phd-thesis.ps.gz`.

Kathleen R. McKeown. Text Generation. Using Discourse Strategies and Focus Constraints to Generate Natural Language Text. Studies in natural language processing. Cambridge University Press, Cambridge, 1985. ISBN 0-521-30116-5.

Eleni Miltsakaki, Rashmi Prasad, Aravind Joshi, and Bonnie Webber. Penn Discourse Treebank: Annotation Tutorial. Institute for Research in Cognitive Science, University of Pennsylvania, June 2004. URL `http://www.cis.upenn.edu/~pdtb`.

Sarah Oates. Generating multiple discourse markers in text. Master's thesis, University of Brighton, 2001a. URL `ftp://ftp.itri.bton.ac.uk/reports/ITRI-01-25.pdf`.

Sarah Oates. A listing of discourse markers. Technical Report ITRI-01-26, Information Technology Research Institute, University of Brighton, 2001b. URL `ftp://ftp.itri.bton.ac.uk/reports/ITRI-01-26.pdf`.

Mick O'Donnell. Intermixing multiple discourse strategies for automatic text composition. Revista Canaria de Estudios Ingleses (RCEI), (40 Special Issue on Intercultural and Textual Approaches to Systemic-Functional Linguistics), April 2000. URL `http://www.wagsoft.com/Papers/Canaries.pdf`.

Kenji Ono, Kazuo Sumita, and Seiji Miike. Abstract generation based on rhetorical structure extraction. In Proceedings of the International Conference on Computational Linguistics (COLING'94), volume 1, pages 344–348, Kyoto, Japan, 1994. URL `http://www.dcs.shef.ac.uk/~gael/Articles/Summarization/Webpage/Ono.ps`.

Daniel S. Paiva. A survey of applied natural language generation systems. Technical Report ITRI-98-03, Information Technology Research Institute, University of Brighton, 1998. URL `ftp://ftp.itri.bton.ac.uk/reports/ITRI-98-03.ps`.

RAGS. Towards a reference architecture for natural language generation systems. Technical report, Information Technology Research Institute, University of Brighton, 2002. URL `http://www.itri.brighton.ac.ukprojects/rags/`.

Ehud Reiter and Robert Dale. Building Natural Language Generation Systems. Studies in natural language processing. Cambridge University Press, Cambridge, United Kingdom, 2000. ISBN 0-521-62036-8.

David Reitter. Rhetorical analysis with rich-feature support vector models. Master's thesis, University of Potsdam, February 2003. URL `http://www.reitter-it-media//compling/index.html`.

Holger Schauer and Udo Hahn. Phrases as carriers of coherence relations. In Proceedings of CogSci'2000, pages 429–434, Philadelphia, PA, USA, August 2000.

Karen Sparck Jones. What might be in a summary? In G. Knorz, J. Krause, and C. Womser-Hacker, editors, Information Retrieval '93: Von der Modellierung zur Anwendung, pages 9–26. Universitätsverlag Konstanz, Konstanz, 1993. URL `ftp://ftp.cl.cam.ac.uk/public/papers/ksj/ksj-whats-in-a-summary.ps.gz`.

Manfred Stede and Carla Umbach. DiMLex: A lexicon of discourse markers for text generation and understanding. In Proceedings of COLING-ACL '98, Montreal, Canada, August 1998. URL `http://flp.cs.tu-berlin.de/~marker/colingacl98.ps.gz`.

Keith Vander Linden and James H. Martin. Expressing rhetorical relations in instructional text: A case study of the purpose relation. Computational Linguistics, 21(1):29–58, 1995.