

Reference Manual for the Analysis and Annotation of Rhetorical Structure (Version 1.0)*

Brian Reese, Pascal Denis, Nicholas Asher, Jason Baldridge and Julie Hunter
Departments of Linguistics and Philosophy
University of Texas at Austin

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1 Introduction

This document is a reference manual for the segmentation and annotation scheme developed in the context of the DISCOR project (Discourse Structure and Coreference Resolution). The goal of DISCOR is to test hypotheses about the interaction of discourse structure and the resolution of anaphoric links in a text. Since Polyani [REFERENCE] discourse structure has been taken to constrain the set of accessible antecedents to anaphoric expressions through a “right frontier” constraint. The annotation scheme presented was used to annotate the MUC6 and ACE2 corpora for discourse structure, following the model of discourse structure hypothesized by Segmented Discourse Representation Theory (Asher and Lascarides 2003). These corpora were chosen because they already include annotation of coreferential chains. To date, 60 Wall Street Journal articles from the MUC6 corpus have been annotated, and annotation of the newswire section of the ACE2 corpus has commenced. It is our hope that the resulting corpus of discourse structure annotated texts can be made available to the larger community for research in other NLP tasks, such as text summarization, etc., supplementing existing discourse corpora such as the RST corpus (Carlson et al. 2003) and the Penn Discourse Treebank (The PDTB Research Group 2006).

The annotation scheme utilizes a relatively small vocabulary of discourse relations: 14 in total. The RST corpus, by comparison, uses 78 relations. However, RST relations can be grouped into a more coarse-grained set of 16 classes based on overall semantic similarity. Wolf and Gibson (2005) use 11 relations.

There are two steps in the annotation process: segmentation and annotation. §2 describes the conventions for defining the elementary discourse units of a given text. §3 and §4 describe the semantics of the 15 discourse relations assumed for the annotation process and the annotation format itself.

2 Segmentation

The first step in the construction of a corpus of discourse structure annotated texts is to identify the elementary discourse units (EDUs), or “words”, of a given text. Segmentation of EDUs is currently done manually, but an automatic text segmenter is being developed. We turn now to a detailed discussion of our segmentation conventions. ‘<***>’ is used to mark EDU boundaries.

2.1 Base case

By default, a segment boundary is placed after all punctuation marking the end of a sentence, i.e., periods, question marks, and exclamation points.

2.2 Sentence internal segmentation.

Subsentential constituents are treated as EDUS if they serve a discernible discourse function. Punctuation and discourse markers are good surface syntactic cues for detecting sentence internal EDUS. Segment boundaries are placed *after* punctuation – including periods, commas, hyphens, colons and semi-colons – but *before* discourse connectors such as “and,” “or,” etc. and complementizers such as “that,” “if,” “whether,” etc.

2.2.1 Subordinate clauses.

Some, but certainly not all, cases of syntactic subordination introduce a new elementary discourse unit. Complements of verbs of communication, for example, always introduce an EDU.

- Verbs of communication:
acknowledge, add, announce, argue, concede, disclose, explain, indicate (with animate agent only), make it clear, note, point out, propose, remark, report, respond, tell, etc,

The complements of attitude verbs do not generally introduce discourse segments unless there is discourse structure within the subordinate clause. In ??, for example, the complement of *are sure* is segmented because it is a conditional clause.

- (1) We are sure_{i***ζ} that, likewise, they want us to do our best_{i***ζ} to keep United a strong and prosperous employer._{i***ζ}

2.2.2 Relative clauses.

We assume that only nonrestrictive relative clauses introduce EDUS, unless doing so results in a discontinuous EDU (which is often the case). Restrictive relative clauses are never segmented, as they do not serve a discourse function, but rather restrict the denotation of a common noun. Under these conventions, the following segmentation is correct.

- (2) First, we go to Jane Clayson,<***> who has the details of the accident.

The segmentations in (3a) and (3b), on the other hand, are incorrect. In (3a), segmenting the nonrestrictive relative clause results in a discontinuous EDU. In (3b), the relative clause restricts the denotation of the common noun *fact*.

- (3)
 - a. The president of the Association of Professional Flight Attendants, <***> which represents Americans' s more than 10,000 flight attendants, <***> called the request for mediation...
 - b. Contrary to the implication in your article, the fact<***> that the outside directors have employed independent legal and financial counsel in response to the pilots' proposal to purchase United does not bespeak a lack of confidence in Mr. Ferris.

2.2.3 Adjuncts.

The segmentation of adjuncts is contingent upon whether or not they encode an eventuality, i.e. some sort of event or state. As a result, purely temporal or locative adverbials are not treated as EDUs.

Clausal Adjuncts Clauses introduced by subordinating conjunctions such as *when*, *while*, etc., are treated as EDUs. This follows the event rule stated above, as such conjunctions generally take tensed clauses, which normally introduce eventualities, as arguments.

- (4) For the second time in a week, a widely recognized American figure has died<***> when he was skiing and ran into a tree.
- (5) He was serving his second term in Congress<***> when he died late yesterday at a ski resort on the border...

Infinitival clauses functioning as purpose clauses are treated as separate discourse units. Purpose clauses are identified with the *in order to* test: replace *to* with *in order to* and check for semantic equivalence. For example:

- (6) U.S. troops acted for the first time to capture an alleged Bosnian war criminal, <***> rushing from unmarked vans parked in the northern Serb-dominated city of Bijeljina<***> to seize a former concentration camp commander accused of killing at least 16 Muslims and abusing or terrorizing scores of others.

Other Adverbials The segmentation of other adverbials, especially adverbial PPs, is more problematic. Again, annotators should obey the event rule. For example, adverbial PPs are segmented only if they contain a nominalized **event**, such as *after the meeting*. Frame adverbials, which denote a **time** or **location**, are not treated as discourse segments. However, following the event rule, *by*-phrases introduce discourse segments, as in (7).

- (7) The UAL board is four-square behind Mr. Ferris, his management team and his long-range strategy of making United a more competitive airline<***> by combining it with the premier hotel company and car rental company.

2.2.4 Coordination

Coordinated tensed clauses function as discourse units; however, nonclausal coordinate structures, such as VPs, introduce EDUs only in certain cases. Coordinated VPs are treated as separate discourse segments when they either include a discourse particle or contain discourse structure within (at least one of) the coordinated constituents. In (8), the conjoined NPs are segmented because the second conjunct contains the discourse marker *then*.

- (8) Congressman Sonny Bono was first a songwriter in the nineteen sixties<***> and then a popular entertainer.

3 Discourse Relations

In this section, we discuss the rhetorical relations used to annotate texts. For each relation, we describe its semantic effect on the interpretation of a text and the kind of surface cues that are indicative of the relation. We assume that semantic effect and surface linguistic form together provide sufficient evidence that two discourse units are related by a given relation. All 15 discourse relations are listed in Table 1.

SDRT groups each rhetorical relation according to the structural configuration that it yields in a discourse graph and its semantic import to the discourse as a whole. Accordingly, SDRT distinguishes **coordinating** from **subordinating** relations, and **veridical** from **nonveridical** relations. The classification of discourse relations according to these factors is shown in Table 1. Veridical relations entail the content of (both of) their arguments, whereas non-verdical relations fail to

Coordinating Relations		Subordinating Relations	
<i>Veridical</i>	<i>Nonveridical</i>	<i>Veridical</i>	<i>Nonveridical</i>
Continuation	Consequence	Background	Attribution
Narration	Alternation	Elaboration	
Result		Explanation	
Contrast		Commentary	
Parallel		Source	
Precondition			

Table 1: Discourse Relations used in the Annotation Task

entail the content of at least one of their arguments.

3.1 Subordinating Relations

We begin by describing the subordinating rhetorical relations listed in Table 1, using α and β as variables for EDUs.

3.1.1 Veridical Relations

Background. *Background*(α, β) holds when a constituent β provides information about the surrounding state of affairs in which the eventuality mentioned in α occurs. One consequence of *Background* (and a cue for it) is temporal overlap between the two related eventualities. *Background* is often signaled by aspectual shift, i.e., a shift from an event to a state, or state to an event. Clauses introduced by subordinating conjunctions such as *when* and *while* also are cues for *Background* to the EDU given by the matrix clause. With respect to *while* clauses, the generalization usually holds when the subordinate clause is preposed; however, some care is required in the case of postposed *while* clauses, as they sometimes give rise to *Contrast* (see below). Nonrestrictive, or appositive, relative clauses often attach with *Background*, and nominal appositives always do.

Example (9) shows a typical use of *Background*. *Background* is signaled here by an aspectual shift between the related discourse units: the first sentence describes a past **event** and the second introduces a **generalizing stative**.

- (9) a. Also, about 585 workers were laid off at a stamping plant near Detroit.
b. That plant normally employs 2,800 hourly workers.

Elaboration. $Elaboration(\alpha, \beta)$ holds when β provides further information about the eventuality introduced in α ; for example, if the main eventuality of β is a subtype or part of the eventuality mentioned in α .¹ *Elaboration* implies that a relation of temporal inclusion holds between the related eventualities. Discourse markers like *for instance*, *for example*, or the explicit listing of sub-events (*first*, *second*, etc.), are good cues for *Elaboration*. RST includes a number of specialized elaboration relations, which we subsume under our *Elaboration*.

(10) provides an example of *Elaboration* in which the second EDU provides more information about the deadlock mentioned in the first EDU.

- (10) a. Both sides were deadlocked.
 b. Areas of dispute include use of temporary workers at NBC, the length of the new contract and use of non-network news services.

Explanation. $Explanation(\alpha, \beta)$ holds when the main eventuality of β is understood as the cause of the eventuality in α . *Explanation* has temporal consequences, viz. that the eventuality described in β precedes (or overlaps) the eventuality described by α . *Because* is a monotonic cue for *Explanation* (see (11)).

- (11) a. The department last week rejected TWA's first application as "deficient"
 b. because it omitted such important information as the merger's potential impact on competition and pricing.

Purpose clauses are always related via *Explanation* to the matrix clause, as in (12). In this case, the relation receives an intensional interpretation.²

- (12) a. Both parties are using business leaders as proxies of sorts
 b. to put pressure on swing votes in the Senate and House,

In (12), both parties are using business leaders as proxies not only to put pressure on swing votes in the Senate and House, but also because they *want to* put pressure on swing votes in the house and senate. This use of *Explanation*, therefore, is nonveridical.

¹Eventualities can be introduced by nominal expressions, viz. those that denote eventualities in some way.

²p.c., James Pustejovsky.

Source and Attribution. *Source*(β, α) and *Attribution*(α, β) are used to relate the content of a communicative act, given in β , to the agent of that act, given in α . Both relations are subordinating, but *Attribution* is intensional, and consequently nonveridical, while *Source* is veridical in both arguments. *Source* and *Attribution* are structurally distinguished as well. When *Source*(β, α) holds, the matrix clause, α , is subordinate to the embedded clause, β ; whereas when *Attribution*(α, β) holds, these relationships are reversed: the embedded clause β is discourse-structurally subordinate to the matrix clause α .

Source is the default relation used to connect communicative agents to the content of their communicative acts. Semantically, *Source* marks a kind of evidential use of communicative verbs. Thus, *Source* should be used when:

- the content of the communicative act carries the main rhetorical import;
- the communicative agent is in “a position to know”, e.g. when agents discuss their own mental states, or a company spokesperson talks about the actions of the company;
- the verb of communication occurs as a parenthetical expression; and
- lexical items such as *acknowledge*, *clearly* or *as previously reported* occur in the matrix clause.

The example in (13) illustrates the first two bullet points. First, the main rhetorical import of the complex segment is that NBC will put its contract offer into effect. Second, the agent of the communication, viz. NBC, is in a position to know about the actions of the network.

- (13) a. National Broadcasting Co. told its technicians
and news employees union
b. that the network will put into effect next Monday
its latest contract offer.

(14) illustrates the third bullet point. In this example the communicative verb occurs in the sentence final parenthetical expression *a source close to the board said*.

- (14) a. But Pan Am, sensing progress in its recent negotiations
with the unions, asked the board to delay acting
on the company's request,
b. a source close to the board said.

Finally, because the verb *acknowledged* is factive, the main rhetorical import of the segment is assumed to be given by the embedded clause. Because of this (15a) is linked to (15b) with *Source*.

- (15) a. Many present and former officials in the middle and lower ranks acknowledged privately
b. that they did not see Clinton's careful statements yesterday as anything like the full-throated denial they were hoping for.

Attribution relates a communicative agent and the content of a communicative act when this content is not taken to form part of the story line attributable to the author of the text. Therefore, *Attribution* is used when:

- the main rhetorical import of the segment is that an agent x has said ϕ ;
- two attributions provide contrasting viewpoints or contradictory allegations;
- the embedded clause contains evaluative adjectives, verbs or abverbs;
- lexical items such as *insisted*, *reportedly* or *complained* are used.

(16) demonstrates the first two bullet points. Here the main rhetorical effect of each attribution is that someone made a claim and, in some sense, these claims are incompatible or contradictory.

- (16) a. The union said
b. the size of the adjustments was inadequate.
c. But Chrysler Canada's chief negotiator, William Fisher, said yesterday
d. that the two sides had reached "some understandings" on economic issues, including pensions.

Example (17) demonstrates the third bullet point, as the agent is voicing his opinion about something already under discussion in the story.

- (17) a. It's a serious application,
b. a department official said of the new filing.

Example (18) illustrates the fourth bullet point. Certain lexical items, like *reportedly*, indicate that the main rhetorical effect is the communicative act itself, rather than the content of the communication.

- (18) a. Mr. Icahn reportedly said

- b. he "couldn't watch that happen."

Commentary. *Commentary*(α, β) holds if β provides an opinion or evaluation of the content associated with α (Asher 1993). "Supplementary adverbs" (Potts 2005) are good surface cues for *Commentary*. These include speaker-oriented adverbs, such as supplemental uses of "luckily", "amazingly", etc, and utterance modifiers such "frankly", "confidentially", etc. The last EDU in (19), for example, will attach to the discourse context via *Commentary* given the presence of the utterance modifier *frankly*.

- (19)
- a. "Yesterday's performance was a departure,"
 - b. Mr. Callahan said,
 - c. [...]
 - d. "Frankly, it's a little mystifying."

(19) also provides an example of the interaction of *Attribution* and *Commentary* that is often found in the corpus. Mr. Callahan's communicative act will attach to the preceding discourse with *Attribution*, because it does not constitute part of the main storyline attributable to the author, but rather provides one agent's commentary or evaluation of the events introduced in the preceding text, viz. that they are mystifying.

Precondition. *Precondition*(α, β) is used to represent "anti-narration" (see below). That is, this use of *Precondition* is like *Narration* except that the order of the arguments are reversed. *After* clauses often give rise to *Precondition*, as in (20).

- (20)
- a. Mr. Gerstner raced to hire Mr. York
 - b. after meeting him for the first time just three weeks ago in IBM's Manhattan offices.

Here the temporal trace of the main eventuality of β precedes the that of the main eventuality described in α . Paraphrasing, Mr. Gerstner first met Mr. York three weeks ago, *then* race to hire him.

3.2 Coordinating Relations

3.2.1 Veridical relations

Narration. *Narration*(α, β) holds when the main eventualities of the EDUs α and β occur in sequence and have a common topic. Certain spatio-temporal con-

sequences follow from *Narration*; for example, the pre-state of the eventuality associated with β overlaps with the post-state of the eventuality associated with α . *And* and *then* are good monotonic cues for *Narration*.

- (21) a. it expects to borrow as much as \$2 billion from banks to complete the acquisition.
- b. It then plans to refinance the bank loans with proceeds from public or private equity and subordinated debt offerings.

Continuation. *Continuation*(α, β) is like *Narration* without the spatio-temporal consequences. *Continuation* often holds between two EDUS when they both elaborate or provide background to the same segment. In (22), for example, (22b) and (22c) are related to (22a) via *Background* and to each other via *Continuation*.

- (22) a. American officials "felt talks had reached a point where mediation would be helpful."
- b. Negotiations with the pilots have been going on for 11 months
- c. ; talks with flight attendants began six months ago.

Contrast. *Contrast*(α, β) holds when α and β have similar semantic structures, but contrasting themes, i.e. sentence topics, or when one constituent negates a default consequence of the other. *But, however, on the other hand, nevertheless* are all strong cues for *Contrast*. Postposed *while*-clauses also sometimes introduce *Contrast*.

- (23) a. And VHS-C can be played on existing VHS machines with only a simple adapter;
- b. by contrast, 8mm tapes are incompatible with the VHS machines.

Parallel. *Parallel*(α, β) has the same structural requirements as *Contrast*, but instead requires α and β to share a common theme. Cue phrases such as *too* and *also* are good indicators of *Parallel*.

- (24) a. The United Telegraph Workers union represents 4,400 Western Union employees around the country.
- b. The Communications Workers of America represents 300 company employees in New York City.

Result. $Result(\alpha, \beta)$ relates a cause to its effect: the main eventuality of α is understood to cause the eventuality given by β . Thus *Result* is the dual of *Explanation*, which relates an effect to its cause. (25) and (26) provide illustrations. Note the cue phrase *as a result* and the discourse marker *so*.

- (25) a. Chrysler stopped output of Dodge Dynasty and Chrysler New Yorker cars yesterday at its Belvidere, Ill., plant
- b. Some 1,700 of the plant's 2,900 hourly employees were laid off as a result.
- (26) a. The mediator has imposed a news blackout on the two sides,
- b. so a Big Board spokesman couldn't comment on the talks.

3.2.2 Nonveridical relations

Consequence and Alternation. *Consequence* and *Alternation* are nonveridical, coordinating relations and correspond semantically to the logical operators \rightarrow and \vee respectively. As such, they are normally introduced by *if...then* (a conditional clause) or *or*.

- (27) a. If a settlement comes today or tomorrow,
- b. Chrysler's 10,000 Canadian workers could vote on a contract this weekend,
- (28) a. either by TWA's acquisition of USAir,
- b. or USAir's acquisition of TWA.

The example below is also treated as *Alternation*, which follows from the logical equivalence of $\phi \vee \psi$ and $\neg\phi \rightarrow \psi$.

- (29) a. "It looks like we're going to be there on the street,
- b. unless there is a miracle,"

We abuse *Alternation* slightly by using it to account for examples like (30). Intuitively in (30), the state described in the first EDU will hold until the state or event described by the second EDU obtains.

- (30) a. Several appointees of President Bush are likely to stay in office at least temporarily,
- b. until permanent successors can be named.

Paraphrasing loosely, either ϕ or ψ holds, but not both ϕ and ψ —just as in exclusive disjunction. For this reason, we annotate such examples with *Alternation*. However, this choice is semantically incorrect, as whatever relation in fact relates the two EDUs in (30) should entail the truth of the left argument, viz. that Bush’s appointees will stay in office.

4 The Annotation of Discourse Structure

4.1 SDRT Basics

The annotation scheme for encoding rhetorical structure is a straight forward encoding of segmented discourse representation structures, or SDRSs. An SDRS represents the rhetorical connections between various segments of a text and the hierarchical structure of discourse. Formally, an SDRS is a tuple $\langle A, \mathcal{F} \rangle$, where

- A is a set of labels, and
- \mathcal{F} is a function from A to the set of well-formed SDRS-formulae.

The well-formed SDRS formulae include the logical forms for elementary discourse units; specifically, they include single clauses, formulae of the form $R(\alpha, \beta)$ (where R is a rhetorical relation and α and β are labels in A), and the dynamic conjunction of SDRS formulae. The labels in A include labels for elementary discourse units, as well as labels for larger text segments.

The constructed discourse in (31) illustrates many of the important features of SDRSs.

- (31)
- a. John had a lovely evening last night. (π_1)
 - b. He had a great meal. (π_2)
 - c. He ate salmon. (π_3)
 - d. He devoured lots of cheese. (π_4)
 - e. He then won a dancing competition. (π_5)

Intuitively, the EDUs (31b) and (31e) elaborate the main eventuality described in (31a), namely John’s lovely evening. (31e) continues a narrative segment begun by (31b). First, John had a great meal. Then he won a dancing competition. The segments given by (31c) and (31d) elaborate the great meal and together form a second narrative segment.

The SDRS $\langle A, \mathcal{F} \rangle$ for (31) is provided below.

- $A = \{\pi_0, \pi_1, \pi_2, \pi_3, \pi_4, \pi_5, \pi_6, \pi_7\}$

- $\mathcal{F}(\pi_1) = K_{\pi_1}$
 $\mathcal{F}(\pi_2) = K_{\pi_2}$
 $\mathcal{F}(\pi_3) = K_{\pi_3}$
 $\mathcal{F}(\pi_4) = K_{\pi_4}$
 $\mathcal{F}(\pi_5) = K_{\pi_5}$
 $\mathcal{F}(\pi_0) = \textit{Elaboration}(\pi_1, \pi_6)$
 $\mathcal{F}(\pi_6) = \textit{Narration}(\pi_2, \pi_5) \wedge \textit{Elaboration}(\pi_2, \pi_7)$
 $\mathcal{F}(\pi_7) = \textit{Narration}(\pi_3, \pi_4)$

The labels π_6 and π_7 represent spans of text corresponding to two or more EDUs. π_7 , for example, represents the narrative segment composed of the EDUs π_3 and π_4 which elaborate the great meal introduced in π_2 .

An SDRS $\langle A, \mathcal{F} \rangle$ can be visualized as a directed acyclic graph in which the labels in A provide vertices, or nodes, and the rhetorical connections between labels introduce labeled edges between nodes. If an SDRS contains the formula $R(\alpha, \beta)$, then the corresponding graph contains an edge from the node α to the node β labeled R . If R is a coordinating relation, the edge is horizontal; if R is a subordinating relation, the edge is vertical. The graph encoding of (31) is provided in Fig. 1. The formula corresponding to the top most label in the SDRS for (31), which is omitted in the graph, is $\textit{Elaboration}(\pi_1, \pi_6)$. Since $\textit{Elaboration}$ is a subordinating relation, the graph for (31) contains a vertical edge from π_1 to π_6 labeled $\textit{Elaboration}$.

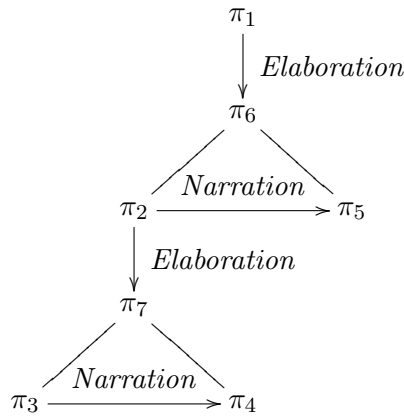


Figure 1: SDRS graph for (31).

During the construction of an SDRS only a subset of the labels in A are available for attachment, namely those on the right-frontier of the graph. In the graph in

figure 1, for example, only π_1 , π_6 and π_5 are for the attachment of additional material. As a result, (32) could not be used to elaborate on the salmon introduced in π_3 .

(32) #It was a beautiful pink.

4.2 The Current Annotation Scheme

In the current annotation scheme the graph for the text in (31) shown in Fig. 1 is represented as follows:

- Elaboration(1, [2, 5])
- Elaboration(2, [3, 4])
- Narration(3, 4)
- Narration(2, 5)

Each line consists of a relational formula stating the rhetorical connection between two discourse units. Elementary discourse units are assigned a positive integer as a label, and larger discourse units are assigned a unique identifier based on the segments that they immediately dominate in the SDRS graph representation. π_6 from Fig. 1, for example, is assigned the identifier [2, 5] because it immediately dominates π_2 and π_5 .³ The identifiers for the subsegments are placed in square-brackets and separated by commas. We take such complex identifiers to be names of complex discourse units, comparable to π_6 and π_7 from Fig. 1.

The construction of non-elementary discourse units becomes especially relevant when a series of contiguous discourse units are connected by coordinating discourse relations. In such cases potential ambiguities arise with regard to the interpretation of the discourse. Consider the discourse in (33) from Asher (1993). On one interpretation, π_4 relates to a complex discourse unit composed of π_1 , π_2 and π_3 via *Contrast*. On this reading, the anaphoric pronoun *this* in (33d) refers the summation of the claims made by the three plaintiffs.

- (33) a. One plaintiff was passed over for promotion three times. (π_1)
 b. Another didn't get a raise for five years. (π_2)
 c. A third plaintiff was given lower wage compared to males who were doing the same work. (π_3)
 d. But the jury didn't believe *this*. (π_4) This reading is encoded in our annotation scheme as follows:

³ π immediately dominates π' in an SDRS graph iff either (i) $\mathcal{F}(\pi)$ contains as a conjunct $R(\pi', \pi')$ or (ii) $R(\pi'', \pi')$ and *coordinating*(R).

- Continuation(1, 2)
Continuation(2, 3)
Contrast([1, 2, 3], 4)

On another reading, however, π_4 is connected to π_3 with *Contrast*, and the pronoun refers only to the claim made by the third plaintiff.

In general, any situation in which three or more discourse units are related by coordinating discourse relations is three ways ambiguous. The general situation is schematized as follows:

$$\alpha \xrightarrow{R_1} \beta \xrightarrow{R_2} \gamma$$

Given such a situation an annotator could potential encode in one of three ways. First:

- R_1(a, b)
R_2(b, c)

On this reading, β relates to α through R_1 and γ relates to β through R_2 . This roughly corresponds to the second interpretation of (33) above. (34) illustrates.

- (34)
- In the Ford-UAW talks, the two parties turned to economics yesterday in addition to the job-security issue. (54)
 - [...]
 - On the job-security issue, it is understood that Ford agreed not to lay off any workers during the life of the contract except during a major sales plunge. (59)
 - The company also promised to replace half of all workers leaving the company. (60)
 - At last report, the two sides were still haggling over details of the job-security plan, (61)

In (34) the complex segment [60, 61, 62] elaborates 54 and each EDU in [60, 61, 62] is connected by *Continuation*. Thus (34) is annotated as follows:

- Elaboraton(54, [60, 61, 62])
Conintuation(60, 61)
Continuation(61, 62)

Alternatively, the annotator might decide that β and γ are related by R_2 and that α is related to the complex segment formed by β and γ . This interpretation is encoded as follows:

- R.1 (a, [b, c])
R.2 (b, c)

(35) provides an example of this situation from our corpus. The EDUs 10 and 11 are related with *Contrast*. This complex segment continues EDU 10.

- (35) a. the Guild, which represents nearly 300 of the Post's 700 employees, voted Saturday to end its strike. (10)
- b. Guild members have been invited to reapply for their old jobs today, (11)
- c. though it is assumed that dozens of them won't be rehired. (12)

Finally, α and β can potentially form a complex segment related to γ by the discourse relation R_2 . Schematically, this situation would be annotated as follows:

- R.1 (a, b)
R.2 ([a, b], c)

The text segment in (36) illustrates this situation. The EDUs in 65 and 66 are related by *Contrast*, as indicated by the discourse cue phrase *by contrast*, and EDU 67 continues this complex segment.

- (36) a. Chrysler last year paid Mr. York \$414,167 in salary, a \$300,000 bonus and \$327,621 in long-term compensation based on quality improvements in the company's products. (65)
- b. By contrast, IBM paid Mr. Metz, its former chief financial officer, a total of \$725,000 last year. (66)
- c. Mr. York also had stock options that Chrysler valued at \$2.9 million at the end of 1992. (67)

Consequently, (36) is the mirror image of (35).

4.3 Other Issues

Importantly, SDRSs represent directed acyclic graphs, not trees. The non-treeness of discourse structure assumed by SDRT manifests itself in several ways, e.g. multiple relations holding between two utterances and multiple parents. Since our annotation scheme is a straightforward encoding of a relation structure, we have no problems handling such cases if/when they arise. We refer the reader to Baldrige and Lascarides (2005) for a more thorough discussion of these issues.

References

- Asher, Nicholas. 1993. *Reference to abstract objects in discourse*. Number 50 in *Studies in Linguistics and Philosophy*. Dordrecht: Kluwer.
- Asher, Nicholas, and Alex Lascarides. 2003. *Logics of conversation*. Cambridge University Press.
- Baldrige, Jason, and Alex Lascarides. 2005. Annotating discourse structures for robust semantic interpretation. In *Proceedings of the Sixth International Workshop on Computational Semantics (IWCS)*. Tilburg, The Netherlands.
- Carlson, Lynn, Daniel Marcu, and Mary Ellen Okurowski. 2003. Building a discourse-tagged corpus in the framework of rhetorical structure theory. In *Current directions in discourse and dialogue*, ed. Jan van Kuppevelt and Ronnie Smith, 85–112. Kluwer Academic Publishers.
- Potts, Christopher. 2005. *The logic of conventional implicatures*. Oxford University Press.
- The PDTB Research Group. 2006. The Penn discourse treebank 1.0 annotation manual. Technical report, Institute for Research in Cognitive Science, University of Pennsylvania.
- Wolf, Florian, and Edward Gibson. 2005. Representing discourse coherence: A corpus based study. *Computational Linguistics* 31:249–287.