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Coherence Relation Reasoning in Persuasive Discourse

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Abstract

One major element of discourse understanding is to perceive coherence relations between portions of the discourse. Previous computational approaches to coherence relations reasoning have focused only on expository discourse, such as task-oriented dialog or database querying. For these approaches, the main processing concern is the *clarity* of the information that is to be conveyed. However, in a persuasive discourse, such as debates or advertising, the emphasis is on the *adequacy* of presenting the information, not just on clarity. This paper proposes a formalism and a system in which coherence relations corresponding to speech actions such as *clarify*, *make adequate* and *remind* are represented. Furthermore, in relating to human reasoning in general where studies have revealed that implicational and associative reasoning schema are prevalent across various domains, this formalism demonstrates that coherence relation reasoning is similar to this human reasoning, in the sense that coherence relations can be defined by domain independent implicational and associative schema. A prototype system based on this formalism is also demonstrated in this paper in which real world advertisements are processed.

1 Introduction

Some texts hang together better than others. To explain this fact, coherence relations have been proposed, which specify the possible ways in which sentences or other portions of discourse can connect to each other. Using coherence relations, a text's clarity can be evaluated. If an acceptable coherence relation structure can be built, then the text is clear; if not, it is not.

Most of the work in coherence relations has been done on task-oriented dialogues, or on stories. In this sort of discourse, clarity is an essential, and relatively straightforward, feature of the text. For example, in describing a task, the text is coherent if the steps of the task are specified in a well-connected manner. However, coherence is not as simple in persuasive texts, such as debates or advertisements. In these types of discourse, the author's speech actions are constantly affected by precautions such as to be objective or to be polite, etc. Hence, for understanding persuasive discourse, a formalism is needed which can represent those portions of discourse conforming not just to the clarity of the information, but also to the *adequacy* of presenting the information.

An example will illustrate the difference between clarity and persuasive coherence (adopted from Halliday's [HH76], p. 241):

- (1.a) Mary is leaving. She was never really happy here.
- (1.b) Is Mary leaving? She will be better off somewhere else.

In (1.a), after the second sentence is mentioned, the reason why Mary is leaving becomes clear to the hearer/reader. By being given this reason, the reader shall clarify his picture about the event and understand it better. However, in (1.b), the second sentence is used as a "justification" for the adequacy of the question. It explains why the speaker ask the question. That is, given that Mary shall be happier somewhere else, it is reasonable to ask the question. Similarly, by being given this justification, the hearer may be more willing to cooperate and answer the question as best he can.

In fact, in real life, many discourses can be seen in which an author/speaker will tend to draw support for his requests and beliefs, or try to concede an opinion by acknowledging other facts in order to invite the hearer's cooperation. Such discourses may include debates in an election, arguments in the court, advertisements in magazines or even everyday conversations. Consider, for example, the following two passages:

(2.a) Your oldest son can't help you take care of the other kids. But he can run errands for you.

(2.b) Your invitation is very nice. But I am not available that night.

Although these two utterances would be used in very different situations (one between two mothers, the other between a guest and a host), it is not hard to see the commonality between the two passages. Particularly, they both exhibit a counter-expectation deduced by the following implication-like schema,

The situation is A but it is not so A.

For example, A may stand for BAD in (2.a), since it is “bad” that the oldest kid cannot help take care of the other kids, however it is not so BAD because he can do something else. Similarly, A may stand for GOOD in (2.b), since being invited to a party is “good,” but not able to make it is not so “good.” To summarize, from a discourse point of view, the first sentence in both (2.a) and (2.b) serves as a concession to hearer’s point of view so that they can cooperate and accept the second statement.

In this paper, a formalism is proposed in which coherence relations are treated as individual speech actions connecting portions of discourses. The types of speech actions categorized in this formalism are *clarify*, *make adequate*, and *remind*. A set of 20 coherence relations originally identified by Mann & Thompson [MT88] are then categorized into the above three classes. For example, for *clarify*, there are coherence relations such as volitional-result and unvolitional-result to indicate the result of events; for *remind*, there are restatement and summary; for *make adequate*, there are evidence, justification, motivation, etc.

A set of implicational semantic relations are summarized from previous psychological studies in our formalism [TvdBS89], [CH85]. The relations included are Goal-oriented (GO), psychological-causation (PSI), physical-causation (PHI), enablement (ENB), obligation (OB), permission (PE), and material-implication (MI). For example, for (1.a) as well as (1.b), the underlying semantic connection between the two sentences is:

If A is unhappy about B then A avoids B.

This is one of the psychological causations between a state and a reaction categorized in Trabasso’s [TvdBS89].

Besides implicational semantic relations, there are other underlying relations, which are called associative in our formalism. Following Chaffin and Herman’s [CH84] categorization, there are: opposite (OPP), part-whole (PW) and class-inclusion (CI). These semantic relations are believed to underlie coherence relations such as contrast, elaboration and antithesis, which in turn, serve to clarify information. For example, for antithesis,

America rescued Panama. We did not invade it.

There is an opposite (OPP) semantic relation between rescuing and invading, which underlies the relation between the two sentences. The reasons for these categorizations are twofold: first, to capture subcategorizations of coherence relations due to subcategorization in semantic relations; and secondly, as a consequence of the first point, to reveal the hierarchy of coherence relations. The details will be shown in section 3.

2 Defining Coherence Relations (CR’s)

In this section, a formalism is introduced which modifies and extends Hovy’s system briefly sketched in his paper [Hov88]. The two major “players” in the system are denoted as S-for speaker/author, H-for hearer/reader. Each entity in this formalism has a type and can have associated attributes. Basically, the formalism assumes the representational scheme in a rule-based system such as Soar or Ops5.¹

The major entities in the formalism are defined in the following.

¹In the following, the actual representations are abbreviated for clarity of presentation

1. State of affairs, abbreviated as P. State of affairs is the direct semantic representation corresponding to a clause or entities that can be recursively defined as below. For example, "Peter is hungry" is represented as (Hungry Peter).
2. Implication relations, denoted as (IMP P Q), where P and Q are states of affairs. An implication can any one of the 7 types mentioned in section 1. For example, the relation "If A is a policeman then A can investigate people" is represented as (IMP P Q :type Permission), where P and Q denote (Is-a A Policeman) and (Investigate A people), respectively.
3. Associate relations, denoted as (ASSOC P Q), where P and Q are states of affairs. For example, If P is (Rescue America Panama) and Q is (Invade America Panama), then the associated relation between them is Opposite, that is (ASSOC P Q :type opposite).
4. Belief, abbreviated as (BEL X P). A belief has a holder and a content. For examples, the fact that a speaker uses present tense in the sentence "Peter is hungry" indicates his belief that Peter is hungry, denoted as (BEL S (Hungry Peter)).
5. Goal, abbreviated as (GOAL X P). A goal has a holder (X) and the desired state of affairs (P). Goals related to a speaker S are reflected by their speech acts. There are 3 types of major speech acts in this formalism, denoted as SACT (a) Demand actions, denoted as ACT; (b) Inform reference of an entity, denoted as INFORMREF; (c) Inform factual status of an affair, denoted as INFORMYN². For example, a question, "Would you tell me where John is?", is represented as (GOAL S (INFORMREF H S P')), where P' is the proposition (Be-at John ?loc), where ?loc means the location is unknown to the speaker.³
6. Mutual belief, denoted as (MB X Y P), where X is the holder of the mutual belief, Y are the other partners who share mutual belief with X, and P, the content of the mutual belief.
7. Mention, denoted as (MEN S P), represents the speech action performed by an author/speaker where S it the speaker and P is the statement being mentioned. Two things should be noted for mentioning. First, the difference between (MEN S P) and (BEL S P) can be demonstrated by the following the sentence,

Peter might be a student.

it is translatable as (MEN S P') where P' is (Is-a Peter student) but not as (BEL S P'). Secondly, Mention can takes English words and hence, its implied word order as its arguments). So if speaker says "P because Q" then it can be represented as (MEN S (P because Q)). If the word order is not crucial then a dot is put between the two statements, so (MEN S (P . Q)) means P and Q can be mentioned in any order.

8. Acknowledgment, denoted as (ACK X P), describes an attitude toward a belief or command. In our domain, X is usually the hearer and P is belief or command the speaker wants to implant into the hearer's mind.
9. Coherence relations to make a passage adequate, denoted as (CR S P Q), where CR corresponds to the speech actions Justify, Evidence, motivate, enablement, and concession, were S is the speaker, P and Q are the relevant state of affairs.

Given the above represented entities, coherence relations related to the three major speech actions can be defined as follows⁴

Coherence relations of *make adequate* There are 5 coherence relations included in this category: Evidence, Justification, Motivation, Enablement, and Concession. Let's take Evidence and Justification as examples.

²For the latter two types, Cf. Allen's [All83]

³Later on, a primed proposition P' of P indicates P' is the declarative counterpart of a question or command expressed by P, or a modal-less propositions of the one with modal

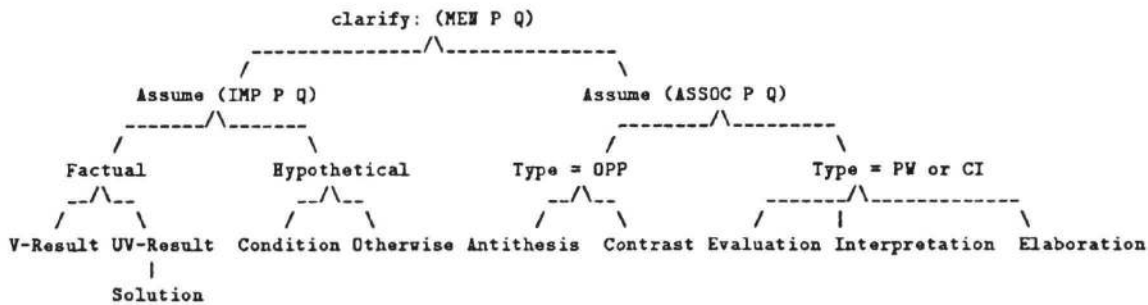
⁴We take the initial coherence relations as those listed in Mann & Thompson's Rhetorical Structure Theory.

The taxonomy is self-explanatory. The reason why Motivation is under Justification is because Motivation is to Justify a command by resorting to the pleasure or benefit (a PSI type of implicational relation) of the hearer.

Coherence relations of clarify. There are ten coherence relations included in this category: Volitional-cause/result, Non-volitional-result/cause, solution, purpose, condition, otherwise, evaluation, interpretation, elaboration, antithesis, and contrast. The definitions for Contrast CR and Antithesis CR are given below:

<pre>(Contrast P Q) If (MEM S P) and (MEM S Q) and (MEM S (P Q)) and (MB S (ASSOC P Q :type OPP)) Then (MEM S (Contrast P Q))</pre>	<pre>(Antithesis P Q) If (BEL S -P) and (BEL S Q) and (MEM S (P Q)) (MB S (ASSOC P Q :type OPP)) Then (MEM S (Antithesis P Q)) and (ACK H (BEL S Q))</pre>
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The definitions indicate that the difference between Antithesis and Concession in of their underlying semantic relations. Antithesis assumes a associative type relation. On the other hand, Concession assumes a implicational type relation. These relations can be summarized in the following taxonomy:



The reason why solution is a especial case of UV-result is because it requires the precedent to be a problem. Evaluation and Interpretation both assume that the situation where the state of affairs is assessed is a part of the entire belief space. The part could be the speaker's individual belief as for Evaluation or another state of affairs as for Interpretation. It is obvious that an Elaboration CR assumes class-inclusion semantical relations.

Coherence relations of remind There are two such relations, they are Summary and Restatement. Restatement is a repetition of the exact terms that are mentioned in the previous context, whereas summary is a repetition of some derived terms from the previous context. Their definitions are straightforward. However, it will be shown in the next section that these CR's have an effect on the discourse stack that is not seen in the former two types of CR's.

3 Processing advertisements

The above formalism is currently under development in a system called BUYER (Cf. [LW89]). It takes propositions extracted from real-world advertisements as its input. The final output is the set of coherence relations that are derived from the entire discourse. Following are the control flow of the system and two examples:

The processing control flow.

(0) If end of passage then done, otherwise go to (1), if it is just a sentence or to (2), if it is preceded by a connective.

- | | |
|---|---|
| (1) Processing a sentence: | (2) Processing a connective between P and Q: |
| (1.a) Decide its referential continuity. | (2.a) Hypothesize the corresponding CR's. |
| (1.a.1) If not continuous then create a new segment and push the old context. | (2.a.1) Start with the most general one if there is no clues for specific ones. For example, Connective So:
General: Conclusion or Cause.
Specific: Summary or Restatement.
or Justification, etc. |
| (1.b) Store potential referents in the current segment. | (2.b) Decide the continuity of the discourse. |
| (1.c) Decide the speech acts of the sentences (e.g., it may a BEL, MEN, or GOAL). | (2.c) Processing the latter one, Q. |
| (1.d) Abstraction to semantic frames, e.g., to a commodity as follows:
Commodity Kraft-singles:
Brand: Kraft.
Category: Food.
Ingredient: Milk.
Flavor: Tasty. | (2.d) Go to (0) |
| (1.e) Decide implicational or semantical relations and coherence relations. | |
| (1.f) Go to (0). | |

The examples.

The washer ad

- S1. It all comes out in the wash.
- S2. You can crank-up a GE washer
- S3. and get electro-mechanical effect.
- S4. Or you can tap-touch a Speed-Queen Marathon
- S5. and enjoy fully-programmable laundry.
- S6. Match temperature to fabrics.
- S7. Recall favorite cycles.
- S8. GE or Speed Queen.
- S9. The answer is at your figure tips.

The Kraft ad

- S1. The older sister said milk is better than oil.
- S2. We would never argue with such an authority.
- S3. Imitation slices are made from oil and water.
- S4. But Kraft singles is made from milk.
- S5. Some people already know why Kraft is better than slices.
- S6. They are the big brothers and sisters.

We will now describe the processing on the two examples presented above.

The washer ad. After S1 is processed, the referent of "it" is expected to be resolved. The referent is specified as of type PROBLEM, since the undergoer-slot of "comes out" is of PROBLEM type. When S2 is processed, due to referential discontinuity, a new segment is created and the old one pushed. The Coherence relation between S2 and S3 is determined to be volitional-result, since it is one of the CR's that correspond to the connective "and" and there is an underlying implicational relation: If A operates a machine then A gets the effect of the machine. Similar processing happened between S4 and S5, so the Volitional-result CR is decided. At the same time, while processing the connective "or," the relation between S2 and S4 are determined to be the Contrast CR because of the propositional structure corresponding to them is "symmetrical." Furthermore, since the expectation of PROBLEM is stacked, the Contrast CR is interpreted as an exclusive-or (adversative) instead of an inclusive-or (alternative). Thus, the referent of "it" is also resolved. S6 and S7 are evidences to S5 since "If A is a Match-temperature-to-fabric or a Recall-cycles then A is a Programmable-laundry." Meanwhile due to the referential discontinuity, the segment S2-S5 is pushed. Then, S8 is decided as a restatement of the Contrast CR, also the segment S2-S5 is popped because the restatement refers to the terms in the previous segment. R9 is an Evaluation CR, since the judgment references the reader's knowledge. The output can be summarized as:

- | | |
|---------------------------------|---------------------------------|
| Elaboration(S1,Contrast(S2,S4)) | Evidence(S6,S5) |
| Volitional-Result(S2,S3) | Evidence(S7,S5) |
| Contrast(S2,S4) | Restatement(S8,Contrast(S2,S4)) |
| Volitional-Result(S4,S5) | Evaluation(S9,S8) |

The Kraft ad. After S1 and S2 are processed, a Justification CR between them is determined, since a implicational relation “If A is an authority then what he says is true” is recognized. S3 and S4 form a new segment because of the referential discontinuity, a Contrast CR between them is also determined, since the propositions corresponding to S3 and S4 have the same predicates but different subjects and objects. Then, the system recognizes when the claim (viz., milk is better than oil) is justified and the contrast related to the claim is given (viz., Kraft singles v.s. imitation slices), the speaker is indicating an exclusive-choice between the contrasted pairs. This causes the system to derive that Kraft singles is better than imitation slices, since milk is better than oil. S5 serves as summary of the above derived facts. S6 is an evaluation of S5, since it references the speaker belief. The output can be summarized as:

Justify(S2,S1)	Summary(S5,S1-S4)
Contrast(S3,S4)	Evaluation(S6,S5)

Top level CR sequence. One interesting observation in advertisement domains is that the top level CR’s sequence tends to follow a few fixed patterns. For example, in the above two examples, they both have an assertion (either stated or justified) followed by a contrast, then followed by a Summary and Evaluation. This first part of the sequence resembles a common story plot: background, suspense and resolution. The difference is that in a persuasive discourse, the reader is reminded to reinforce the point. To study these common patterns of persuasion, called debate-plan, is just underway in our investigation.

4 Related work

Being a descriptive theory, Mann&Thompson’s [MT88] Rhetorical Structure Theory proposes the initial categorization of coherence relations into presentation and subject-matter, two classes which roughly correspond to our *make adequate* and *clarify* speech actions. However, the definitions given for their Rhetorical relations tend to be too informal for a computational model. Particularly, the theory fails to capitalize on the fact that the constraints of a Rhetorical relation actually can be conceptualized as implicational and associative semantic relations. Also, the notion of “positive-regard”, which was vague in their theory, is represented explicitly in our formalism as the belief and acknowledgment of the reader. Furthermore, their multiple-nuclei Sequence Rhetorical relations, occurring in the top level of the discourse, do not tell us much about the semantic content of the passage. However, as demonstrated in processing advertisements, our system recognizes the sequence to be debate-plans that are commonly seen in persuasive discourse.

Hobbs’ theory [Hob], on the other hand, captures of the general semantic relations underlying part of the CR’s (those to clarify). However, little emphasis is put on the analysis of the CR’s *make adequate* and *remind*.

Hovy’s and Mckewon’s [Hov88] [McK85] approaches work in the domain of generating answers to data-base queries. The CR’s formulated are mostly concerned with clarifying a piece of information. Since their system is for text-generation, it applies knowledge in a back-chaining way. On the other hand, our system applies knowledge in forward-chaining way, and a back-chaining mechanism for understanding a discourse is being investigated for our system.

Allen and Litman’s approaches [All83] [Lit86] [Lit87] share the common weakness of previous approaches in missing the CR’s *make adequate* and *remind*. Furthermore, for the CR *clarify*, they did not capture the underlying implicational and associative semantical relations, which makes their approaches more domain dependent, especially in their earlier systems.

Cohen’s [Coh87] is another computational approach which defines the CR of *make adequate*. However, only the Evidence CR is formulated. The argumentation structure derived from evidence coherence relations thus can not fully cover the debate-plan structure on which most advertisements are based.

5 Future Work

Three types of coherence relations are formulated in this paper: those of *make adequate*, of *clarify* and of *remind*. A prototype system based on this formalism together with other discourse processing mechanisms is shown to process advertisements. However, the formulation, as well as the system, is still rudimentary. Further enhancement can be pursued both in the formalism and the system.

In formalizing discourse reasoning, two goals are set: (1) To refine the formalism's vocabulary, so it make more use of the information deducible from grammatical morphemes for recognizing the implicational semantic relations. (2) To link up the sentence level processing with Unification Grammar based systems and investigate the possibility of even extending the unification mechanism up to the discourse level.

In enhancing the system performance, there are also two goals: (1) To refine the mechanism for deciding referential continuity. Currently the mechanism is simple-minded and works on the advertisements seen so far. A more complicated mechanism may be needed. However, if it turns out there is no need for such mechanism in advertisements, then it may contribute to our understanding of how referential continuity works in debate discourse. (2) To incorporate back-chaining inferencing in implicational relation recognition. According to our observation, advertisements make use of more "immediate" causal relations in consecutive sentences, unlike stories in which causal connections tend to involve several steps. However, there might be cases where hidden connections should exist. In those cases, assumptions should be made and a back-chaining mechanism should be incorporated.

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