

Agreement: How to Reach it? Defining Language Features Leading to Agreement in Dialogue

Tatiana Zidraşco

Technical University of Moldova
tzidrashco@yahoo.com

Shun Shiramatsu

Nagoya Institute of Technology
siramatu@toralab.ics.nitech.ac.jp

Victoria Bobicev

Technical University of Moldova
victoria.bobicev@rol.md

Tadachika Ozono

Nagoya Institute of Technology

Toramatsu Shintani

Nagoya Institute of Technology
tora@toralab.ics.nitech.ac.jp

Abstract

Consensus is the desired result in many argumentative discourses such as negotiations, public debates, and goal-oriented forums. However, due to the fact that usually people are poor arguers, a support of argumentation is necessary. Web-2 provides means for the on-line discussions which have their characteristic features. In our paper we study the features of discourse which lead to agreement. We use an argumentative corpus of Wikipedia discussions in order to investigate the influence of discourse structure and language on the final agreement. The corpus had been annotated with rhetorical relations and rhetorical structures leading to successful and unsuccessful discussions were analyzed. We also investigated language patterns extracted from the corpus in order to discover which ones are indicators of the following agreement. The results of our study can be used in system designing, whose purpose is to assist on-line interlocutors in consensus building.

1 Introduction

The issue of consensus building within discourse has become more substantial since the computer and web technologies offer vast opportunities for public debates, collaborative discussions, negotiations etc. In computational linguistics there have been numerous studies dedicated to discourse analysis, modelling and analysis of collaboration (Chu-Carroll and Carbery, 1998; Sidner 1994),

negotiations (Sokolova et.al. 2004) and agreement process (Di Eugenio et al., 2000).

Two important components of discourse studies are representation of discourse structure and language. We investigated discourse structure in an attempt to find out how it can reflect successful or unsuccessful result of a web-discussion. Our aim was to determine structures of discourse representation that lead to consensus at the end of the discussion and structures that do not lead to consensus. We think these types of structures could help for better understanding of position and intentions of participants during agreement process. We performed our study using web-discussions (Wikipedia Talk pages, English language), where participants had as their goal to agree upon the editing policy of Wikipedia articles.

To build up the discourse structure we used Rhetorical Structure Theory (RST) relations (Mann and Thomson, 1987). We then applied statistical analysis to our corpus of discussions annotated with 918 relations.

As mentioned before, another important component of discourse analysis is language cue or better said those words and phrases used by the participants to directly indicate the structure of the argument to the other participants. After preliminary determination of some rhetorical structures that could lead to consensus, we, as well, investigated how language reflects success or failure in our web-discussions.

2 Related works

There have been a number of approaches of modelling and analyzing negotiation and agreement process in computational linguistics.

In (Sidner 1994) multiagent collaborative planning discourse is analyzed and an artificial language is formulated for modeling such discourse. Multiagent collaborative planning process is represented in artificial language as one agent making a proposal to the other agents, and the other agents either accept or reject this proposal. Modeling is done using proposal/acceptance and proposal/rejection sequences. Propose-Evaluation-Modify framework for collaboration is proposed in (Chu-Carroll and Carbery, 1998). They focus on identifying strategies for content selection, when 1) the system initiates information-sharing to gather further information in order to make an informed decision about whether to accept a proposal from the user, and 2) the system initiates collaborative negotiation to negotiate with the user to resolve a detected conflict in the user's proposal. A slightly different approach to the problem of modeling of agreement process is described in (Di Eugenio et al., 2000). They propose specific instantiations of the agreement process attuned to the characteristics of task oriented dialogues. They model their participant's collaborative behavior according to Balance-Propose-Dispose agreement process and they focus on how information is exchanged in order to arrive to a proposal and what constitutes a proposal and its acceptance or rejection and discover that the notion of commitment is more useful to model the agreement process. We proposed to build discourse structure using RST and based on empirical analysis, to determine which types of discourse structures are leading to final consensus.

In (Sokolova et al. 2004) the preliminary study investigates how language reflects success or failure of electronic negotiations. They seek text characteristics which can help in prediction of negotiations success or failure. Using NLP and ML techniques they show how language differs in successful and failed negotiations. Thus we have also analyzed the discussion language in order to identify language features that influence the outcome in argumentative discourse.

3 Discourse structure

We collected a corpus of discussions from Wikipedia free encyclopedia Talk pages. The purpose of Wikipedia talk page is to provide space for

editors to discuss changes to associated article or project page. We stopped at Wikipedia discussions for two reasons: 1) these are web-mediated discussions; 2) these are task-oriented discussion - the purpose is to reach consensus when discussing subtopics related to the final version of Wikipedia article. Each subtopic was discussed by two or more participants (editors). We considered a discussion to be successful when most of the participants agreed on the solution of the problem given within the subtopic at the time given.

As mentioned above, we aimed to represent argumentative discourse structure so, that it would be possible to analyze the consensus building process within the discourse. To build up the structure of the discourse we address Rhetorical Structure Theory; we use rhetorical relations, which are well-known tagging schemes for annotating both monologue texts and dialogues (Toboada and Mann, 2005). The kinds of intentional relations we borrowed from RST include *evidence*, *justification* (original *justify*), *background*, *concession* etc. We, as well, introduced additional rhetorical relations that helped to reflect the structure of argumentative discussions. For example, in such discussions, it is important for question-answer pairs to identify the question intention. So we added *require evidence*, *require detail*, *require yes/no* rhetorical relations. We obtained 27 rhetorical relations that can be divided into 7 groups that have some common rhetorical meaning: *Answer*, *Argumentation*, *Consensus*, *Question*, *Action Request*, *Dialogue Act*, and *Conclusion*. For example, *Consensus* includes *agreement* and *disagreement* relations. In Table 1 we present the example of organization of our annotation tag set.

For the cases when the relation definition is not covered with any of the rhetorical relations from our tag set, we introduce relation tag unknown.

Next issue, following the definition of the tag set was determination of annotation elementary unit. Since one user's statement might contain different types of information; we segmented statements into units corresponding to speech acts. According to the definition, speech act is a term that refers to the act of successful communicating an intended understanding to the listener. Each speech act within one user's statement has a separate speech function like asking question, explaining, etc. Thus, in this study, speech act became the elementary unit for annotation.

<i>Answer</i>	<i>Action Request</i>
Affirmation	Request to do
Negation	Suggestion
<i>Argumentation</i>	<i>Dialogue Act</i>
Evidence	Apology
Justification	Accusation
Elaboration	Gratitude
Explanation	Ironic_comment
Background	Offence
Example	Solution
<i>Consensus</i>	Warning
Agreement	<i>Conclusion</i>
Disagreement	Concession
<i>Question</i>	Summary
Require evidence	Unknown
Require detail	Response
Require yes/no	Addition

Table 1: Annotation tag set

Once, the elementary units have been determined, text segments were connected through rhetorical relations, building discourse structure. For each unit one or more relations were allowed. For example, the sample below,

A: (1) I think you should stop smoking

B: (2) Why should i?

A: (3) For example, me, stopped smoking two years ago.

was annotated in the following way: (1) ← (2) was tagged as *require evidence*, (2) ← (3) as *response*, (1) ← (3) was labeled as *example*.

The annotation was done with the help of the tool for visualizing the discussion structure. The tool allowed to segment participants' statements into units and provided annotator with the list of the rhetorical relations.

4 Rhetorical structure analysis

To investigate the influence of rhetorical structures on agreement we model our discourse as a directed graph with nodes representing statements and arcs representing rhetorical relations that hold between statements. We first investigated the frequency of rhetorical relations. The most frequent relations are listed in Table 2. As it can be seen, the most frequent rhetorical relations were *evidence*, *agreement*, *disagreement*.

We assumed that successful or unsuccessful tendency of argumentative discourse can be determined through patterns of rhetorical structures that hold between the discourse units.

Relation	Frequency	Percentage
Explanation	151	16.4%
Agreement	150	16.3%
Disagreement	135	14.7%
Suggestion	96	10.5%
Evidence	55	6.0%
Justification	42	4.6%
Require evidence	41	4.5%
Gratitude	29	3.2%
Answer	29	3.2%
Ironic_comment	27	2.9%
Other rhetorical relations	96	10.5%
Total	918	100%

Table 2: Frequent rhetorical relations

For example, we presumed that the discourse sub – graph structures *require evidence – evidence* or *evidence – agreement* have tendency to create a successful discussion. In addition, we made a supposition, that in successful discussions the number of pairs such as *evidence – agreement* will be bigger compared to the *evidence – disagreement* or *suggestion – agreement*.

To verify the assumptions, we firstly, analyzed our corpus performing so called sequence-based analysis. We counted frequencies of bigrams of rhetorical relations (r1, r2), where let r1 be a preceding relation and r2 be a succeeding relation that follows r1. We calculated frequency of rhetorical relations bigrams for *agreement (disagreement)* pairs and calculated priori

$$P(r2|r1)=C(r1,r2)/C(r1) \quad (1)$$

and posterior

$$P(r1|r2)=C(r1,r2)/C(r2) \quad (2)$$

probabilities, where, C(r) and C(r1,r2) denote frequencies of a rhetorical relation r and relation bigram (r1,r2), respectively. Here, C(r) and C(r1,r2) denote frequencies of a rhetorical relation r and relation bigram (r1,r2), respectively.

These calculations allow us to identify rhetorical relations that precede *agreement* and *disagreement*. The results are presented in Table 3 and Table 4.

We sorted data by posteriori probability of preceding relation when the following relation is agreement/disagreement, because it can be regarded as a contribution of preceding rhetorical relation for consensus building. The results showed that, most frequently, agreement relation was preceded by evidence.

Relation r_1	$P(r_2=Agreement r_1)$	$P(r_1 r_2=Agreement)$
Evidence	0.176 (12/68)	0.072 (12/166)
Suggestion	0.170 (19/112)	0.114 (19/166)
Disagreement	0.133 (22/166)	0.133 (22/166)
Agreement	0.120 (20/166)	0.120 (20/166)
Answer	0.138 (4/29)	0.024 (4/166)
Explanation	0.107 (18/169)	0.108 (18/166)
Require evidence	0.082 (4/49)	0.024 (4/166)
Justification	0.021 (1/47)	0.006 (1/166)

Table 3: Priori and posteriori probability for most frequent agreement pairs

Relation r_1	$P(r_2=Disagreement r_1)$	$P(r_1 r_2=Disagreement)$
Evidence	0.221 (15/68)	0.090 (1/166)
Suggestion	0.277 (31/112)	0.187 (31/166)
Disagreement	0.127 (21/166)	0.127 (21/166)
Agreement	0.024 (4/166)	0.024 (4/166)
Answer	0.034 (1/29)	0.006 (1/166)
Explanation	0.077 (13/169)	0.078 (13/166)
Require evidence	0 (0/49)	0 (0/166)
Justification	0.064 (3/47)	0.018 (3/166)

Table 4: Priori and posteriori probability for most frequent disagreement pairs

After that, we applied Evidence-based analysis to investigate the influence of contribution (on this stage it is evidence) relation on final agreement. The contribution relation r_1 is a target relation for analyzing its influence on final consensus relation. The consensus relation r_2 corresponds to agreement or disagreement. Here we concentrated on evidence as the contribution relation. There is a probability that usually when evidence is given, it will be rather followed by agreement. We calculated the probability of the bigram (r_1, r_2) to see the probability that agreement would come after the evidence.

We considered the following two possibilities: when r_2 is agreement (disagreement), while r_1 is Evidence and when r_2 is agreement (disagreement), while r_1 is any other rhetorical relation. We compared ratios of appearing of agreement and disagreement in evidenced and non-evidenced pairs and observed the following inequations from our corpus

$$(r_2 = Agr|r_1 = Ev) > P(r_2 = Agr|r_1 \neq Ev) \quad (3)$$

and

$P(r_2 = Agr|r_1 = Ev) > P(r_2 = Disagr|r_1 = Ev)$ (4). Fisher's exact test for (3) showed that (3) is statistically significant in 1% level because p-value was 0.0047 (<0.01). Hence, the two 95% confidence intervals for

$$P(r_2 = Agr|r_1 = Ev)$$

and

$$P(r_2 = Agr|r_1 \neq Ev)$$

do not overlap. Fisher's exact test for (4) showed that observation of (4) didn't have enough statistical significance because p-value was 0.146 (>0.01). That is, the results indicated partial validity of our assumption about *evidence* being the first relation followed by *agreement*, which allowed us to say that evidenced structures tend to lead to success in discussions.

5 Language patterns investigation

We also made another assumption, that language used in discussions has an impact on consensus building. Thus, we decided to analyze word unigrams, bigrams and trigrams in different types of statements. (Sokolova et al., 2004) proved that there were characteristic words for successful and unsuccessful negotiations called 'indicative words'.

We made an attempt to make similar analysis for our corpus. The corpus consisted of 320 files of Wikipedia discussion pages, total number of word tokens was 148948 and number of word types was 11545.

In (Sokolova et al., 2004) analysis of negotiations were based on the final result: success or failure of the negotiation; thus all discussion was considered as successful or unsuccessful. In our dialogue there was no final result; we concentrated on each message as one unit with its rhetorical relation. Firstly, we made frequency dictionaries of words, word bigrams and word trigrams for all messages annotated with the same rhetorical relations. Quick analysis of these dictionaries revealed 'indicative words' for the relations. For example, *disagreement* is indicated with the higher rate of negations 'not', 'i don't', 'there is no', 'it is not', etc. *agreement* on the contrary, had clear indicators: 'I agree with', 'have to agree'. However, not all relations could be detected so easily; for example, *justification*, *explanation*, *suggestion* had less specific words and much more content words referring to the discussed topic. As 'indicative words' for these relations could be mentioned:

- *justification* – adverbs 'reasonably', 'rather', 'as well';

- *explanation* – verbs ‘want to’, ‘could be’, ‘I feel’;
- *suggestion* – ‘I think’, ‘should be’, ‘we should’.

Actually, the investigation of ‘indicative words’ for different type of relations should be a more extensive study which we plan for the future. In this paper we concentrated on the connections between relations, particularly on the relations which preceded *agreement* and *disagreement* messages.

We selected all relations pairs r_1, r_2 , where r_2 is agreement or disagreement and r_1 is the message which precedes r_2 . We create the unigram, bigram and trigram frequency dictionaries for r_1 messages which preceded agreement or disagreement respectively and calculated log-likelihood statistics as was described in (Sokolova et al., 2004). The next step was the comparison of words for one type of messages which preceded agreement and disagreement respectively in order to reveal which words are indicative for the following agreement. In Table 5 the most frequent pairs of relations are presented, their indicative words and some comments are added.

In general, we observed that bigrams and trigrams of words which are indicative for agreement do not depend on relation. For all relations we investigated, specific features for agreement are gentle, polite phrases. Also, to our surprise, pronouns have the great impact on following

agreement: ‘we’ is good indicator of agreement, while ‘you’ indicate opposition, especially in phrases ‘you have’, and ‘you should’. We did not find verbs to be indicative words. Adverbs also have less impact on the result.

6 Conclusion

In the paper we attempted to investigate two important components of the discourse: representation of the discourse structure and linguistic cues. We proposed to represent discourse structure using Rhetorical Structure Theory and based on empirical analysis, to determine what types of rhetorical structures in the discourse do lead to final consensus. We collected a corpus of web-mediated discussions from Wikipedia and annotated it with our tag set of rhetorical relations. Our corpus contained 1764 statements with the total number of 506 participants and 918 rhetorical relations labels that connected statements. We made an assumption that successful or unsuccessful tendency of argumentative discourse can be determined through patterns of rhetorical structures that hold between the discourse units. To verify the assumptions, we applied two types of statistical analysis: *sequence-based* and *Evidence-based* which allowed us to detect the existence of rhetorical structures patterns that could influence consensus building in collaborative discussion.

Relation bigram		indicative words	comments
r_1	r_2		
Suggestion	Agreement	i think, we have, could be, kinds of, think we should, we could	use of pronoun ‘we’ predominate, which indicate that people are rather colleagues than opponents
Suggestion	Disagreement	highly, quite, rather, reason is quite, should be, would be, better to	suggestions are more categorical and are formulated as from superior to inferior which provoke negation
Explanation	Agreement	if i’m wrong, maybe, correct me if, we should, why should, i feel	a mild language, less personal, more text on topic, the pronoun ‘we’ is used again
Explanation	Disagreement	will not admit, you can, no good	the phrases used are categorical and the authors form opposition
Evidence	Agreement	we, if, a few, a certain, for the purposes, deem that, can cite some	less indicative words, more text about the topic, the language is more concrete and more gentle
Evidence	Disagreement	you due to, you need a, you will need, you’d have to	an aggressive language with many combinations of ‘you have’, ‘you should’, etc.

Table 5: The most frequent pairs of rhetorical relations, their indicative words and comments

The obtained results partially confirm our assumptions about existence of discourse structures

that can indicate tendency to consensus. It should be mentioned in this respect, that in order to ob-

tain more extensive and reliable results, it would also be desirable to investigate which relations are significantly more often appearing before *agreement* and *disagreement*, rather than only focus on the evidence analysis. Also other criteria, as for example, participants ID of statements and considering relationship between participants during the analysis, would be important factors for the consensus building.

Investigation of the indicative words unigrams, bigrams and trigrams showed that specific features of language which led to *agreement* or *disagreement* were similar indifferent which type of rhetorical relation preceded *agreement* or *disagreement* respectively. Actually, one of the most natural extensions of the study of language in discussion is more sophisticated statistical method application but our corpus is comparatively small and data is rather sparse. Thus we leave this study for the future when we obtain more annotated texts

The results we obtained could be used for consensus facilitating function design in an argumentation support system.

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