

Developing a Model of Agreement Negotiation Dialogue

Mare Koit

Institute of Computer Science, University of Tartu, Liivi 2, Tartu, Estonia

Keywords: Dialogue Structure, Dialogue Act, Dialogue Corpus, Knowledge Representation.

Abstract: We are investigating human-human dialogues in the Estonian dialogue corpus with the further aim to develop a dialogue system which carries out negotiations with a user in a natural language. Two sub-corpora are analysed and compared: (1) MSN conversations, and (2) everyday dialogues, both phone calls and face-to-face conversations. In the dialogues, the participants are trying to achieve an agreement about doing an action. The structure of negotiations is represented as a sequence of dialogue acts. A special case of negotiation – debate where the participants have contradictory communicative goals – has been implemented as an experimental dialogue system.

1 INTRODUCTION

Negotiation is a dialogue between two or more people or parties, intended to reach an understanding, resolve point of difference, or gain advantage in outcome of dialogue. Collaborative and adversarial negotiations are different. In a discussion, the parties hold points of view, but are potentially open to learning from alternative perspectives. Debates, on the other hand, are marked by an adversarial approach where each party comes equipped to promote their position and to undermine that of the other side (Cummins, 2011).

Rahwan et al (2004) discuss three approaches to automated negotiation: game-theoretic, heuristic-based and argumentation-based. The last approach to negotiation allows agents to argue about their beliefs and other mental attitudes during the negotiation process.

Besnard and Hunter (2008) formalize argumentation by using classical logic. Logical models of argument support decision making by participants, guide negotiation and allow reach agreements (Amgoud and Cayrol, 2002).

Hadjinikolis et al. (2012) provide an argumentation-based framework for persuasion dialogues, using a logical conception of arguments that an agent may undertake in a dialogue game, based on its model of its opponents.

Amgoud et al. (2015) introduce a target language for representing arguments mined from natural language. They propose a formal language (RC language) for representing reasons and claims of

arguments, and a framework for reasoning about arguments.

Overviews of the state of art in modelling agreement negotiation can be found in (Amgoud et al., 2015), (Besnard and Hunter, 2008), and (Chesñevar et al., 2000).

We are studying the interactions in natural language between two participants (A and B) about doing an action, e.g. fixing an appointment. The communicative goals of the participants can coincide or be different. The participants are presenting arguments and counterarguments during a dialogue. They can also ask and answer questions in order to make choices among the arguments for averting the partner's counterarguments.

If A and B have contradictory goals when starting interaction then they are involved into debate. One participant will achieve his or her communicative goal (wins debate) and another has to abandon her or his initial goal (loses debate).

If A and B have a common communicative goal then they are cooperatively looking for arguments that support achieving this goal. Still, one of them can indicate to obstacles which do not allow achieve the goal. Then the partner has to find arguments for showing how the obstacles can be exceeded. The final result of negotiation is whether achieving the collective goal (win-win model) or its withdrawal if some of the obstacles cannot be eliminated (lose-lose model).

We have worked out a dialogue model which includes a reasoning model as its part and implemented it in an experimental dialogue system

(DS) (Koit and Õim, 2014; Koit, 2015). In the current paper, we will further develop the model as based on the analysis of human-human dialogues. Our main goal here is to explain how people negotiate. The further aim is to develop our DS.

The rest of the paper is structured as follows. Section 2 introduces the used dialogue corpus and gives the results of the corpus analysis. The structure of human-human agreement negotiation will be represented by using dialogue acts. Section 3 discusses some questions related to the implementation of the structure in a DS which interacts with the user in a natural language and follows norms and rules of human-human conversation. Conclusions will be made in Section 4.

2 CORPUS ANALYSIS

2.1 The Dialogue Corpus

Our study is based on the Estonian dialogue corpus (EDiC) (Koit and Õim, 2014). It includes three different kinds of human-human dialogues: (1) recordings and transcripts of human-human spoken dialogues, (2) written dialogues collected in simulations by Wizard-of-Oz method, and (3) (written) MSN conversations. The corpus also includes log files of interactions with some DSs. The spoken dialogues are recorded in authentic situations and transcribed by using the transcription system of Conversation Analysis (CA) (Sidnell, 2010). There are both institutional and everyday phone calls as well as face-to-face conversations in the corpus.

Dialogue acts (DA) are annotated in the corpus by using a customized typology (Koit, 2015) which is based on CA. In the typology, the acts are divided into two groups – adjacency pair (AP) acts where the first pair part expects a certain second pair part (like request – grant), and single (non-AP) acts which do not expect any response (like acknowledgement *ah*). Names of the DAs consist of two parts separated by a colon: (a) the first two letters present an abbreviation of the name of an act-group, e.g. DI – DIrectives, VR – Voluntary Reactions. The third letter is only used for AP acts – the first (F) or the second (S) pair part of an AP act; (b) the proper name of the act. There are acts as DIF: Request, DIS: Giving information, VR: Acknowledgement, etc. The total number of the acts is 126.

We are using custom-made web-based software for annotation of dialogues. An utterance can get more than one DA tag if it is multifunctional (cf. Example 1: a phone call of friends *A* and *B*; ‘I

separates the DA tags of a multifunctional utterance).

(1)
A: .hhhhh ˈtulge meile ˈpühapäeval
 ˈkülla. **DIF: Proposal**
Please come to visit us on Sunday.
B: ˈpühapäeval. **QUF: Offering answer** |
RPF: Checking
On Sunday?
A: mhmh **QUS: Yes** | **RPS: Repair**
Yes.
 ...
B: okei. **DIS: Accept**
OK.

Another custom-made software tool enables to calculate some statistics for the dialogues: the counts of utterances, words, different DAs, frequency of words and certain sequences of DAs, etc.

Here we will study two different sub-corpora of EDiC. The first one consists of 40 MSN conversations, and the second one of 44 everyday dialogues where an action is negotiated and argued (among them 22 phone calls and 22 face-to-face conversations). We believe that MSN dialogues and everyday phone calls might be a suitable basis for the development of a DS which interacts with a user following the rules of human-human conversation. Face-to-face dialogues will be analysed for comparison. Our aim is to find out the typical structure of negotiations in the different types of dialogues as represented by DAs. Further, we attempt to design a general structure of argumentation-based negotiation in order to develop our experimental DS.

2.2 Negotiation in MSN Conversations

The analysed 40 MSN conversations include 3313 utterances in total; the average length of a conversation is 82.8 utterances (min 24, max 193). The total number of words is 23,943, i.e. the average length of a conversation is 599 words. Among the conversations, there are 17 where agreement negotiation takes place. (In the remaining 23 dialogues, the participants are discussing about their everyday experience: visiting lectures, parties, movies, skiing, etc.). The number of utterances in the agreement negotiation dialogues is 1427 in total and the number of words is 9367.

In Example 2, the friends *A* and *B* are negotiating a meeting. *A* asks a question about the meeting time. *B* excludes some days of the current week bringing out the explanations and proposes the next week for the meeting. The participants do not appoint a weekday and time but they agree to continue the negotiation later.

(2)
A: Kuna me kokku võiksime saada? **QUF: Wh-question**
When do we meet?
B: hmm.. las ma nüüd mõtlen, kuidas mul see nõdal on. **QUS: Giving information**
Let me think about this week.
neljap peab kaili sünnat, siis ei soboi
AI: Justification
On Thursday, Kaili has her birthday party, then it is impossible.
...
aga järgmine nädal? **QUF: Offering answer**
How about the next week?
A: Järgmine nädal sobiks paremini vast küll. **QUS: Yes**
The next week is better.
B: tore **VR: Acknowledgement**
Fine.
kas lepime kohe mingi aja kokku?
Do we appoint the time just now?
või räägime järgmine nädal **QUF: Alternative question**
Or do we discuss the next week?
A: Ei, räägime järgmine nädal. **QUS: Alternative answer: one**
No, let's discuss the next week.

In another conversation, the participants *A* and *B* are discussing about a surprise for mother's birthday. *A* proposes to call broadcasting where congratulations will be delivered. *B* is doubtful but *A* succeeds to convince him by the arguments. They also determine a hit song for the congratulation in radio.

The general structure of MSN conversation where an action is negotiated looks like follows (Fig. 1). The winding brackets '{' and '}' connect a part that can be repeated (0 or more times); round brackets connect a part that can be missed; '/' separates alternatives; '- ' starts a comment.

AP acts (directives and questions together with their second pair parts) form an encompassing structure of negotiation. Arguments are represented by non-AP acts (primary single act of giving information PS: Giving information, and additional information act of justification AI: Justification).

A: DIF: Proposal/ QUF: Wh-question
{
B: (PS: Giving information/ AI: Justification - -
<argument>)
DIF: Request/ QUF: Wh-question/ QUF:
Offering answer
A: DIS/ QUS: Giving information/ QUS: Yes
(PS: Giving information/ AI: Justification

--<argument>)
}
-- Decision
B: DIS: Accept/ QUS: Giving information/ DIS/
QUF: Deferral

Figure 1: The structure of MSN negotiation (*A* makes a proposal to *B* to do an action). The winding brackets '{' and '}' connect a part that can be repeated; round brackets connect a part that can be missed; '/' separates alternatives; '- ' starts a comment.

2.3 Negotiation in Everyday Dialogues

The participants of the everyday dialogues are acquainted or friends and the initiator *A* makes a proposal to the partner *B* to perform an action. In our analysed dialogues, positive decision has been achieved in 25 cases and negative in one case (in a phone call). The remaining dialogues (out of 44) finish with the postponement of the decision. Several DAs are used for giving arguments: non-AP acts like in MSN conversations as well as AP acts.

2.3.1 Phone Calls

The total number of utterances is 1172 in the analysed 22 phone calls and the average length of a dialogue is 53.3 utterances. The number of words is 6,412, i.e. the average length of a call is 291 words. As compared with the MSN conversations, the phone calls include 2.8 times less utterances and 3.7 times less words in total. That can be surprising because typing is more time consuming than speaking. Still, our phone calls are negotiations but MSN conversations include more chatting than negotiation. In addition, the number of MSN conversations is almost two times bigger than the number of calls. However, if we only take into account the 17 agreement negotiation MSN conversations then we again see that the phone calls are in average shorter than computer-mediated written conversations. People are more economical when speaking by phone as compared with MSN communication.

Examples (1) and (3) are the typical phone calls where agreement negotiation takes place.

(3)
A: =kule kas sa 'välja ei 'viitsi tulla=vä. **QUF: Yes/no question**
Do you come out with me?
(0.3)
...
B: jah **QUS: Yes**
Yes.
aga (0.5) prä- (.) noh mul läb natuke

´aega onju. **AI: Justification**
But I need some time before.
 ...
 A: ´millal me=s ´lähme. **QUF: Wh-question**
When do we go?
 (0.2)
 B: noh ´lähme nimodi:: (.) panen
 ´riidesse. **QUS: Giving information**
I need to dress myself.
 ...
 A: no poole viiest ´lähme. **DIF: Proposal**
Let's go half past four.
 B: jah. **DIS: Accept**
yes.

The general structure of a phone call where an action is negotiated is represented in Fig. 2 (cf. Koit, 2015).

```
{
A: DIF: Proposal/ QUF: Wh-question/ Yes/no
question
(PS: Giving information/ AI: Justification
--<argument>)
{
  B: DIF: Request/ QUF: Wh-question
  (PS: Giving information/ AI: Justification
--<argument>)
  A: DIS: Giving information
  (PS: Giving information / AI: Justification
--<argument>)
}
-- Decision
B: DIS: Accept/ Deferral/ Reject/ QUS: Giving
information/ Yes/ No
}
```

Figure 2: The structure of everyday negotiation (a phone call: *A* makes a proposal to *B* to do an action). The winding brackets '{' and '}' connect a part that can be repeated; round brackets connect a part that can be missed; '/' separates alternatives; '- -' starts a comment.

As we see, the structures in Fig. 1 and Fig. 2 are quite similar with the difference that more than one proposal can be made by the initiator *A* of dialogue in the case of a phone call (in our corpus).

2.3.2 Face-to-Face Conversations

The total number of utterances is 2,362 in the analysed 22 face-to-face conversations and the average length of a dialogue is 107.4 utterances. The number of words is 20,653. Therefore, the face-to-face conversations are approximately two times longer than phone calls in total and more or less as long as MSN conversations (but the number of the

analysed MSN conversations is almost two times bigger than the number of face-to-face dialogues). That is not surprising because there are no limits caused by a medium in face-to-face conversations (neither phone nor computer). Therefore, we can expect that the typical structure of a face-to-face conversation is more complicated as compared with phone calls and MSN conversations.

In Example 4, the companions *A* and *B* are planning to buy an apartment. A problem is that its cellar needs reconstruction.

(4)
 A: mis=selle ´korteriga teeme. **QUF: Wh-question**
What do we do with the apartment?
 (6.9)
 B: mt=.h mulle jättis see ´vāga=hea
 ´mulje. **QUS: Other | OPF: Opinion**
I like it very much.
 (3.3)
 hhh=see:: (0.3) g=-eeee ´korteri
 ´omanik oli see ´naine, (0.8) mt (0.5)
 kes=seal:= eeeeeeee (0.5) ´ootas=see
 oli: üsna süm´paatne ´inimene [{}-]]
OPF: Opinion
The owner is a sympathetic woman.
 A: [noja=aga=ta=i tead]nud sest
 ´korterist mitte ´midagi=ju. **OPS: Other**
| OPF: Assertion
Yes, but she seemed to know nothing
about the apartment.
 (2.0)
 ...
 B: a=´uvitav kas nendes ´teistes
 majades mida: ´pakk- (0.2) noh milles
 seal ´kortereid saada ´on kas ´seal on
 ka ´nii madalad ´keldrid vä. **QUF:**
Yes/no question
Btw, do the other apartments we visited
similarly have that low cellars?
 ...
 A: ma=i ´tea. **QUS: Other**
I don't know.
 ...
 selles=mõttes=et meil=poleks ´vahet
 et=et=e=.hh (0.9) hh ostad ´korteri
 ´ära ja tellid ´uurimise tuleb
 nagu=´ei: või .hhh (0.2) või: t- ostad
 ´korteri ´ära=ja hakkad ´ise
 tegema=ja=tuleb=´ei: et=et,=h (4.1)
 ma=i ´taha ´uskuda=et seal ´korteri=all
 kus need ´gaasijuhtmed jooksevad. **OPF:**
Opinion
No difference for us: we buy the
apartment and then request an
exploration or we do the reconstruction
ourselves. I don't believe that the gas
trace is going under the apartment.
 B: ei ´seda küll. **OPS: Accept**
No, indeed.

It is significant that most of the face-to-face conversations include opinions (the adjacency pair acts OPF: Opinion/ Assertion and OPS: Accept/ Reject). Thus, the arguments are often represented by AP acts and not by non-AP acts like in the other types of the analysed dialogues. The typical structure of a face-to-face dialogue where an action is negotiated is given in Fig. 3.

```

A: DIF: PROPOSAL/ QUF: Wh-question/ Yes/no
question
  (PS: Giving information/ AI: Justification
  --<argument>)
  {
    B: (PS: Giving information/ AI: Justification
    --<argument>)
    DIF: Request/ QUF: Wh-question
    A: DIS: Giving information
    (PS: Giving information/ AI: Justification
    --<argument>)
    }
    B: OPF: Opinion/ Assertion --<argument>
    A: OPS: Accept/ Reject | OPF: Assertion
    --<argument>
    {
      B: OPS: Accept/ Reject | OPF: Opinion/
      Assertion --<argument>
      A: OPS: Accept/ Reject | OPF: Opinion/
      Assertion --<argument>
    }
    -- Decision
    B: DIS: Accept/ Deferral/ Reject
    
```

Figure 3: The structure of everyday face-to-face negotiation (*A* makes a proposal to *B* to do an action). The winding brackets '{' and '}' connect a part that can be repeated; round brackets connect a part that can be missed; '/' separates alternatives; '|' separates the DA tags of a multifunctional utterance; '--' starts a comment.

The initiator *A* when attempting to convince *B* to perform an action presents his arguments by using non-AP acts (PS: Giving information, AI: Justification/ Specification/ Explanation) and does not expect the reaction of the partner. If the partner *B* is antagonistic then she takes over the initiative and presents her arguments as the first pair parts of the opinion AP (OPF: Opinion/ Assertion) expecting *A*'s reaction. Such a reaction is different as compared with phone calls where the participants mostly are collaborative.

3 DISCUSSION

The corpus analysis demonstrates that the structure

of everyday face-to-face conversations is more complicated than in the case of phone calls and MSN conversations. The reason is that the participants have more freedom when communicating face-to-face. On the other hand, both typing (MSN conversations) and calling (phone calls) set some limits to the participants as caused by the communication mode.

As said before, our typology of DAs is based on Conversation Analysis. The corpus analysis has demonstrated that single acts (PS: Giving information, AI: Justification, etc.) are preferred for representing arguments both in MSN and phone conversations. Still, the participants have a common communicative goal in most of the conversations. On the other hand, when communicating face-to-face, the participants often have different communicative goals. They express their opinions which expect reaction of the other side, i.e. they use AP acts OPF: Opinion/ Assertion and OPS: Accept/ Reject, etc.). For example, there are 723 OPF acts in total in the analysed face-to-face conversations but only 82 OPF acts in the everyday phone calls. If the participants are collaborative and one of them expresses an opinion then both they usually accept arguments of each other (using DA 'accept'). If they are confrontational then at least one of them rejects the arguments of the partner (using DA 'reject') and presents his or her own counterarguments.

Taking into account the results of the analysis, we can represent the general structure of argumentation-based negotiation where performing an action is discussed as a sequence of (generalized) DAs in Fig.4.

An experimental dialogue system has been created which carries out (written) debates with a user about performing an action and presents counterarguments to the arguments given by the user (Koit, 2015). Both the computer and the user can choose their arguments from given sets of utterances in natural language. The structure of debate implemented in our DS is presented in Fig. 5.

```

A: proposal
  {
    B: question
    A: giving-information
    }
  {
    B: assertion/ justification/ giving-information
    -- argument
    A: accept/ justification/ giving-information/
    reject
    (assertion)
    -- argument
    
```

```

    }
  B: accept/ deferral/ reject

```

Figure 4: The structure of negotiation (A makes a proposal to B to do an action). The winding brackets ‘{’ and ‘}’ connect a part that can be repeated; round brackets connect a part that can be missed; ‘/’ separates alternatives; ‘- -’ starts a comment.

The study demonstrates that the actual human-human negotiations have more complicated structure than in our implementation. Therefore, our DS has to be developed.

```

A: proposal
  assertion - - argument
  {
    B: reject | assertion - - argument
    A: reject | assertion - - argument
    assertion - - argument
  }
B: accept/ reject

```

Figure 5: The structure of debate implemented in our DS (A makes a proposal to B to do an action). The winding brackets ‘{’ and ‘}’ connect a part that can be repeated; ‘|’ separates the different functions of a multifunctional utterance; ‘- -’ starts a comment.

4 CONCLUSION AND FUTURE WORK

We analyse two kinds of human-human negotiation dialogues with the aim to find out the general structure of agreement negotiation. We use dialogue acts in order to represent the structure. This structure can be taken as a basis of the dialogue manager when developing DS which interacts with the user in a natural language following rules of human-human communication. We believe that such a DS can help to train the user’s argumentation skills.

We have implemented on the computer a simple argumentation-based debate where A ’s communicative goal is “ B will do an action D ” but B ’s goal is “do not do D ”. Our further aim is to develop our DS by implementing the results of the study.

ACKNOWLEDGEMENTS

This work was supported by the Estonian Ministry of Education and Research (IUT20-56), and by the European Union through the European Regional

Development Fund (Centre of Excellence in Estonian Studies).

REFERENCES

- Amgoud, L., Besnard, P., Hunter, A., 2015. Logical Representation and Analysis for RC-Arguments. In *Proc. of ICTAI*, 8 p. <https://www.irit.fr/~Leila.Amgoud/ictai2015-1.pdf>
- Amgoud, L., Cayrol, C., 2002. A Reasoning Model Based on the Production of Acceptable Arguments. In *Ann. Math. Artif. Intell.* 34(1-3), 197-215.
- Besnard, P., Hunter, A., 2008. *Elements of Argumentation*, MIT Press, Cambridge, MA.
- Chesñevar, C., Maguitman, A., Loui, R., 2000. Logical models of argument. In *ACM Computing Surveys*, vol. 32(4), 337–383.
- Cummins, T., 2011. *Negotiation: Discussion or Debate?* <https://commitmentmatters.com/2011/11/29/negotiation-discussion-or-debate/>
- Hadjinikolis, C., Modgil, S., Black, E., McBurney, P., Luck, M., 2012. Investigating Strategic Considerations in Persuasion Dialogue Games. In *STAIRS*, 137–148.
- Koit, M., 2015. Analysing Human-Human Negotiations with the Aim to Develop a Dialogue System. In *Proc. of 17th International Conference SPECOM 2015, LNAI, 9319*, pp. 73–80, Springer-Verlag.
- Koit, M., Öim, H., 2014. A Computational Model of Argumentation in Agreement Negotiation Processes. In *Argument & Computation*, 5 (2-3), pp. 209–236, Taylor & Francis Online. DOI: 10.1080/19462166-2014.915233
- Rahwan, I., Ramchurn, S.D., Jennings, N.R., Mcburney, P., Parsons, S., Sonenberg, L., 2004. Argumentation-based negotiation. In *The Knowledge Engineering Review*, vol. 18(4), 343–375, Cambridge University Press, DOI: 10.1017/S0269888904000098
- Sidnell, J., 2010. *Conversation Analysis: An Introduction*, London: Wiley-Blackwell.