

Changing of Participants' Attitudes in Argument-based Negotiation

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Abstract: We are modelling argument-based negotiation where the initiator is convincing the partner to do an action. The initiator is using a partner model which evaluates the hypothetical attitudes of the partner related to the action under consideration. The partner when reasoning operates with an actual model – the actual attitudes which still are hidden from the initiator. Both models are changing during negotiation as influenced by the presented arguments. The choice of an argument by a negotiation participant depends, on one hand, on the attitudes related to the action, and on the other hand, on the result of reasoning based on these attitudes. The paper studies how the participants are changing their attitudes during a dialogue. A human-human dialogue illustrates the results of the analysis of a small dialogue corpus. A limited version of the model is implemented on the computer.

1 INTRODUCTION

Negotiation is a form of interaction in which a group of agents, with a desire to cooperate but with potentially conflicting interests try to come to a mutually acceptable division of a scarce resource or resources (Rahwan et al., 2003). Negotiation dialogues are aimed at reaching an agreement between participants when there is a perceived divergence of interest. However, the participants are also cooperative, at least to the extent that they are willing to enter into joint interaction to agree on a division of the resource at issue (DeVault et al., 2015).

Argumentation-based negotiation is the process of decision-making through the exchange of arguments (Lewis et al., 2017).

According to Scherer's typology, attitudes are relatively enduring, affectively coloured beliefs, preferences, and predispositions towards objects or persons (Scherer, 2000). Attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour. Attitudes refer to people's evaluations of entities in their world. Attitudes often serve a key mediational role in behaviour change i.e., attitude change can mediate the impact of some influence treatment on behavioural compliance (Petty and Briñol, 2015).

Our aim is to develop a dialogue system (DS) which interacts with the user in a natural language following norms and rules of human communication. For that reason, we study human-human spoken dialogues. We have worked out a formal model of negotiation dialogue (Koit and Oim, 2014; Koit, 2018a) which includes a reasoning model and communicative strategies applied by the participants in order to achieve their communicative goals. Two kinds of attitudes of communication participants have been introduced in the model – respectively, related to a communication partner and related to a negotiation object, in our case, an action (Koit, 2018b).

Communicative space has been determined in order to model the attitudes related to communication partners. In the current paper, we will concentrate on reasoning of communication participants and accordingly, on their attitudes related to a negotiation object. We analyse human-human argumentation dialogues where the initiator is convincing her partner to make a decision to do an action, i.e. the negotiation object is an action. We study how the participants can influence each other when negotiating and how they change their attitudes related to the action under consideration using arguments. The only possibility is to analyse the wording of the people not the insight.

The remainder of the paper is structured as follows. Section 2 introduces our dialogue model which includes a reasoning model about doing an action. Attitudes of a communication participant in relation to the action will be represented as coordinates of the vector of motivational sphere of the reasoning subject. The attitudes are changing in dialogue as influenced by the arguments of communication participants. So far, we have applied the reasoning model on simple artificial dialogues. In this paper, we are aiming to evaluate the model on actual human-human dialogues. For that, we analyse a dialogue corpus which will be introduced in Section 3. Section 4 presents a case study – a dialogue example from the corpus which demonstrates how the reasoning model describes changing of the attitudes related to the negotiation object. Section 5 discusses the reasoning model and introduces the implemented DS. Section 6 draws conclusions.

2 DIALOGUE MODEL

We are modelling negotiations between two participants A and B in a natural language. One of them (let it be A) initiates the dialogue by requesting her partner B to agree to do an action D . If B refuses then A in negotiation tries to influence him by presenting various arguments for doing D . The arguments are based on the partner model – the image A has about B 's attitudes related to different aspects of the action D . The partner B , in his turn, may present counterarguments based on his actual attitudes. The counterarguments show which beliefs of A about B 's attitudes were wrong and therefore, how A has to change her partner model. The dialogue finishes with B 's decision: to do D or not. Depending on the decision, A either has achieved or not her initial communicative goal.

2.1 Reasoning Model

After A has made a proposal or request to the partner B to do the action D , B can respond with agreement or rejection, depending on the result of his reasoning. Rejection can be (but not necessarily) supported with an argument against doing D . These arguments can be used by A as giving information about the reasoning process that brought B to his decision. Therefore, a reasoning model should be included into the dialogue model.

There are various formal approaches to reasoning, e.g. the Elaboration Likelihood Model

(Cacioppo et al., 1986; Petty et al., 2018), Social Judgment Theory, Social Impact Theory, etc. Nevertheless, we use a naïve, 'folk' theory in our reasoning model (D'Andrade, 1987; Davies and Stone, 1995; Öim, 1996). Our model is based on the studies in the common-sense conception of how the human mind works in such situations. The general principles of the model are analogous to the BDI (Belief-Desire-Intention) model (Grosz and Sidner, 1986; Allen 1995; Boella and van der Torre, 2003) but it has some specific traits (cf. Koit and Öim, 2014).

First, along with desires we also consider other kinds of motivational inputs for creating the intention to do an action in a reasoning subject (e.g. whether the subject considers the action pleasant or useful to him/her or s/he is forced to do it independent on his/her immediate wish).

Secondly, we suppose that people start, as a rule, from this conception, not from any consciously chosen scientific one. We want to model a naïve 'theory' that people themselves use when they are interacting with other people and trying to change their attitudes, to predict and influence their decisions.

Our reasoning model consists of two parts including a model of human motivational sphere, and reasoning procedures.

(1) We represent *the model of motivational sphere* of a reasoning subject by the following vector of attitudes related to the reasoning object – the action D :

$$w_D = (w(resources_D), w(pleasant_D), w(unpleasant_D), w(useful_D), w(harmful_D), w(obligatory_D), w(punishment-not_D), w(prohibited_D), w(punishment-do_D)).$$

We suppose in our model that the attitudes have numerical values (weights). Here $w(pleasant_D)$, etc. mean the weight of pleasant, etc. aspects of D ; $w(punishment-not_D)$ – the weight of the punishment for not doing D if it is obligatory; $w(punishment-do_D)$ – the weight of the punishment for doing D if it is prohibited. Further, $w(resources_D) = 1$ if the subject has all the resources necessary to do D (otherwise 0); $w(obligatory_D)/w(prohibited_D) = 1$ if D is obligatory/prohibited for the reasoning subject (otherwise 0). The values of other weights can be non-negative natural numbers on the scale from 0 to 10.

Some comments are necessary here. Definitely, people do not operate with numerical weights in their reasoning. Instead, they rather use words of a natural language to characterize the attitudes. For

example, the pleasantness of an action can be evaluated by such words and expressions as *excellent*, *very pleasant*, etc. Still, the words can approximately be represented on a numerical scale. Instead, fuzzy logic can be used. Further, the aspects of actions considered here are not fully independent. For example, harmful consequences of an action as a rule are unpleasant for a subject (but unpleasant will not always be harmful). However, we do not assume the independence of the aspects in the reasoning process.

(2) The second part of the reasoning model consists of *reasoning procedures* that regulate, as we suppose, human action-oriented reasoning.

According to our model, the reasoning process can be triggered by three main types of determinants – wish-, needed- and must-determinant (Öim, 1996). The process itself consists of a sequence of steps where such aspects participate as resources of the reasoning subject for doing D , positive aspects of D or its consequences (pleasantness, usefulness, and also punishment for not doing D if it is obligatory), and negative aspects (unpleasantness, harmfulness, and punishment for doing D if it is prohibited).

There are three reasoning procedures in our model (WISH, NEEDED, and MUST) which depend on the determinant that triggers the reasoning. Each procedure represents the steps that a subject goes through in the reasoning process when comparing and summarizing weights of different aspects of D , and the result is the decision: to do D or not.

The reasoning procedures include some principles which represent the interactions between the determinants, e.g.

- people want pleasant states and do not want the unpleasant ones
- if the sum of the values of the internal (wish- and needed-) determinants and the value of the external (must-) determinant appear equal in a situation then the decision suggested by the internal determinants is preferred.

As an example, let us present the reasoning procedure WISH as a step-form algorithm in Fig. 1 triggered by the *wish* of the reasoning subject to do D , that is, D is not less pleasant than unpleasant for the subject, cf. (Koit, 2016). Here we do not indicate the action D which remains the same during the reasoning.

If D is not less useful than harmful then the reasoning procedure NEEDED can be triggered by the reasoning subject. Finally, if D is obligatory then the subject can trigger the reasoning procedure MUST, cf. (Koit and Öim, 2014). When reasoning, a

subject applies the procedures in a certain order as motivated by the internal or external determinants. First of all, s/he tries to apply the procedure WISH. If it is impossible (the presumption is not fulfilled) or it gives the decision “do not do D ” then the subject applies the procedure NEEDED and finally, the procedure MUST, until the decision (do D or not) is achieved (Koit and Öim, 2014).

Presumption: $w(\textit{pleasant}) \geq w(\textit{unpleasant})$.

- 1) Is $w(\textit{resources}) = 1$? If not then go to 11.
- 2) Is $w(\textit{pleasant}) > w(\textit{unpleasant}) + w(\textit{harmful})$? If not then go to 6.
- 3) Is $w(\textit{prohibited}) = 1$? If not then go to 10.
- 4) Is $w(\textit{pleasant}) > w(\textit{unpleasant}) + w(\textit{harmful}) + w(\textit{punishment-do})$? If yes then go to 10.
- 5) Is $w(\textit{pleasant}) + w(\textit{useful}) > w(\textit{unpleasant}) + w(\textit{harmful}) + w(\textit{punishment-do})$? If yes then go to 10 else go to 11.
- 6) Is $w(\textit{pleasant}) + w(\textit{useful}) \leq w(\textit{unpleasant}) + w(\textit{harmful})$? If not then go to 9.
- 7) Is $w(\textit{obligatory}) = 1$? If not then go to 11.
- 8) Is $w(\textit{pleasant}) + w(\textit{useful}) + w(\textit{punishment-not}) > w(\textit{unpleasant}) + w(\textit{harmful})$? If yes then go to 10 else go to 11.
- 9) Is $w(\textit{prohibited}) = 1$? If yes then go to 5.
- 10) Decide: do D . End.
- 11) Decide: do not do D .

Figure 1: The reasoning procedure WISH.

We use two vectors of attitudes – w^B_D and w^{AB}_D – in our dialogue model. Here w^B_D is the model of motivational sphere of B who has to make a decision about doing D ; the vector includes B 's (actual) evaluations of D 's aspects and it is used by B when he is reasoning about doing D . The other vector w^{AB}_D is the partner model which includes A 's beliefs concerning B 's attitudes (the hypothetical evaluations) and it is used by A when she is planning her next turn in dialogue. Both models w^{AB}_D and w^B_D are changing as influenced by the arguments presented by the participants in negotiation.

2.2 Communicative Strategies and Tactics

A communicative strategy is an algorithm used by a participant for achieving his/her communicative goal (Koit and Öim, 2014; Koit, 2018a). The initiator A when having a communicative goal to convince B to make a decision to do D can realize her communicative strategy in different ways, e.g. she can *entice*, *persuade* or *threaten* the partner B to do

D. Respectively, she stresses the pleasantness or usefulness of doing *D* or punishment for not doing *D* if it is obligatory. We call these ways of realization of a communicative strategy *communicative tactics*. *B* similarly applies his communicative strategy through related communicative tactics. Some algorithms are presented in (Koit, 2018a).

The initiator *A* chooses a suitable communicative strategy and the communicative tactics in order to direct *B*'s reasoning to the desirable decision. When trying to influence *B* to make the pursued decision (do the action *D*) and to change his initial attitudes (the model w^B_D), *A* uses a partner model w^{AB}_D . *A* stresses the positive and downgrades the negative aspects of the action. Various arguments for doing/not doing *D* will be presented by the participants in a systematic way. While enticing (respectively, persuading or threatening) the partner *B* for doing *D*, *A* attempts to trigger the reasoning procedure WISH (respectively, NEEDED or MUST) in *B*'s mind (Koit and Öim, 2014).

3 EMPIRICAL MATERIAL

The current study is based on the Estonian dialogue corpus (Hennoste et al., 2008). The main part of the corpus is formed by transcripts of human-human dialogues recorded in authentic situations. Among them are phone calls (travel negotiations, telemarketing calls, directory inquiries, etc.) as well as face-to-face conversations, in total 1056 transliterated texts (206,485 tokens).

For this study, a small sub-corpus consisting of five everyday phone calls between acquaintances has been chosen from the corpus. In the dialogues, participants are negotiating about doing an action by one of them. We will consider how the participants are reasoning in order to make their decisions about the action and how they are influencing the partner to change his/her attitudes related to the action. However, direct access to their minds is impossible. Instead, we can make conclusions only by analysing their utterances – a dialogue (text).

In order to describe the reasoning processes of the participants, we use the models w^{AB}_D and w^B_D , and the reasoning procedures introduced in the previous section. We are wondering how well the models describe authentic human-human dialogues and whether they can be used when developing a DS which interacts with the user 'like a human'.

The initiator *A*, starting a dialogue, generates a partner model w^{AB}_D (using her preliminary knowledge) and determines the communicative

tactics T^A which she will use (e.g. *enticement*), i.e. she accordingly fixes a reasoning procedure R^A which she aims to trigger in *B*'s mind (e.g. WISH). *A* applies the reasoning procedure in her partner model, in order to 'put herself' into *B*'s role and to choose suitable arguments when convincing *B* to make a decision to do *D*.

B has his own model – the vector w^B_D (the exact values of which coordinates *A* does not know similarly like w^{AB}_D is not directly accessible for *B*). He in his turn determines a reasoning procedure R^B which he will use in order to make a decision about doing *D* (the procedure can be different from R^A fixed by *A*) and his communicative tactics T^B .

4 CHANGING THE ATTITUDES: A CASE STUDY

Let us consider an example from our analysed sub-corpus in order to demonstrate how both models of motivational sphere are used in a reasoning process and how the attitudes of participants captured in the models are changing.

The following dialogue is a transcript of a phone call of mother (participant *A*) to her son (participant *B*). *A* makes a proposal to *B* to bake gingersnaps (the action *D*) and presents a lot of arguments during the dialogue in order to produce/increase *B*'s wish to do the action, until *B* finally agrees. Transcription of Conversation Analysis is used in the example (Sidnell and Stivers, 2012). In the following, we do not indicate the action *D* in the vectors w^{AB} and w^B because it remains the same.

Let us suppose that mother *A* (knowing her son *B*) has created the following partner model: $w^{AB} = (1,6,2,1,1,1,0,0,0)$, i.e. *A* believes that *B* will have all the resources to bake gingersnaps (the value of the first coordinate equals to 1), further, the action is much more pleasant (6) than unpleasant (2) for *B*, it is useful for *B* because gingersnaps will be prepared, and similarly harm because it needs time (both values 1), obligatory (1) for *B* because son is obliged to fulfil mother's request, but no punishment (0) will follow if *B* will not agree; the action is not prohibited (0) and therefore no punishment (0) will follow when doing it. The coordinates of the vector w^{AB} should be empirically confirmed, based on *A*'s preliminary knowledge about *B*. (Still, an external observer can hardly ever determine these values exactly, only analysing the dialogue. Similarly, as already said above, people do not operate with exact numerical values when reasoning.)

We further suppose that mother *A* will *entice* her son *B*, assuming that *B* wants to do *D*. This assumption is confirmed by the following dialogue analysis – all the arguments presented by *A* increase the pleasantness of the action. (Still, we carry out an informal analysis here; the automatic analysis of utterances with the aim to determine the certain aspects of the action that they influence, remains for the further work.) The reasoning procedure WISH applied by *A* in the initial partner model gives the decision „do *D*“ (cf. Fig.1, steps 1, 2, 3, 10). Therefore, *A* makes a proposal, optimistically looking for *B*'s agreement:

/---/
A: küsimus.
 A question.
 (0.6) .hhhhh kas sulle pakuks ´pinget ´piparkookide küpsetamine.
 Do you like to bake gingersnaps?
 (1.7)
B: ´praegu.
 Just now?
 (0.6)
A: jah.
 Yes.
 (0.6)

Let us further suppose that for *B*, the initial model $w^B = (1,1,5,2,1,1,1,0,0)$, i.e. the resources exist (value 1), the action is much more unpleasant (5) than pleasant (1) but nonetheless, more useful (2) than harm (1) for him. Therefore, *B*'s initial attitudes are quite different as compared with *A*'s guesses. (Again, here we evaluate the coordinates/attitudes only approximately, by an informal analysis of the dialogue.) Thus, *B* does not want to do *D* because its pleasantness is smaller than the unpleasantness (on the contrary to *A*'s supposition). Based on w^B , *B* cannot trigger the reasoning procedure WISH in his mind because the assumption of the procedure is not fulfilled (cf. Fig. 1). However, he can trigger the procedure NEEDED (because *D* is more useful than harmful for him) which still gives the decision „do not do *D*“ as demonstrated by *B*'s next utterance:

B: .hhhhhhh ma=i=´tea vist ´mitte.
 I don't know, perhaps not.

As follows from *B*'s refusal, *A* has to update the partner model. The updated model will be $w^{AB} = (1,6,2,2,1,1,1,0,0,0)$ because it should give the decision „do not do *D*“ by applying the reasoning procedure WISH (valid for *A*) like *B* got (cf. Fig. 1, steps 1, 2, 6, 7, 8, 11). Here *A* supposes that *B* applies this same reasoning procedure (which actually is not the case) and she does not change her communicative tactics (enticement).

Now *A* presents an argument for increasing the pleasantness:

A: ja=sis gla´suurimine=ja=´nii.
 And then glazing and so on.
 (0.6)

At the same time, she increases the value of the pleasantness in her partner model. We suppose (in our implementation) that every argument increases (respectively, decreases) the targeted value by one unit (by 1). Thus, we consider all the arguments to be equal, having the value/weight 1 (which still is a simplification although in the reality, the arguments could have different weights). New partner model will be $w^{AB} = (1,2,3,2,1,1,1,0,0,0)$. The reasoning procedure WISH gives the decision „do *D*“ in this model therefore *A* is again looking for *B*'s agreement.

As influenced by *A*'s argument, *B* in his turn increases the value of the pleasantness (by 1) in his model: $w^B = (1,1+1=2,5,2,1,1,1,0,0)$. *B* continuously applies the reasoning procedure NEEDED which again gives the decision „do not do *D*“:

B: ´ei, ´ei, ´ei ei=´ei.
 No, no, no, no, no.
 (0.9)

Based on *B*'s rejection, *A* has to update the partner model: $w^{AB} = (1,3,2,2,1,1,1,0,0,0)$. Now the reasoning procedure WISH applied by *A* gives the decision „do not do *D*“ like *B* got. When enticing, *A* once more increases the pleasantness presenting the following argument:

A: me saaksime nad ´vanaema=jurde ´kaasa võtta.
 We can take them with us when going to visit grandmother.
 (0.4)

New partner model is $w^{AB} = (1,2,3,2,1,1,1,0,0,0)$, the reasoning procedure WISH gives the decision „do *D*“.

Influenced by the presented argument, *B* changes his attitude about the pleasantness, after that $w^B = (1,2+1=3,5,2,1,1,1,0,0)$. The reasoning procedure NEEDED, continuously applied by *B*, gives the decision „do not do *D*“:

B: ´präagu ei=´taha.
 I don't want.
 (1.3)

A once more has to decrease the pleasantness in her partner model, getting $w^{AB} = (1,3,2,2,1,1,1,0,0,0)$ where the procedure WISH gives the result „do not do *D*“.

B: aga (.) noh, kas sa mõtled nagu .hhh kui sa tuled koju=vä.

But what do you think - after you come home?

A: .hhh ei

No.

ma mõtlen: kui mind kodus ei=ole.

I think, when I'm not home.

The argument presented by *A* (I'm not home) implies $w^{AB} = (1, -2, 3, 2, 1, 1, 1, 0, 0, 0)$ and the decision will be „do *D*“. This argument increases the pleasantness of *D* also for *B* (he obviously likes to act alone, while his mother is not home). After the update, $w^B = (1, 3+1=4, 5, 2, 1, 1, 1, 0, 0)$, and the procedure NEEDED finally gives the result „do *D*“ – *B* agrees:

B: aa.

Aha.

(0.5) .hhh et lähen ostan tainast=vä.

Then I'll go to buy paste, yes?

A: ja=niimodi=jah.

Yes, right.

(1.4)

Nevertheless, the pleasantness of *D* is less than the unpleasantness in w^B , therefore *B* does not even now want to do *D*, but he only takes it as needed (more useful than harmful). *A* presents her next argument for the pleasantness:

.hhh sinna: Pereleiva kohvikusse võiksid minna @ võiksid seal endale ühe kohvi lubada=ja @ (2.7) teha ostmise mõnusaks=ja (0.8) ja=siis tulla koju=ja? (1.7) piparkooke teha=ja

And you could go to Pereleiva cafe and take a coffee in order to make buying pleasant for you, and then go home to bake gingersnaps.

(1.2)

The reasoning procedure WISH gives „do *D*“ as before in the updated partner model $w^{AB} = (1, -3, 4, 2, 1, 1, 1, 0, 0, 0)$. *B* similarly updates his model: $w^B = (1, 4+1=5, 5, 2, 1, 1, 1, 0, 0)$. Now the pleasantness equals to the unpleasantness therefore *B* started to want to do *D*. He can yet apply the reasoning procedure WISH. The result will be „do *D*“ (cf. Fig.1, steps 1, 2, 6, 9, 10):

B: okei?

OK.

/---/

(Actually, both procedures NEEDED and WISH give the same positive decision in w^B . *B* prefers to apply the procedure WISH.) However, *A* does not finish the call but she presents an additional (the

last) argument in order to increase *B*'s wish once more:

A: .hhhhhhhhhh (0.2) ja siis ma tahtsin sulle öelda=et külmkapis on: sulatatud või tähendab=ned külmutatud ja ülessulanud maasikad ja vaarika mömm.=hh

And I wanted to tell you that there are frozen strawberries and raspberries in the icebox.

B: jah

Yes.

(0.3)

A: palun paku endale sealt.

Please help yourself.

/---/

After this argument, both models will change:

$w^{AB} = (1, -4, 5, 2, 1, 1, 1, 0, 0, 0)$

$w^B = (1, 5+1=6, 5, 2, 1, 1, 1, 0, 0)$.

In both models, the reasoning procedure WISH gives the final decision „do *D*“.

Only one attitude (the pleasantness) is changing in the models w^{AB} and w^B during negotiation. That is because *A* over and over again presents the arguments for the pleasantness of the action for *B*, i.e. she continuously applies the communicative tactics of enticing by trying to trigger the reasoning procedure WISH in *B*'s mind. The partner *B* in the beginning of the negotiation does not want to do *D* but he takes it only useful. When reasoning, *B* uses the procedure NEEDED. Nevertheless, *A*'s arguments increase the pleasantness of *D* for *B* to such an extent that the wish to do *D* arises in his mind: the pleasantness finally becomes equal to the unpleasantness which makes it possible to trigger the reasoning procedure WISH. The balance of the other weights in w^B contribute to achieve the result of the reasoning „do *D*“. This final result is the same in both models w^{AB} and w^B regardless of their difference in the beginning as well as in the end of the negotiation.

5 DISCUSSION

The corpus analysis demonstrates that our dialogue model can be used when describing actual human-human dialogues. A big challenge when applying it for the dialogue analysis has been creating of initial models w^{AB} and w^B . It is hard to determine, only based on a dialogue text, such models that adequately describe the attitudes and attitude changes of the participants during a dialogue. Another problem is recognition of the communicative strategies and tactics applied by the

participants. This needs the linguistic analysis of utterances in order to understand which aspect of the action (i.e. the negotiation object) is affected by a certain utterance (e.g. the pleasantness, unpleasantness, etc.).

Still, here our primary aim is not the automatic analysis of dialogues in a natural language but rather we want to design and develop a DS which follows norms and regulations of human communication.

When reasoning about doing an action, a subject is weighing and comparing different aspects of the action (the availability of resources, its pleasantness, usefulness, etc.) which are captured in his/her model of motivational sphere as attitudes.

When attempting to direct *B*'s reasoning to the desirable decision ("do *D*" in our case), *A* presents several arguments stressing the positive and downgrading the negative aspects of *D*. The choice of *A*'s argument is based on one hand, on the partner model and on the other hand, on the (counter) argument presented by the partner. Still, *B* is not obliged to present a counterargument but he can simply refuse to do the proposed action if his reasoning gives a negative decision (like in the considered example). When choosing the next argument for *D*, *A* triggers a reasoning procedure in her partner model depending on the chosen communicative tactics, in order to be sure that the reasoning will give a positive decision after presenting this argument. *B* himself can use the same or a different reasoning procedure triggering it in his own model. After the updates made both by *A* and *B* in the two models during a dialogue (*A*'s model of *B* will be updated by *A*, and *B*'s model of himself will be updated by *B*), the models will approach each to another but, in general, do not equalize. Although the results of reasoning in both models can be equal, as demonstrated the example considered in the previous section. Therefore, *A* can convince *B* to do *D* even if not having a complete picture of him.

Our dialogue model considers only a limited kind of dialogues but although, it illustrates the situation where the dialogue participants are able to change their attitudes related to the negotiation object (doing an action) and bring them closer one to another by using arguments. The initiator *A* does not need to know whether the counterarguments presented by the partner *B* have been caused by *B*'s opposite initial goal or are there simply obstacles before their common goal and can be eliminated by *A*'s arguments. *A*'s goal, on the contrary is not hidden from *B*. Secondly, as said in Section 2.2, the different communicative tactics used by *A* are aimed to trigger different reasoning procedures in *B*'s

mind. *A* can fail to trigger the pursued reasoning procedure in *B* but however, she can achieve her communicative goal when having a sufficient number of statements for supporting her initial goal. In the considered example (Section 4), *A* finally succeeded to trigger the desirable reasoning procedure and achieved her communicative goal.

We have implemented the model of negotiation as a simple DS where the computer plays *A*'s and the user *B*'s role. The participants are interacting in written Estonian. The computer uses ready-made sentences for presenting arguments but the user can optionally use another set of ready-made sentences or also put in free texts which include specific keywords or key phrases. Based on the implementation, we can study how attitudes of the participants are changing in argumentation dialogue.

6 CONCLUSIONS

We are considering the dialogues where the participants *A* and *B* negotiate doing an action *D* by *B*. Their initial communicative goals can conform or be opposite. They are presenting arguments for and against doing *D*, in order to achieve their goals. The arguments take into account the counterarguments presented by the partner. In addition, *A*'s arguments are based on her partner model whilst *B*'s arguments are based on his model of himself. Both models include the attitudes related to the availability of the resources, positive and negative aspects of doing *D* which have numerical values in our implementation. Both models are changing during negotiation. We study how the models are updated in a dialogue, and track the changes.

We have worked out a model of argument-based negotiation which includes a reasoning model. When reasoning about doing an action, the subject is weighing, summarizing and comparing different aspects of the action under consideration. If the positive aspects weigh more than negative then the decision will be "do the action" otherwise "do not do it".

We have implemented the model of negotiation as a simple DS. Our future work includes development of the implementation by adding text processing tools to DS in order to achieve more human-like interaction of a user with the system.

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