

Reasoning and Arguments in Negotiation

Developing a formal model

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Abstract—Our aim is to develop a model of negotiation where two participants present arguments for/against of doing an action. The choice of an argument depends, on one hand, on the beliefs about the positive and negative aspects of doing the action and the needed resources, and on the other hand, on the result of reasoning affected by these beliefs. The model is based on the analysis of human-human negotiations (in this paper, we consider telemarketing calls). A limited version of the model is implemented as a dialogue system. The computer attempts to influence the reasoning of the user by its arguments in order to convince the user to make a decision.

Keywords—reasoning; beliefs; negotiation; argument; dialogue system.

I. 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 scarce resources [1]. Negotiation is simultaneously a linguistic and a reasoning problem, in which intent must be formulated and then verbally realized. A variety of agents have been created to negotiate with people within a large spectrum of settings including the number of parties, the number of interactions, and the number of issues to be negotiated [2]. Negotiation dialogues contain both cooperative and adversarial elements, and their modelling require agents to understand, plan, and generate utterances to achieve their goals [3].

Our aim is to develop a model of conversational agent that interacts with a user in Estonian and carries out negotiation. We start with the analysis of human-human negotiations aiming to model the reasoning processes which people go through when pursuing their communicative goals and coming to a decision.

The rest of the paper is organized as follows. Section 2 describes related work. In Section 3, we analyze a kind of human-human negotiation dialogues – telemarketing calls, in order to explain how do people reason and argue when negotiating about doing an action. In Section 4, we introduce our model of conversational agent that takes into account the results of the analysis of human-human negotiations, and an implementation – a simple Dialogue System (DS). Section 5 discusses the model and the DS. In Section 6, we draw conclusions and plan future work.

II. RELATED WORK

A conversational agent, or DS, is a computer system intended to interact with a human using text, speech, graphics, gestures and other modes for communication. It will have both dialogue modelling and dialogue management components [4]. A dialogue manager is a component of a DS that controls the conversation. Four kinds of dialogue management architectures are most common: plan-based, finite-state, frame-based, and information-state [5]. An information state includes beliefs, assumptions, expectations, goals, preferences and other attitudes of a dialogue participant that may influence the participant's interpretation and generation of communicative behavior. The functions of the dialogue manager can be formalized in terms of information state update [6].

Rahwan et al. [7] discuss three approaches to automated negotiation: game-theoretic, heuristic-based and argumentation-based. Argumentation-based approaches to negotiation allow agents to 'argue' about their beliefs and other mental attitudes during the negotiation process. Argumentation-based negotiation is the process of decision-making through the exchange of arguments [3].

In negotiation, an argument can be considered as a piece of information that may allow an agent to: (a) justify its negotiation state; or (b) influence another agent's negotiation state [8]. Amgoud and Cayrol define an argument as a pair (H, h) where: (i) H is a consistent subset of the knowledge base, (ii) H implies h , (iii) H is minimal, so that no subset of H satisfying both (i) and (ii) exists. H is called the support and h the conclusion of the argument [9].

Automated negotiation agents capable of negotiating efficiently with people must rely on a good opponent modelling component to model their counterpart, adapt their behavior to their partner, influencing the partner's opinions and beliefs [10]. NegoChat is the first negotiation agent successfully developed to use a natural chat interface while considering its impact on the agent's negotiation strategy [2]. A virtual human that negotiating with a human helps people learn negotiation skills. For virtual agents, the expression of attitudes in groups is a key element to improve the social believability of the virtual worlds that they populate as well as the user's experience, for example in entertainment or training applications [11][12][13].

An interesting and useful kind of DSs are embodied conversational agents [11][14][15].

III. ANALYSIS OF HUMAN-HUMAN NEGOTIATIONS

Our further aim is to implement a DS which interacts with a user in Estonian and carries out negotiations like a human does. For that, we are studying human-human negotiations using the Estonian dialogue corpus [16]. All the dialogues are recorded in authentic situations and then transliterated by using the transcription of Conversation Analysis [17]. A sub-corpus of telemarketing calls is chosen for the current study. In the dialogues, two official persons are communicating – a sales clerk of an educational company (its changed name is Tiritamm, he is the initiator of a call), and a manager or a personnel officer of another institution (she is here a customer). Tiritamm offers training courses (management, sale, etc.) which can be useful for the employees of the customer's institution. The communicative goal of a sales clerk is to convince the customer to decide to take a course. Several typical phases can be differentiated in telemarketing negotiations [18]. The most important phase is *argumentation*. A sales clerk (A) presents different arguments that take into account the actual needs of the customer (B) explained by him (A) before or during the call. A tries to bring out the factors that are essential for the customer, in order to convince her to make a positive decision (Example 1). If B accepts these factors then A will demonstrate/prove how the proposed course will solve B's problem. In an ideal case, the customer will agree with the proof offered by the clerk and will decide to take the course.

Example 1 (transcription of Conversation Analysis is used in the examples)

A: /---/(1.0) .hh sest loomu`likult et=ee `töökogemuste kaudu: õpib ka: alati aga .hh a `sageli ongi just `see (0.5) mt ee `kursused pakuvad sellise `võimaluse kus saab siis `teiste .hh oma hh `ala `spetsia`listidega samuti `kokku=ja `rääkida nendest `ühistest prob`leemidest ja samas siis ka .hh ee `mõtteid ja `ideid ee hh ee=`Tiritamme poolt sinna `juurde.

because, of course, one can learn from experience but frequently training courses make it possible to meet other specialists in the field and discuss common problems; additional thoughts and ideas come from Tiritamm argument (.)

B: £ `jah?

yes

accept

The behaviour of sales clerks and customers is different when they are arguing for/against a course. A sales clerk when having the initiative provides his arguments for taking the course either asserting something (then a customer typically accepts the assertion, Example 1). A customer, to the contrary, does not accept assertions/arguments of a sales clerk when arguing against taking a course (Example 2).

Example 2

/---/ B: aga jah ei mul on see läbi `vaadatud=ja (.) `kahjuks ma pean ütlema=et (.) et `teie (.) seda meile (.) `ei suuda `õpetada (.) mida (.)`mina: (.) tahan.

but I have looked through your catalogue of courses and unfortunately, I have to say that you can't teach what is needed for us counter argument

/---/

A: .h ja mida kon`kreetselt=ee `teie tahate.

and what do you want

question

(0.8) mida te `silmas `peate.

what do you have in view

question

B: noo (0.2) `meie (.) `äri`tegevus on (.) `ehitamine.

well, our business is house-building

answer

/---/

A: nüüd kas (0.2) näiteks (0.5) `lepingute `saamisel (0.5) mt ee `tegelete te ka: läbi`rääkimistega.

well, do you need to carry out negotiations in order to achieve agreements

question

B: noo ikka.

yes, of course

answer

(0.8)

A: mt et see=on ka üks `valdkond mida me: (0.2) `käsitleme.

but that is one of our fields which we cover

argument

The argumentation continues in a similar way. A attempts to convince B preparing his new arguments by questions. Either A constructs his arguments during the conversation or he chooses suitable arguments from an existing set of possible arguments collected by previous experience with customers.

When modelling negotiation, a good way seems to follow the sales clerks' strategy: try to take and hold the initiative and propose 'hard' arguments for the strived action, i.e., the statements that do not provoke the partner's rejection but accept. In order to have such arguments at disposal, it is necessary to know as possible more about the partner in relation to the goal action.

IV. MODELLING CONVERSATIONAL AGENT

Results of the analysis of human-human negotiations motivated our model of conversational agent. Let us consider negotiation between two participants A and B where A is the initiator. Let his communicative goal be to bring B to the decision to do an action D. When convincing B, he is using a partner model (a picture of the communication partner) that gives him grounds to believe that B will agree to do the action. A starts the dialogue by proposing B to do D. If B, as the result of her reasoning, refuses, then A must influence her in the following negotiation, continuously correcting the partner model and trying to guess in which reasoning step B reached her negative decision. In this way, a dialogue – a sequence of utterances will be generated together by A and B.

A. Information States in Negotiation Process

Let A and B be conversational agents. Let us assume the following [18]:

1) a set G of communicative goals where both participants choose their own initial goals (G^A and G^B , respectively). In our case, $G^A = \text{"B decides to do D"}$

2) a set S of communicative strategies of the participants. A communicative strategy is an algorithm used by a participant for achieving his/her communicative

goal. This algorithm determines the activity of the participant at each communicative step

3) a set T of communicative tactics, i.e., methods of influencing the partner when applying a communicative strategy. For example, A can entice, persuade, or threaten B in order to achieve the goal G^A , i.e., A attempts to demonstrate that achieving this goal is, accordingly, pleasant, useful or obligatory for B

4) a set R of reasoning models, which are used by participants when reasoning (here: about doing an action D). A reasoning model is an algorithm, which returns the positive or negative decision about the reasoning object (the action D)

5) a set P of participant models, i.e., a participant's depiction of the beliefs of himself/herself and his/her partner in relation to the reasoning object: $P = \{P^A(A), P^A(B), P^B(A), P^B(B)\}$

6) a set of world knowledge

7) a set of linguistic knowledge.

A conversational agent passes several *information states* during interaction starting from initial state and going to every next state by applying *update rules*. Information states represent cumulative additions from previous actions in the dialogue, motivating future actions. There are two parts of an information state of a conversational agent [7] – private (information accessible only for the agent) and shared (accessible for both participants).

Two categories of *update rules* will be used by a conversational agent for moving from current information state into the next one: (1) for interpreting the partner's turns and (2) for generating its own turns.

B. Reasoning Model

The initial version of our reasoning model is introduced in [19]. In general, it follows the ideas realized in the BDI (Belief-Desire-Intention) model [20]. The reasoning process of a subject about doing an action D consists of steps where the resources, positive and negative aspects of D will be weighed. A communication partner can only implicitly take part in this process by presenting arguments to stress the positive and downgrade the negative aspects of D .

Our reasoning model includes two parts: (1) a model of (human) motivational sphere that represents the beliefs of a reasoning subject in relation to the aspects of the action under consideration, and (2) reasoning procedures.

1) Model of Motivational Sphere

We represent the model of *motivational sphere* of a communication participant as a vector with (here: numerical) coordinates that express the beliefs of the participant in relation to different aspects of the action D :

$w_D = (w(\text{resources}_D), w(\text{pleasant}_D), w(\text{unpleasant}_D), w(\text{useful}_D), w(\text{harmful}_D), w(\text{obligatory}_D), w(\text{prohibited}_D), w(\text{punishment-do}_D), w(\text{punishment-not}_D))$.

The value of $w(\text{resources}_D)$ is 1 if the reasoning subject has all the resources needed for doing D , and 0 if some of them are missing. The value of $w(\text{obligatory}_D)$ or $w(\text{prohibited}_D)$ is 1 if the action is obligatory or,

respectively, prohibited for the subject (otherwise 0). The values of the other coordinates can be numbers on the scale from 0 to 10 – $w(\text{pleasant}_D)$, $w(\text{unpleasant}_D)$, etc., indicate the values of the pleasantness, unpleasantness, etc. of D or its consequences; $w(\text{punishment-do}_D)$ is the punishment for doing a prohibited action and $w(\text{punishment-not}_D)$ – the punishment for not doing an obligatory action.

2) Reasoning Procedures

The reasoning itself depends on the *determinant*, which triggers it. With respect to the used theory, there are three kinds of determinants that can cause humans to reason about an action D : wish, need and obligation [21]. Therefore, three different prototypical *reasoning procedures* can be described – WISH, NEEDED, and MUST. Every procedure consists of steps passed by a reasoning subject and it finishes with a decision: do D or not. When reasoning, the subject considers his/her resources as well as different positive and negative aspects of doing D . If the positive aspects (pleasantness, usefulness, etc.) weigh more than negative (unpleasantness, harmfulness, etc.) then the decision will be “do D ” otherwise “do not do D ”. The reasoning subject checks primarily his/her wish, thereafter need and then obligation and he/she triggers the corresponding reasoning procedures. If no one procedure returns the decision “do D ” then the reasoning ends with the decision “do not do D ”.

In Figure 1, we present the reasoning procedure NEEDED, which is triggered by the need of the reasoning subject to do the action D (i.e., doing the action is more useful than harmful for the subject) The procedure is presented as a step-form algorithm. We do not more indicate the action D .

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

Figure 1. Reasoning procedure NEEDED.

We use two vectors w^B and w^{AB} , which capture the beliefs of communication participants in relation to the action D under consideration. Here w^B is the model of motivational sphere of B who has to make a decision about doing D ; the vector includes B 's (actual) evaluations (beliefs) of D 's aspects. These values are used by B when reasoning about doing D . The other vector w^{AB} is the partner model that includes A 's beliefs concerning B 's beliefs in relation to the action. It is used by A when planning next turns in dialogue. We suppose that A has some preliminary knowledge about B in order to compose

the initial partner model before making the initial proposal.

Both the models will change as influenced by the arguments presented by both the participants in negotiation. For example, every argument presented by *A* targeting the usefulness of *D* will increase the corresponding values of $w^B(\text{useful})$ as well as $w^{AB}(\text{useful})$.

C. Implementation

A simple dialogue system is developed that carries out negotiations with a user in a natural language about doing an action [18]. The participants can have different initial goals: the initiator (either DS or a user) tries to achieve the decision of the partner to do the action but the partner's goal can be opposite. DS interacts with a user using texts in a natural language. There are two work modes. In one case, the computer is playing *A*'s and in the other – *B*'s role.

Both *A* and *B* have access to a common set of reasoning procedures. They also use fixed sets of dialogue acts and the corresponding utterances in a natural language, which are pre-classified semantically, e.g., the set $P_{\text{missing_resources}}$ for indicating that some resources for doing a certain action *D* are missing (e.g., *I don't have proper dresses*, see example 3 in the next section), $P_{\text{increasing_resources}}$ for indicating that there exist resources for (e.g., *The company will cover all your expenses*), $P_{\text{increasing_usefulness}}$ for stressing the usefulness of *D* (e.g., *You can be useful for the company*), etc. Therefore, no linguistic analysis or generation will be made during a dialogue. The utterances will be accidentally chosen by conversational agent from the suitable semantic classes (in our implementation, every utterance can be used only once). However, these restrictions will bring along that the generated dialogues are not quite coherent.

If *A*'s goal is "*B* will do *D*" and *B*'s goal is opposite then *A*, starting interaction, generates, by using his knowledge a partner model w^{AB} and determines the communicative tactics *T*, which he will use (e.g., persuasion), i.e., he accordingly fixes the reasoning procedure *R*, which he will try to trigger in *B*'s mind (e.g., NEEDED). *B* has her own model w^B (which exact values *A* does not know). *B* in her turn determines a reasoning procedure R^B that she will use in order to make a decision about doing *D*, and her communicative tactics T^B .

D. Reasoning and Arguments

When attempting to direct *B*'s reasoning to the positive decision (do *D*), *A* presents several arguments stressing the positive and downgrading the negative aspects of *D*. Preparing an argument, *A* triggers a reasoning procedure in his partner model w^{AB} , in order to be sure that the reasoning will give the positive decision. When opposing, *B* can use the same or a different reasoning procedure triggering it in the model of herself w^B . After the changes made by both the participants in the two models during a dialogue, the models will approach each to other but, in general, do not equalise. Although, the results of reasoning in both models can be (or not be) equal.

Let us consider a dialogue with our DS (Example 3). Here *A* is the conversational agent playing the role of the boss of a company and *B* is the user playing the role of an employee of the company who is at the same time studying at a university. *A* presents arguments for doing *D* by *B* (*D*=travel to *N*. in order to conclude a contract there). It succeeds to decline *B*'s counter arguments and convince *B* to accept its goal.

Example 3

1. A: The company offers you a trip to *N*. Our company needs to conclude a contract there.
2. B: I don't have proper dresses.
3. A: The company will pay your executive expenses. You can be useful for the company.
4. B: I can have some problems at my university.
5. A: It's all right-your examinations period will be extended. The company will evaluate your contribution.
6. B: OK, I'll do it.
7. A: I am glad.

Let us consider how the partner model is used in the dialogue. *A* will implement the tactics of *persuasion* and generates a partner model, let it be

$$w^{AB} = \{w^{AB}(\text{resources})=1, w^{AB}(\text{pleasant})=4, w^{AB}(\text{unpleasant})=2, w^{AB}(\text{useful})=5, w^{AB}(\text{harmful})=2, w^{AB}(\text{obligatory})=0, w^{AB}(\text{prohibited})=0, w^{AB}(\text{punishment-do})=0, w^{AB}(\text{punishment-not})=0\}.$$

The reasoning procedure NEEDED (Figure 1) yields a positive decision in this model. *A*'s *initial information state* is as follows.

Private part

- initial partner model $w^{AB} = (1, 4, 2, 5, 2, 0, 0, 0, 0)$
- the tactics chosen by *A*—persuasion
- *A* will use the reasoning procedure NEEDED, the presumption is fulfilled: $w^{AB}(\text{useful}) > w^{AB}(\text{harmful})$
- the set of dialogue acts at *A*'s disposal: {proposal, arguments for increasing/decreasing values of different coordinates of w^{AB} , accept, reject}
- the set of utterances for expressing the dialogue acts at *A*'s disposal: {*The company offers you a trip to N, You can be useful for the company, etc.*}

Shared part

- the reasoning procedures WISH, NEEDED, MUST
- the tactics of enticement, persuasion, threatening
- dialogue history—an empty set.

Let us suppose that every statement (argument) presented in dialogue will increase or respectively, decrease the corresponding value in the model of beliefs by one unit. Still, this is a simplification because different arguments might have different weights for different dialogue participants.

Conversational agent *A* starts the dialogue with a proposal. Using the tactics of persuasion and attempting to trigger the reasoning procedure NEEDED in *B*, it adds an argument for increasing the usefulness to the proposal (turn 1). In the same time, it increases the initial value of the usefulness in its partner model w^{AB} by 1. The current reasoning procedure NEEDED still gives a positive

decision in the updated model. *A* does not know the actual values of attitudes, which *B* has assigned in the model w^B of herself. As caused by every counter argument presented by *B*, *A* has to update the partner model w^{AB} . However, *B*'s counter argument (turn 2) demonstrates that *B* actually has resources missing (*I don't have proper dresses*) therefore, *A* has to decrease the value of $w^{AB}(\text{resources})$ from 1 to 0 in its partner model. Now *A* must find an argument indicating that the resources are available: it selects an utterance from the set $P_{\text{increasing_resources}}$ (*The company will pay your executive expenses*) and following the tactics of persuasion it adds an argument for increasing the usefulness (*You can be useful for the company*) in turn 3. The value of $w^{AB}(\text{resources})$ will now be 1 and the value of $w^{AB}(\text{useful})$ will be increased by 1 in the partner model. The reasoning in the updated model gives a positive decision. Nevertheless, *B* has a new counter argument indicating the harmfulness of the action: *I can have some problems at my university* (turn 4).

Now *A* has to increase the value $w^{AB}(\text{harmful})$ in the partner model, it turns out that by 6 not by 1 as we assumed. Let us explain why. So far, *A* was supposing that *D* is not prohibited for *B*. This assumption proves to be wrong because otherwise it is impossible for *B* to indicate the harmfulness of *D* (if she is applying the reasoning procedure NEEDED as *A* supposes). Therefore, *B* supposedly compares the values of beliefs at the step 4 of the procedure and makes a negative decision. *B* can come to the step 4 only after the step 3 where she detects that *D* is prohibited and doing *D* involves a punishment (turn 4). Therefore, *A* changes the value of $w^{AB}(\text{prohibited})$ from 0 to 1 and increases the value of $w^{AB}(\text{punishment-do})$ in the partner model at least by 1. (Being optimistic, *A* increases the value exactly by 1 and not more.) Now *A* checks, how to change the value of the harmfulness in the partner model in order to get the negative decision like *B* did. According to the reasoning procedure NEEDED *A* calculates that the value has to be increased (at least) by 6. Therefore, $w^{AB}(\text{harmful})$ will be $2+6=8$.

Responding to *B*'s counter argument *A* decreases the value of $w^{AB}(\text{harmful})$ by 1 using the utterance *It's all right - your examinations period will be extended*, and increases the value of $w^{AB}(\text{useful})$ once more using the utterance *The company will evaluate your contribution* (turn 5). The reasoning procedure NEEDED gives a positive decision in the updated partner model. Now it turns out that *B* has made this same decision (turn 6). *A* has achieved its communicative goal and finishes the dialogue (turn 7).

Example 3 demonstrates how *A* is updating the partner model w^{AB} in negotiation with *B*. The final model will be $w^{AB} = (1, 4, 2, 8, 7, 0, 1, 0, 1)$. As compared with the initial model, the values of four aspects have increased. All the changes are caused by *A*'s arguments and *B*'s counter arguments.

In this way, *A* is able to convince *B* to do *D* if he has enough arguments for doing *D* and his initial picture of *B* does not radically differentiate from *B*'s actual beliefs. Both the beliefs in the partner model w^{AB} and *B*'s actual beliefs in the model w^B of herself (if *B* is a conversational

agent similarly with *A*) are changing during the dialogue as influenced by the arguments presented by the participants. Although the models w^{AB} and w^B do not necessarily coincide at the end of the dialogue, the proportions of the values of the positive (pleasantness, etc.) and negative aspects of doing *D* (unpleasantness, etc.) will be similar. Still, if *B* is a human user then she is not obliged to use models and algorithms (although can) but can choose utterances from suitable semantic classes.

V. DISCUSSION

Our model of conversational agent is motivated by the analysis of human-human negotiations. We consider the dialogues where two participants *A* and *B* negotiate doing an action *D*. In the analysed telemarketing calls, the communicative goal of a sales clerk of the educational company is to convince a customer to take a training course offered by the company. If the participants are collaborative and one of them presents his/her argument then the partner mostly accepts it. If the participants are antagonistic then at least one of them does not agree with the opinion of the partner and presents his/her counterargument(s). The more the clerk knows about the customer, the more convincing arguments is he able to choose. Asking questions is a way to learn more.

When reasoning about doing an action, a subject is weighing different aspects of the action (its pleasantness, usefulness, etc.), which are included into his/her model of motivational sphere. In the model presented here, we evaluate these aspects by giving them discrete numerical values on the scale from 0 to 10. Still, people do not use numbers but rather words of a natural language, e.g., *excellent*, *very pleasant*, *harm*, etc. Further, when reasoning, people do not operate with exact values of the aspects of an action but they rather make 'fuzzy calculations', for example, they suppose/believe that doing an action is more pleasant than unpleasant and therefore they wish to do it. Another problem is that the aspects of actions considered here are not fully independent. For example, harmful consequences of an action as a rule are unpleasant. In addition, if the reasoning object is different (not doing an action like in our case) then the attitudes of a reasoning subject can be characterized by a different set of aspects.

When attempting to direct *B*'s reasoning to the desirable decision, *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, which captures *A*'s knowledge about *B*, and on the other hand, on the (counter) argument presented by *B*. Still, *B* is not obliged to present any counter argument but she can only refuse (*I do not do this action*). When choosing the next argument for *D*, *A* triggers a reasoning procedure in his 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* herself can use the same or a different reasoning procedure triggering it in her own model. After the updates made both by *A* and *B* in the two models during a dialogue, the models will approach each

to another but, in general, do not equalize. Nevertheless, the results of reasoning in both models can be similar, as demonstrated example 3. Therefore, *A* can convince *B* to do *D* even if not having a perfect picture of her.

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 beliefs related to the negotiation object and bring them closer one to another by using arguments. The initiator *A* does not need to know whether the counter arguments presented by the partner *B* have been caused by *B*'s opposite initial goal or are there simply obstacles before their common goal, which can be eliminated by *A*'s arguments. *A*'s goal, on the contrary is not hidden from *B*. Secondly, 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 he can achieve his communicative goal when having a sufficient number of arguments supporting his initial goal.

In our implemented DS, the user interacts with the computer, choosing ready-made, semantically pre-classified sentences as arguments and counter arguments for and against doing a certain action. We suppose that this kind of software is useful when training the skills of finding arguments and counter arguments for and against of doing an action. The computer can establish certain restrictions on the argument types and on the order in their use. Still, when interacting with the computer, a human user does not use neither a formal partner model, nor a formal model of herself, nor reasoning procedures. However, both implementation modes allow study how the beliefs of the participants are changing in negotiation.

VI. CONCLUSION AND FUTURE WORK

We are considering the dialogues where two (human or artificial) agents *A* and *B* negotiate doing an action *D* by one of them (*B*). We analyse human negotiations in order to explain how arguments are used to convince a dialogue partner. Initial communicative goals of the participants can be similar or opposite. The partners present arguments for and against of doing *D*. The arguments of initiator *A* are based on his partner model w^{AB} whilst *B*'s arguments – on her model of herself w^B . Both models include beliefs about the resources, positive and negative aspects of doing *D* that have numerical values in our implementation. Both models are updated during a dialogue.

Our further aim is to develop the DS concentrating foremost on the reasoning model. So far, we are using an intuitive reasoning theory. However, there are several other approaches to model change of a person's opinion, e.g., Elaboration Likelihood Model, Social Judgment Theory, and Social Impact Theory. Some of the theories can be better to model human reasoning. Our further research will explain this.

ACKNOWLEDGMENT

This work was supported by the European Union through the European Regional Development Fund (Centre of Excellence in Estonian Studies).

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