Reasoning and Communicative Strategies in a Model of Argument-Based Negotiation

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***Abstract*—We are developing a model of negotiation in a natural language where the communicative goal of the initiator is to achieve the decision of the communication partner about doing a certain action. In order to make a decision, the partner starts a reasoning process, checking the existence of the needed resources as well as the positive and negative aspects of doing the proposed action. If the partner does not make the expected decision then arguments for and against of doing the action will be presented by the participants in the following communication. We discuss involvement of a reasoning model as well as communicative strategies and communicative tactics in the negotiation model. We consider how the partners can influence each other when reasoning in order to achieve their communicative goals. A limited version of the model of negotiation is implemented on the computer.**

Keywords—negotiation; model; reasoning; communicative strategy, communicative tactics

I. INTRODUCTION

Negotiation is a strategic discussion that resolves an issue in a way that both parties find acceptable [1]. Each party tries to persuade the other to agree with his or her point of view. When making a proposal or assertion, the speaker has to be prepared to receive critiques or counterproposals and react to them [2]. Both parties try to maximize some personal utility in the face of partially conflicting interests, while striving to reach an agreement [3]. Argumentation-based negotiation is the process of decision-making through the exchange of arguments [4].

In dispute, differently as compared with negotiation, a speaker who asserts a proposition expects to be asked for reasons/arguments in support of it and is prepared to present and defend them [5].

Many researchers have been modelling negotiation and persuasion on the computer. Yuan et al. [6] present a computer game for abstract argumentation and strategies for a software agent to act as a game player. The game enables two human and/or computational agents to exchange arguments, and this provides a basis for extending the game for use in argumentative agent systems. Hadjinikolis et al. [7] consider opponent modelling in persuasion dialogues based on an agent's experience obtained through dialogues. Thimm [4] provides a review of strategies in multi-agent argumentation. Hunter [8] investigates a probabilistic user model, including how the system updates the model at each step of the dialogue, how it uses the model to choose moves, and how it can query the user to improve the model. He claims that strategies for persuasion, in particular taking into account beliefs of the opponent are under-developed. Kang et al. [9] introduce a framework for different persuasion strategies and present a model for adaptive persuasion for virtual agents. The agent is able to change the others' attitudes and behaviors intentionally, interpret individual differences between users and adapt to user's behavior for effective persuasion. Rosenfeld and Kraus [3] present a methodology for persuading people through argumentative dialogues by combining theoretical argumentation modelling, machine learning and Markovian optimization techniques.

Overviews of the state of art in argument modelling and argument-based interaction can be found e.g. in [10], [11], [4], [12], and [13].

We study the dialogues in a natural language between two participants where the initiator *A* makes a proposal to the partner *B* to do (or prevent doing) an action *D* and argues for positive outcomes of doing (respectively, not doing) *D* by *B*. The communicative goal of the partner *B* can be the same or opposite. In the last case, *B* has to rebut *A*'s arguments and to present his or her own counterarguments. Even if having the same goal with *A*, there can be obstacles which prohibit or constrain *B* to do *D*. In both cases, *A* has to response to *B*'s counterarguments. If *B* refuses to accept *A*'s communicative goal then the participants are involved into dispute. Both parties present their arguments and finally, whether *A* wins, i.e. achieves *B*'s decision that corresponds to *A*'s communicative goal, or *A* loses, i.e. has to withdraw.

We have worked out and implemented on the computer a formal model of argumentation dialogue [14]. In the current paper, we will further develop the model and concentrate on the reasoning of the participants who apply communicative strategies and communicative tactics for achieving their communicative goals.

The paper has the following structure. In section II we introduce our model of negotiation which includes reasoning about doing an action. We introduce communicative strategies and communicative tactics of participants. Implementation is presented in section III. An example demonstrates how the beliefs of the participants are changing in interaction. Section IV discusses the model and its implementation. In section V we draw conclusions.

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II. A Model of Negotiation

Let us consider a dialogue between two participants (human or artificial agents) in a natural language about doing an action [15], [16], [17]. Let the communicative goal of the initiator *A* be to convince his partner *B* to decide to do (or, alternatively, not to do) an action *D*. In communication, *A* uses a partner model which evaluates *B*'s resources, positive and negative aspects of doing *D* and motivates *A* to believe that *B* will accept *A*'s communicative goal. *A* starts the dialogue by making a proposal to *B*. The partner *B* has her own model – evaluations of the aspects of *D* which can be different as compared with *A*'s partner model. After the proposal is made, *B* starts a reasoning procedure in her mind taking into account her evaluations of *D* and finally, she comes to a decision. If *B* accepts *A*'s goal then the dialogue finishes. If *B* does not accept *A*'s goal then *A* must correct his partner model – it did not correspond to the reality. Depending on *B*'s counterarguments *A* has to find out new arguments in order to bring the negotiation to the desired end. Therefore, reasoning plays an important role in interaction and should be taken into account in a dialogue model.

A. Reasoning Model

1) Determinants of Human Reasoning

When aiming at a certain goal in communication, the subject must know how to direct the functioning of the partner's psychological mechanisms in order to bring about the intended result in the partner. When one attempts to change a person's attitude through communication then he/she might use the Elaboration Likelihood Model (ELM) [18] – a theory of thinking process. Alternative models are e.g. Social Judgment Theory which emphasizes the distance in opinions, and Social Impact Theory which emphasizes the number, strength and immediacy of the people trying to influence a person to change its mind, etc.

In our model, we are using a naïve, "folk" theory (cf. [19], [20]). According to the naïve theory of reasoning, there are three kinds of determinants which can cause humans to reason about an action [21]. The determinants can be either internal or external. The internal determinants are the wishes of the subject related to the action *D* (WISH-determinants) and his/her considerations that it would be needed, reasonable, necessary to do *D* in the given situation (NEEDED-determinants). WISH-determinants get activated when the subject finds that the action itself or some of its consequences would be pleasurable to him/her; *D* is evaluated on the scale "pleasant–unpleasant". The corresponding scale of NEEDED-determinants is "useful-harmful".

The third class of determinants (MUST-determinants) includes those which originate from outside the subject (the external determinants). Those determinants force him/her to do (or withhold from doing) *D* independent on his/her own likings – obligations, prohibitions, norms, orders, requests, etc. They operate through the idea of punishment which is an action as a reaction to subject's not fulfilling obligations or prohibitions.

When reasoning about doing *D*, the "weights" of its pleasant and unpleasant, useful and harmful aspects, and also the weight of the possibility to get punished, should be put together and the general balance of the weights of positive and negative aspects should be computed. This suggests that the corresponding scales should be represented in some form which makes the cross-scale comparison possible (e.g. in a numeric form where the use of certain numeric values should be empirically grounded).

The process of reasoning which leads to a decision can be described as consisting of certain steps where the contents of the steps constitute "weighting" of the different aspects of the action *D*. Depending on the result of a certain step the reasoner moves further to other aspects of *D*.

The reasoning itself depends on the determinant which triggers it (respectively, WISH, NEEDED, or MUST) and it ends with a decision to do *D* or not to do *D*. Thus, we can describe three different prototypical "reasoning procedures" with WISH, NEEDED, or MUST determinants as their inputs.

2) Beliefs and Reasoning Procedures

Our reasoning model consists of two parts: (1) a model of human motivational sphere which includes beliefs of a reasoning subject about different aspects of doing the action under consideration, and (2) reasoning procedures [16].

Let us represent the model of motivational sphere of a subject by a vector of "weights" of different aspects of the action (with numerical values of its components):

w = (w(resources), w(pleasant), w(unpleasant), w(useful), w(harmful), w(obligatory), w(prohibited), w(punishment-do), w(punishment-not)).

In the description, w(resources) = 1 if the subject has *all* the resources necessary to do *D* (otherwise 0); w(obligatory) = 1 if *D* is obligatory for the reasoning subject (otherwise 0); w(prohibited) = 1 if *D* is prohibited (otherwise 0). The values of other weights can be non-negative natural numbers. Here w(pleasant), etc. mean the weight of pleasant, etc. aspects of *D*; w(punishment-do) – the weight of punishment for doing *D* if it is *prohibited*, and w(punishment-not) – the weight of punishment for not doing *D* if it is *obligatory*. Definitely, when reasoning people do not operate with numbers but they rather use words of a natural language for characterizing the aspects of an action (e.g. *useful, reasonable, essential, vital, wise, unwise, unreasonable, doubtful, thoughtless, harmful*, etc. on the useful-harmful scale). Instead, we use numbers as representations of the words in order to make summarization possible.

The second part of the reasoning model consists of reasoning procedures that supposedly regulate human action-oriented reasoning. As said before, there are three different reasoning procedures in our model with WISH, NEEDED, or MUST determinants as their inputs. Accordingly, the reasoning procedure can be triggered by the WISH-determinant if the pleasant aspects of *D* overweight the

unpleasant ones (i.e. w(pleasant) > w(unpleasant)); by the NEEDED-determinant if the useful aspects of *D* overweight the harmful ones (i.e. w(useful) > w(harmful)), and by the MUST-determinant if doing *D* is *obligatory* for the subject and not doing implies some punishment (i.e. w(obligatory) = 1, and w(punishment-not) > 0). Every reasoning procedure consists of steps that the subject goes through in his/her reasoning process; in every step weights of different aspects of *D* are summarized and compared, and the result is the decision: to do *D* or not [16].

As an example, let us present a reasoning procedure which is triggered by the NEEDED-determinant, that is, the subject believes that doing *D* is more useful than harmful (step-form algorithm in Fig.1, cf. [16]).

```
Prerequisite: w(useful) > w(harmful)
1)    Are there enough resources for doing D? If
not then do not do D.
2)    Is w(pleasant) > w(unpleasant)? If not then
go to step 5.
3)    Is D prohibited? If not then do D.
4)    Is w(pleasant) + w(useful) > w(unpleasant) +
w(harmful)+  w(punishment)?  If  yes  then  do  D.
Otherwise do not do D.
5)    Is D obligatory? If not then do not do D.
6)    Is w(pleasant) + w(useful) + w(punishment-
not) > w(unpleasant) + w(harmful)? If yes then do
D. Otherwise do not do D.
```

Fig 1. Reasoning procedure triggered by NEEDED-determinant.

We use two different vectors of weights in our model of dialogue: (1) $\mathbf{w}^{B}$ is the model of *B* herself which includes *B*'s (actual) evaluations of *D*'s aspects and is used by *B*, and (2) $\mathbf{w}^{AB}$ is the partner model which includes *A*'s beliefs concerning *B*'s evaluations and is used by *A*. Let us suppose that *A* has some preliminary information about *B* in order to compose the initial partner model. Still, both the models $\mathbf{w}^{AB}$ and $\mathbf{w}^{B}$ will change after *A* and *B* entered into dialogue.

B. Communicative Strategies and Tactics

A communicative strategy is an algorithm used by a participant for achieving his/her goal in the interaction [15].

The initiator *A* can realize his communicative strategy in different ways: he can *entice, persuade* or *threaten* the partner *B* to do (respectively, not to do) *D*. We call these ways of realization of a communicative strategy *communicative tactics*. If *A*'s communicative goal is "*B* will do *D*" then by enticing, *A* tries to trigger *B*'s reasoning by the WISH-determinant (i.e. he tries to increase the pleasantness of *D* for *B* as compared with its unpleasantness). Respectively, when persuading, *A* tries to trigger *B*'s reasoning by the NEEDED-determinant (to increase the usefulness) and when threatening, by the MUST-determinant (to increase the punishment for not doing an *obligatory D*). We call the affected aspect (respectively, pleasantness, usefulness or punishment) the *title aspect* of the tactics. When choosing the communicative tactics, *A* believes that *B*'s reasoning triggered by this determinant, will give a positive decision in his partner model. Still, the participants can change their communicative tactics during negotiation.

As an example, let us present a communicative strategy of *A* for achieving the decision of the partner *B* "to do the action *D*" (Fig.2, here '- -' starts a comment).

```
Choose communicative tactics with title aspect t
Implement the tactics to generate a proposal to B
REPEAT
   Analyze B's utterance
   IF B indicated the missing resources THEN choose
and present a (counter)argument to indicate that the
resources exist ELSE
- - (1) choose a (counter)argument when B indicated
some other aspect of D
   CASE B's utterance OF
   pleasantness: increase pleasantness
   unpleasantness: decrease unpleasantness
   usefulness: increase usefulness
   harmfulness: decrease harmfulness
   punishment for not doing obligatory D: increase
punishment
   END CASE
- - (2)
Choose an argument to support t
Present the chosen argument(s) to B (A can
optionally present both (1) and (2), OR only (2))
Update w^AB depending on the chosen arguments
To exchange the communicative tactics? If yes then
choose the new tactics (with new t)
UNTIL B agrees (G^A achieved) OR B postpones the
decision (G^A not yet achieved) OR A decides to
abandon G^A OR A does not have unused tactics and/or
unused arguments (G^A not achieved).
```

Fig. 2. Communicative strategy of the initiator *A* (the communicative goal G^A= "*B* decides to do *D*").

A is supposed to have a set of different utterances (arguments) in order to increase or, respectively, decrease the values of the weights in the vector of motivational sphere (in the partner model $\mathbf{w}^{AB}$). For example, if *A*'s communicative goal is "*B* decides to do *D*" then *A* has the arguments for increasing the weights of resources, of the pleasantness, usefulness and punishment for not doing *D* (if *D* is obligatory). Similarly, *A* can use the arguments of decreasing the weights of the unpleasantness, harmfulness and punishment for doing a prohibited *D*. We suppose (in our implementation) that all the arguments are "equal" in the sense that every argument increases or, respectively decreases a weight exactly by one unit. In addition, we suppose that every argument and communicative tactics can be used only once by the participant. Still, in reality, arguments can have different costs and using of one argument or communicative tactics repeatedly is not excluded.

When following the communicative strategy in Fig.2, *A* rebuts *B*'s counterargument (if it was presented) and adds another argument to support the title aspect of the current communicative tactics. For example, if *B* pointed to small pleasantness of *D* then *A* can present an argument for increasing the pleasantness (case (1) in Fig.2) and in addition, when the communicative tactics is persuasion then *A* presents an argument to increase the value of the title aspect of the tactics – the usefulness (case (2) in Fig.2). At the same time, he introduces the corresponding changes into the partner model $\mathbf{w}^{AB}$, increasing the value of the usefulness by one unit. The value of the pleasantness remains the same: it has been

decreased as a result of *B*'s argument and increased again as a result of *A*'s own argument (in both cases by one unit). Still, *A* can also avoid rebutting of *B*'s counterargument (case (2) in Fig.2). Then he implicitly agrees with the counterargument and correspondingly, makes the needed updates in his partner model (e.g. decreases the value of the pleasantness).

The partner *B* uses a similar communicative strategy (Fig.3). The difference is that *B* does not have initiative at the beginning. Similarly with *A*, *B* is also supposed to have several utterances (arguments) for affecting the values of the different aspects of *D* which she can use in order to rebut (or, respectively, support) *A*'s arguments. Here we assume as before that every argument will increase or, respectively, decrease a value of a weight by one unit and every argument and every reasoning procedure can be used only once during a dialogue.

```
Choose an input determinant (WISH, NEEDED, or MUST)
which determines a reasoning procedure
REPEAT
   Analyze A's utterance
- - update w^B depending on A's utterance
   CASE A's utterance OF
   resources: increase resources
   pleasantness: increase pleasantness
   unpleasantness: decrease unpleasantness
   usefulness: increase usefulness
   harmfulness: decrease harmfulness
   punishment for not doing obligatory D: increase
punishment
   END CASE

To change the current reasoning procedure? If yes
then choose a new procedure
Choose and present a new (counter)argument depending
on the current reasoning procedure OR Refuse to do D
(without presenting any argument)

UNTIL B has used all the reasoning procedures AND B
has used all the arguments AND B's current reasoning
gives decision which corresponds to G^A in the
current w^B (A achieved G^A) OR A abandoned G^A (G^A not
achieved by A) OR B decides to postpone the decision
(G^A not yet achieved by A)
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Fig. 3. Communicative strategy of the partner *B* (the communicative goal G^B = "do not do *D*"; G^A = "*B* decides to do *D*").

For example, if *A* presented an argument for increasing the pleasantness of *D* then *B* increases the corresponding value in her model $\mathbf{w}^B$ (by one unit), and applies her current reasoning procedure in the model for making a decision. If the decision does not correspond to *A*'s goal G^A (do *D*) then *B* can present her counterargument (or alternatively, she can present a refusing utterance without any argument).

III. Implementation

A limited version of the dialogue model has been implemented on the computer. The computer plays *A*'s role and the user *B*'s role. *A*'s communicative goal is "*B* will do *D*" and *B*'s goal, on the contrary is "do not do *D*" [14]. The participants can only present their arguments and counterarguments. Although every argument consists of two parts – reason and claim, cf. [11], [13], [16], the participants present only claims when arguing.

In the current implementation, the computer (*A*) has ready-made written sentences for expressing of arguments, i.e. for stressing or downgrading the values of different aspects of the proposed action, which depend on the user model. The user (*B*) interacts with the computer in written Estonian, putting in free texts. A database is used for identifying different key words and key phrases in the user input (the input is checked against regular expressions). The database also includes an index of answer files and links to suitable answers. Although we already have software for the morphological and syntactic analysis of Estonian, there is no software for the semantic analysis. Therefore, keyword-based topic recognition seems to be a satisfying solution. On the other hand, the available Estonian dialogue corpus [22] is insufficient for implementing statistical or machine learning methods.

The following example (originally in Estonian – an interaction with our implemented dialogue system where the computer plays *A*'s role) demonstrates in more details how the beliefs of both participants (i.e. the vectors $\mathbf{w}^{AB}$ and $\mathbf{w}^B$) are changing in interaction.

The action *D* is "to become a vegetarian". *A*'s goal is to achieve *B*'s decision to do *D*. The initiator *A* (the computer) has chosen the tactics of persuasion (i.e. it has fixed the input determinant NEEDED which it tries to activate in *B* and to direct *B*'s reasoning procedure to a positive decision). Let us suppose that *A* has generated the following partner model:

$\boldsymbol{w}^{AB}$ = *(w(resources)=1, w(pleasant)=5, w(unpleasant)=3, w(useful)=5, w(harmful)=2, w(obligatory)=0, w(prohibited)=0, w(punishment-do)=0, w(punishment-not)=0).*

The reasoning procedure triggered by the NEEDED-determinant yields a positive decision (do *D*) in this model because *w(useful) > w(harmful), w(resources)=1, w(pleasant) > w(unpleasant), w(prohibited)=0* (cf. Fig. 1), therefore, *A* can expect that *B*'s decision will be positive. *A* makes a proposal to *B* (turn 1) but *B* does not agree (turn 2):

(1) A: You should agree to become a vegetarian.

(2) B: I cannot abandon meat.

- - Refusal: *B* (the user) refuses to do *D* because she does not have enough resources (abilities). Therefore, *A* has to correct the partner model: *A* decreases the weight of the resources. Now the reasoning procedure triggered by the NEEDED-determinant will give a negative decision like *B* got. The corrected model $\boldsymbol{w}^{AB}$ will be (0, 5, 3, 5, 2, 0, 0, 0, 0). *A*'s next two arguments will increase the weights of both the resources and the usefulness (by one unit) and the current reasoning procedure will again give a positive decision. The partner model will be (1, 5, 3, 6, 2, 0, 0, 0, 0).

(3) A: That's easy, you can. Doctors argue for vegetarian food.

(4) B: Meat contains many useful components.

- - Refusal: although *A* indicated that the resources exist, it turns out that the usefulness is smaller for *B* than expected by *A*. Now *A* has to decrease the value of the usefulness in the

partner model. *A* also has to decrease the value of the pleasantness in such a way that the reasoning procedure NEEDED would give a negative decision like *B* got (cf. Fig.1). The changed partner model will be (1, 3, 3, 2, 2, 0, 0, 0, 0).

(5) A: Meat contains much cholesterol. Vegetarian food is healthy.

- - Both the two new arguments increase the usefulness. The corrected partner model will be (1, 3, 3, 4, 2, 0, 0, 0, 0),
etc.

At the same time, *B*'s own beliefs ($\mathbf{w}^B$) about the aspects of *D* can be different as compared with the partner model $\mathbf{w}^{AB}$. Let us consider the example again. Let us suppose that the computer now plays *B*'s role and the model of itself is $\mathbf{w}^B$ = (0, 3, 3, 2, 2, 0, 0, 0, 0). After *A*'s proposal (turn 1) *B* starts to reason about doing the action but no reasoning procedure is applicable because the prerequisites are not fulfilled (cf. subsection II.*A.2*). *B* refuses to do *D* indicating that there are no resources (turn 2). After *A*'s arguments for the resources and the usefulness (turn 3) *B* has to update its model: $\mathbf{w}^B$= (1, 3, 3, 3, 2, 0, 0, 0, 0). Now *B* is able to trigger a reasoning procedure by the NEEDED-determinant (Fig.1). However, the decision is negative (turn 4) because w^B(pleasant) is not bigger than w^B(unpleasant). After *A*'s turn 5, *B* corrects its model once more: $\mathbf{w}^B$ = (1, 3, 3, 5, 2, 0, 0, 0, 0), and the interaction continues in a similar way. We see that both the models $\mathbf{w}^B$ and $\mathbf{w}^{AB}$ are changing as influenced by the arguments presented by the participants in interaction. Nevertheless, the models are (and, in general, remain) different. Still, the reasoning in both (even if different) models can give the same final decision.

IV. Discussion

Our dialogue model consists of the following components: *A*, *B* – communication participants; ***D*** – set of actions; ***G*** – set of communicative goals; ***R*** – set of reasoning procedures, ***S*** – set of communicative strategies, ***T*** – set of communicative tactics, **w** – a model of the motivational sphere of a reasoning subject. As compared with the dialogue models considered in section I, our model is different because it includes reasoning which is based on a "folk" theory.

The initiator of dialogue is *A*. The participants negotiate doing an action by *B*. There are two possible communicative goals: "do *D*" or "do not *D*". The goals of participants can coincide or be opposite. A communicative strategy is used by a participant to achieve his/her communicative goal. Communicative strategies can be realized by different communicative tactics. Both participants can use a common set of reasoning procedures. Starting a dialogue, *A* determines a partner model $\mathbf{w}^{AB}$, fixes a communicative strategy depending on his communicative goal and chooses the communicative tactics which he will use, i.e. he determines a reasoning procedure which he will try to trigger in *B*'s mind. *A* implements the reasoning procedure in his partner model in order to put himself into the role of the partner and to choose suitable arguments.

B has her own model $\mathbf{w}^B$ consisting of her actual beliefs about doing the action *D*. Similarly like *A* chooses the communicative tactics for influencing *B*'s reasoning, *B* determines a reasoning procedure which she will use in order to make decisions about doing *D*. The models $\mathbf{w}^B$ and $\mathbf{w}^{AB}$ are different when a dialogue starts but they are approaching each to other during negotiation as influenced by arguments.

Our implemented dialogue system is limited in that the computer plays one fixed role (of *A*) and no natural language processing is involved. The generated dialogues are not quite coherent. Still, we suppose that after including the analyzer and generator of Estonian texts and also the speech recognizer and speech synthesizer (all of them are under development), the dialogues will be more human-like.

We believe that after the needed development, the computer program can be used as a simple tool for training argumentation skills. The program, when acting as an opponent of the user, implements a coherent communicative strategy and in this way, it enforces the user systematically to choose certain counterarguments.

In order to evaluate the implementation, we have analyzed human-human negotiations in the Estonian dialogue corpus and compared them with the interactions with our dialogue system [23]. In the analyzed dialogues, the communicative goals of the participants either coincide or are different. The participants are presenting arguments and counterarguments for and against of doing an action. They also ask and answer questions.

```
A: proposal
{- - information sharing
B: question
A: giving_information
}

{- - argument
B: assertion/ justification/ giving_information
A:   accept/   reject/   justification/   giving_
information
(- - argument
assertion)

}

B: accept/ deferral/ reject
```

Fig. 4. The structure of human-human 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.

A simplified structure of human-human negotiations as a sequence of dialogue acts is given in Fig.4 (cf. [23]). As we can see (compared with the Example in section III), the actual human-human negotiations have more complicated structure than the interactions with our implemented dialogue system. One limitation of the interactions is that no question-answering sub-dialogue follows to the initial proposal. The aim of such a sub-dialogue is to adjust the proposal before arguments and

counterarguments will be presented. However, this needs a deeper natural language processing than keyword recognition as used in our implementation.

V. Conclusion

We are modelling dialogues in a natural language where one participant (initiator, *A*) has a communicative goal that the partner (*B*) will make a decision about doing an action (*D*). When reasoning, *B* considers her resources as well as different positive and negative aspects of doing *D*. If the positive aspects weigh more than negative then the decision will be "do *D*" otherwise "do not do *D*". 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 a decision (e.g. to do the action), *A* uses a partner model. *A* stresses the positive and downgrades the negative aspects of the action. Various arguments for doing *D* are presented in a systematic way, e.g. when persuading, *A* stresses time and again the usefulness of *D*. Partner *B* can similarly stress or downgrade a certain aspect of the action, i.e. she can continuously use a certain reasoning procedure (which can definitely be different as compared with the procedure called by *A*). Even if having a different communicative goal, *B* can simply reject *A*'s goal without presenting any counterargument.

We have implemented the model of argumentation-based negotiation as a simple dialogue system 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 but the user can put in free texts. So far, the implementation does not include asking and answering questions in order to adjust the initial proposal or the presented arguments like in human-human negotiations. This needs a deeper natural language processing and remains for the further work.

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