Modelling Communicative Space

From human communication to conversational agents

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***Abstract*—The paper introduces a work in progress on modelling one aspect of natural human communication – communicative space. Participants of a communication event place themselves at certain points of communicative space which characterizes such relevant features of their relations in the event as communicative distance, dominance, politeness, personal relatedness, etc. Examples of human-human dialogues demonstrate how participants pass different points in communicative space during an event. Our aim is to include such a model of communicative space in our experimental system for modelling conversational agents in order to make interaction with the system more human-like.**

Keywords-dialogue; communicative space; human-human communication, human-computer interaction, conversational agents.

I. INTRODUCTION

Communication between people can take various forms depending on a lot of circumstances – participants' individual characteristics, their social roles, subject of conversation, etc. When a human talks with other people, (s)he evaluates them not only from their words but also from their facial expression, body movement, and gestures. These nonverbal aspects help to convey the 'tone' of the conversation [9]. The lessons learnt from the study of human-human communication can be used when modelling interaction with the computer. Different features have to be taken into account in order to make it possible for a user to interact with the computer in a natural way, i.e., in a natural language and following norms and regulations of human-human communication.

There is one relevant aspect of human communication, which we will center on – communicative space [10]. For a general description see the work in [3].

Healey et al. [6] declare that "there are important differences in the quality of human interaction – in degrees of interpersonal, as opposed to physical, closeness – that are important for the organization of human activities and, consequently, for design". The concept of communicative space provides a useful approach to thinking about the basic organization of human interaction.

Communicative space is a mental space where a communication participant places himself/herself with respect to other ones and where (s)he is 'moving' during a communication event. Communicative space can be characterized by different features, e.g., (social) closeness of a communication participant with the partner, collaboration, politeness, etc. These features of communication can be conveyed by language use as well as by different nonverbal means (body movement, facial expressions, etc.). Still, in this paper we limit ourselves with considering interaction in natural language, without taking into account nonverbal means. In order to model communicative space, we analyze transcripts of human-human spoken dialogues.

The paper is structured as follows. Section 2 introduces a model of communicative space. Section 3 analyzes some dialogue examples, which demonstrate different points in communicative space. Section 4 discusses how communicative space can be used when developing a dialogue system and Section 5 draws conclusions.

II. DIMENSIONS OF COMMUNICATIVE SPACE

Communicative space can be specified by a number of dimensions that characterize the relationships of participants in a communicative encounter. Communication can be collaborative or confrontational, personal or impersonal; it can also be characterized by the social distance of participants (near, far), by the modality of communication (friendly, hostile), by the intensity (peaceful, vehement), etc. [10]. Together, these dimensions bring the social aspect of communication into the model [2]. They represent a subsystem of human communicative competence with deep evolutionary roots, the basic function of which is to regulate the communication process. People have an intuitive, 'naïve' theory of these coordinates; the values of the coordinates can be expressed by specific words [11]. Instead, at present we use numerical values as approximations in our model.

We determine communicative space as an n-dimensional ($n > 0$) space with the following coordinates:

- communicative distance to the partner (on the scale from familiar to remote)
- cooperation (on the scale from collaborative to confrontational)
- politeness (from polite to impolite)
- personality (from personal to impersonal)
- modality (from friendly to hostile)
- intensity (from peaceful to vehement).

The concept of communicative space is thus related to approaches where the concept of social attitude or

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interpersonal stance in interaction (e.g., being polite, distant, cold, warm, supportive, contemptuous) are dealt with [4], or where the interaction space is represented by two dimensions – dominance and liking [17].

The social role of a communication participant (e.g., boss *vs* subordinate, salesman *vs* customer, etc.) influences the choice of a point in communicative space. For example, we usually expect that a salesman politely, impersonally and peacefully interacts with a customer at the same time when some customers are impolite, hostile and vehement. A communicative distance is small between friends but it is big between adversaries, etc.

We use the numbers +1, 0 and -1 for the values of the coordinates of communicative space. For example, the value +1 on the scale of intensity means peaceful and the value -1 means vehement interaction. Communicative distance is +1 if a person is close to his or her communication partner and -1 if (s)he is far from the partner. 0 is the neutral value on any scale. Still, it would be possible to consider a bigger number of values on every scale.

It is especially important to stress two moments related to the location(s) of participants in the communicative space during a communication event. First, the participants can be located at different points of communicative space. For example, a good clerk remains polite also when communicating with an impolite customer; one communication participant can feel closeness to his/her partner whereas the partner has different feeling, etc. Secondly, the participants can also 'move' from one point to another during the encounter. For instance, conversation, which started peacefully can become vehement, or *vice versa*; participants who were on confrontational positions at the outset can reach the collaborative one at the end (and also *vice versa*), etc. It is just this latter moment where the function of communicative space as a regulator and reflector of the dynamics of communication encounters as social events reveals itself (see Section 3, comments to Figure 1).

III. PEOPLE IN COMMUNICATIVE SPACE: EXAMPLES

With the aim to model human-computer interaction we start with considering human-human communication. Where do people place themselves in communicative space when communicating and how do they 'move' there? We are especially interested in linguistic means, which help us to recognize the points of communicative space on the basis of texts of communication participants in a natural language. Let us consider some examples from the Estonian dialogue corpus [7]. The corpus includes mainly audio recordings of human-human dialogues in authentic situations, which are transcribed by using a transcription of Conversation Analysis [8]. Each transcription is provided with a header that lists situational factors, which affect language use, e.g., participants names, social characteristics, relations between participants in the situation, specification of situation (private/public place, private/institutional conversation), etc. We will present examples of two types of conversations: institutional (more concretely, conversations with an information clerk) and everyday conversations between acquaintances.

A. Institutional Conversation

Let us start with considering transcripts of directory inquiries. Customers call an answering service and request some information (phone numbers, addresses, institution names, etc.). A clerk (answerer) is an official person and she has to place herself at a certain point in communicative space: to keep a neutral communicative distance, to be polite (or neutral but not impolite), collaborative (or neutral but not antagonistic), etc. Customers have more freedom. In the following examples, *A* is a customer and *B* is a clerk.

Transcription marks used in the examples can be found in [7]. Let us only point out that a number in parentheses marks duration of a pause, e.g., (3.5) marks a break for 3.5 seconds; (.) marks a micro-pause with duration of 0.2 seconds or less. Comments are given in double parentheses.

When annotating the points of communicative space we present the values of the coordinates in the following order: 1) communicative distance, 2) cooperation, 3) politeness, 4) personality, 5) modality, 6) intensity. All the values can be +1, 0 or -1.

In the first example (1), a customer requests a phone number and a clerk gives it him. Both the customer and the clerk have chosen the same communication point (0,0,0,0,0,0) – the values of all coordinates are 0 (neutral).

(1)
A: paluks Asa `kindlustuse `Tartu `osakonda telefoni`numbrit.
I'd like to get a phone number of Asa insurance in Tartu (0,0,0,0,0,0)
(3.5)
B: neli kolm `kaks (.) `seitse kuus `üks.
Four three two seven six one (0,0,0,0,0,0)

In the case if a clerk does not have the requested information in her data base, she can express her emotion (regret) when answering like in example 2. The value on the scale of cooperation is +1.

(2)
B: *sellist `baari ei ole `antud meie andmebaasi kahjuks.*
Sorry, we don't have such bar in our data base (0,+1,0,0,0,0)

Still, we can concentrate also on one single dimension. Example 3 demonstrates, how the values are changing during a conversation on the scale of collaboration (the second coordinate). The comments start with '//'. Adjacency pairs of utterances [8] are numerated.

(3)
/---/
1 A: ma paluks `Maarjamõisa `kööki
May I get the kitchen in Maarjamõisa? // a neutral information request; communication point (0,**0**,0,0,0,0)
(2.2)
B: `haigla juures või poli`kliinikus.
In the hospital or outpatients' office? // the clerk expresses cooperation by asking an adjusting question; (0,+**1**,0,0,0,0)
2 A: `haigla.

The hospital // the customer similarly expresses cooperation by giving information; (0,**+1**,0,0,0,0)

(0.5)

B: e `köögi numbrit ei ole meil `antud.

We don't have the phone number of the kitchen // the clerk refuses to give information; (0,**-1**,0,0,0,0)

(0.5)

3 A: sääl neil `on telefon peal.

But they have a phone there // the client expresses protest; (0,**-1**,0,0,0,0)

B: jah nendel võib `olla, aga meil ei ole `antud köögi `numbrit.

Yes they may have but we don't have the phone number of the kitchen // the clerk again refuses, and she is excited; (0,**-1**,0,0,0,-1)

(0.5

4 B: ma saan teile `anda `üldinfo `numbri.

I can give you the information number // the clerk expresses cooperation, proposing information; (0,**+1**,0,0,0,0)

(1.0)

5 A: (1.0) jah, (.) `olge pai, `andke.

Yes, be so kind as to give it // the client accepts cooperation, he answers friendly and personally; (0,**+1**,+1,0,+1,0)

B: neli neli kaheksa,

Four four eight // the clerk gives information; (0,**+1**,0,0,0,0)

/---/

In example 3, the clerk is moving from one communication point to another when answering. Plural form of the pronoun 'you' (in Estonian *teile*/you [plural] *vs sulle*/you [singular]) indicates politeness (value +1).

When analyzing the dialogues with the same clerk we can draw her 'portrait' taking into account the communication points she passes in communicative space. We evaluate an information provider as a good clerk if she keeps neutral values of coordinates or at least avoids negative values and she is collaborative in the sense that if she doesn't have the data requested by a customer then she attempts to offer substituting information like in example 3.

Similarly, we can draw the 'portrait(s)' of a participant (or both participants) of a dialogue regarding any coordinate of communicative space. Figure 1 represents the 'portraits' of *A* and *B* in relation to collaboration in conversation (Example 3).

In the same way, it is possible to analyze and compare the changes of values of more than one (selected) dimensions, during a certain dialogue encounter or in some interaction type in general, e.g., in order to investigate possible 'dependency patterns' between different dimensions in different kinds of interaction types. That is, it is possible not only to fix general (static) relationships between dimensions but also to establish dynamic patterns of changes of the values of certain dimensions in the development of communicative encounters we are interested in (e.g., formal negotiations *vs* buying-selling situations *vs* quarrels about personal matters).

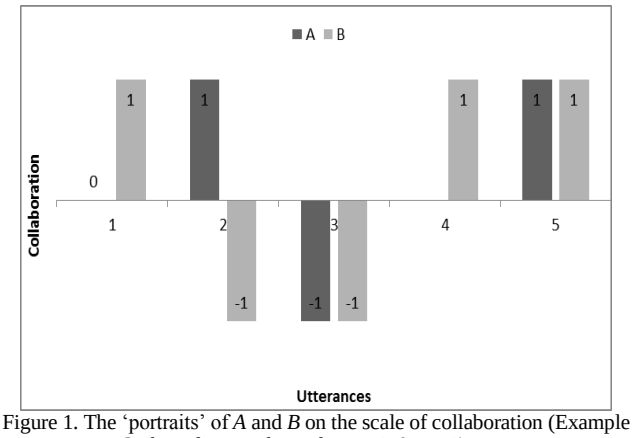

Figure 1. The 'portraits' of *A* and *B* on the scale of collaboration (Example 3; the values on the scale are -1, 0 or +1).

B. Everyday Conversation

Everyday conversation is different as compared with institutional conversation. The participants are not obliged to stay in a certain communication point predetermined by their role in the communication event but the values of coordinates may vary in a wide range.

In the following examples, the participants are friends (the value of communicative distance is fixed as +1).

In example 4, *A* makes a proposal but *B* doesn't agree and answers angrily as indicated by a comment (in double parentheses). The value on the personality scale is +1 because singular imperative is used (*helista*/call [singular imperative] *vs helistage*/call [plural imperative]).

(4)

A: ´helista ´talle.

Call [singular] him (+1,0,0,+1,0,0)

(.)

B: helista ´ise. ((angrily))

Call [singular] yourself (+1,0,-1,+1,-1,-1)

In example 5, *A* expresses protest. The value on the personality scale is +1 because singular is used (*sa käisid kolamas*/you have nosed [singular] *vs te käisite kolamas*/you have nosed [plural]). The values are -1 on the modality and intensity scales.

(5)

A: se=tändab ´seda et sa käisid minu ´sahtlites ´kolamas.

It means that you have nosed [singular] around my lockers (+1,0,0,+1,-1,-1)

In example 6, *A* is surprisingly calling his girlfriend *B*. The comments (in double parentheses) help to follow the 'tone' of the conversation.

(6)

B: ´tsau musi. ((surprised))

Ciao darling (+1,0,0,+1,+1,0)

(0.6)

A: tsau ((dearly))

Ciao (+1,0,0,+1,+1,+1)

/---/

tuled mulle ´külla=vä.

Do you [singular] come to me (+1,0,0,0,+1,+1)

B: mmmmmmm=> ma=i ´saa {praegult} ´tulla. < ((apologizing))

I can't come at the moment (+1,-1,0,0,+1,0)

After presenting these examples, which represent typical data we are working with, and before proceeding to the discussion of specific aspects and problems of our model, let us make here a general comment concerning the model. The properties of communicative space make it possible to represent agent's intellectual states, by changing the values of dimensions during a communication event.

In order to control these properties when modelling real interaction, one needs to take into account also the emotional aspect of communication, i.e., to relate the model of communicative space somehow to the emotional models. This need is especially clear in the case of everyday informal interactions (as one can see also in the case of above examples). There exist some approaches using emotional models. Thus, communication-driven models select an emotional display for its communicative effect. Simulation-based approaches simulate aspects of emotion processes, essentially giving the agent true emotions [5]. But in trying to incorporate such emotional models into a general model of communicative space (in our sense) several critical problems arise, first of all, the problem of delimiting the concept of 'emotional aspect' in this context. In human communication, it includes not only 'pure' feelings and moods, but also attitudes, opinions, (psychological/social) dispositions and stances, which involve also intellectual component in the sense that they can be debated about by using rational arguments. In our present model of communicative space these 'emotional aspects' are implicitly accounted for by different dimensions (modality, politeness, intensity); see also the next Section. But making their role and interdependencies explicit in different types of communicative interaction needs more investigations into deeper levels of human motivational sphere.

IV. DISCUSSION

We are using the values +1, 0, and -1 for the coordinates in communicative space. Actually, all scales could be divided into a bigger number of values and – as said before – a word in a natural language can be used for every value. For example, modality of communication can be *friendly, ironic, hostile*, etc. Still, the words can be substituted with numbers in the model as we do.

The dimensions that we are using for characterization of communicative space are not fully independent on each other. For example, the length of communicative distance is related to personality – a shorter distance implies a bigger value on the personality scale; the impoliteness implies small values of the modality and intensity, etc. Further research is needed in order to elaborate the list of dimensions (some dimensions could be removed and new dimensions added) and the borderlines between different dimensions and different values.

Of course, there are other possible approaches than the one offered by our model, which operates with a predefined system of dimensions and their values (even when not independent). For instance, the reasoning methods in fuzzy rule-based classification systems have been studied by Mesiarová-Zemánková [13][14]. Such systems deal with noisy, imprecise, or incomplete information while keeping a satisfactory level of approximation and a good interpretability of the system. It is shown that reasoning methods and derivation of fuzzy rule consequents are based on multipolar aggregation operators. Nevertheless, such an approach hardly suits for interpreting dialogical texts with the aim of recognizing the covert intentions of the interacting agents and explaining the choice of current turns and their verbal realizations made in a concrete communication situation.

There are some linguistic keys, which help to recognize some parameters of communicative space. For example, if a person uses singular form of a verb or of a pronoun (in Estonian *sa*/you [singular] *vs te*/you [plural]) in his/

her utterance addressed to the partner then it indicates a short communicative distance (value +1) and a big personality (value +1) like in Examples 4 to 6. When communicating with an unfamiliar person Estonians usually use the plural form (Example 3). Still, young people are discarding this tradition.

Feeling words can signal some values, e.g., *please* and *thank* indicate politeness. Some research has been done for detection of emotions in Estonian texts using both lexicon-based and statistical methods [1][15].

Comments in transcripts of spoken recordings can help to determine the 'tone' of conversation like in Example (6).

In order to do automatic recognition of values of coordinates of communicative space, opinion (or sentiment) analysis can be used, which allows to determine the contextual polarity of a text [16]. However, this line of investigations remains for the further research.

Our examples demonstrated that people behave differently in different situations. Dialogue participants have different expectations when communicating, e.g., with a near friend or with an official person. The path covered by a communication participant in communicative space characterizes his/her attitudes regarding the partner.

How to use the notion of communicative space when developing human-computer dialogue systems? A number of possible applications could be offered but here we will simply point at two general directions of research where the need for some kind of such conceptual mechanism should be obvious.

First, the systems can be created, which analyze the protocols of certain interaction sessions and 'reconstruct' the placements of participants and the changes of the locations during a session. The second direction (chosen also by us) is more interesting for research. It is related to intelligent agents with two constraints. First, such agents are interacting with human users in a natural language, and secondly, they are planned to play a certain 'social role' in interaction. Such interaction systems have been created for a long time but the aspect of their social role has usually not been explicated. The conversational agents [12] and especially, the conversational characters, which have recently become popular, take into account only the features of a limited field (e.g., a virtual guide of an art exhibition). At the same time, the agents can be created, which could be 'tuned' to behave according to certain locations in communicative space depending on the user. For example, a travel agent gives information about a trip but it can also add various advices being neutral, advertising or even

intrusive. An advisor system in negotiation can take in the coordinates of the location of the user in communicative space related to his/her partner and then recommend suitable data to use (facts, arguments).

V. CONCLUSION AND FURTHER WORK

We analyze human-human dialogues with the aim to develop a dialogue system, which interacts with a user in a natural language following norms and rules of human communication. This paper considers a model of communicative space – a mental space where conversation participants are situated and where they are 'moving' during a conversation. We are modelling communicative space as an *n*-dimensional space with such dimensions as communicative distance of a participant to his/her partner, cooperation, politeness, personality, modality, and intensity. We assign the values +1, 0, or -1 to the coordinates. The analysis of human-human dialogues demonstrates how different points in communicative space are visited during conversation. Using the path covered by a communication participant in communicative space we can create his/her 'portrait' and implement it in a dialogue system.

We have implemented an experimental conversational agent, which argues for doing an action interacting with the user in written Estonian. We believe that including the model of communicative space into the system will make the interaction more natural. This remains for the further work.

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