

## THE STRUCTURE OF INFORMATION DIALOGUES: A CASE STUDY

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**Abstract:** *In the paper we consider the structure of information dialogues. Our study is based on Estonian dialogue corpus which contains two kinds of dialogues – transcriptions of spoken conversations, and dialogues collected with the Wizard of Oz method. We are using two ways for describing the structure of dialogues – a typology of dialogue acts, and a system of communicative strategies. We depart from the notion of communicative strategy introduced by Kristiina Jokinen in her Constructive Dialogue Model. The analysis of our empirical material shows that people are using similar communicative strategies in telephone conversations and computer interactions. In the same time, the structure of human-human conversation is much more complicated.*

**Keywords:** *Computer intellectualization*

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### Introduction

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Estonian dialogue corpus consists of two kinds of dialogues. Firstly, 255 spoken dialogues are recorded and transliterated by the transcriptional system of conversation analysis (Jefferson 1979). 150 of the dialogues are telephone conversations where a person calls an office (railway station, bus terminal, travel agency, etc.) aiming to get some information. The remained 100 are face-to-face conversations. Secondly, we have collected 20 dialogues by the Wizard of Oz (WOZ) method. All the WOZ dialogues are information requests. The participants of our WOZ experiments were allowed to ask questions about bus schedule in Estonia and ship or plain traffic between Estonia and Finland. Therefore, we have a reasonable number of information dialogues in our corpus.

Building our corpus, we have two goals. The first goal is studying of spoken human-human conversation, and the second is modelling of human-computer interaction. Our further aim is to build an experimental dialogue system which could act as a rational agent and provide the needed information to the user. The dialogue system will integrate several language technology modules built up for Estonian so far (morphological and syntactic analysis, text-to-speech synthesis etc.). To work out a dialogue manager, we are studying the structure of our information dialogues.

There are several ways to describe the dialogue structure. From one side, we can use a system of dialogue acts and represent dialogue as a sequence of such acts. From the other side, communicative strategies for achieving certain communicative goals can be found in dialogues, and dialogue can be represented as implementation of the strategies. Both of these developments are methods for expressing and achieving the coherence of dialogues.

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### Typology of Dialogue Acts

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There exist several typologies of dialogue acts. The first well known typology was worked out by J. Sinclair and M. Coulthard on the ground of the study of real dialogues (Sinclair, Coulthard 1975). The system of dialogue acts was further developed by A.-B. Stenström (Stenström 1994). Several researchers are considering practical problems of dialogue acts determination during the last decade – corpus linguists, discourse and conversation analysts, language technologists (Hakulinen 1989; Allwood et al. 2000; Stolcke et al. 2000; Jokinen et al. 2001).

Choosing a dialogue act mark-up system we have had two goals: to study spoken human-human conversation and to model human-computer interaction. We started with analysis of existing dialogue act systems and typologies (Klein, Soria 1998, Francis, Hunston 1992, Stenström 1994, Dybkjær 2000). It proved difficult to take over a ready-made typology because most of them are domain-oriented (eg. furnishing an apartment, guessing a journey on the map, determining a meeting, etc.). Therefore, we decided to work out our own typology. We departed from the Stenström system which is based on conversation analysis.

There are 140 dialogue acts in our system divided into 8 groups:

- 1) rituals – greeting, introducing, etc.;
- 2) acts for re-structuring of conversation, with help of which the speaker starts a new topic or changes the type of conversation;

- 3) acts for exchanging of turn-takings, with help of which the speaker is asked to continue, or the existence of contact is checked;
- 4) repairing acts, with help of which partners are solving communication problems;
- 5) directive acts for giving and receiving of commands, requests, etc.;
- 6) questions and answers – pairs of acts, with help of which one partner asks a question and another answers it;
- 7) acts for taking up of attitudes, with help of which one partner represents an attitude (belief, evaluation, charge) and another responds it;
- 8) the last group contains the remaining acts (additional information, argument, conclusion, promise, acknowledgement, signal of new information, etc.).

The acts from all the groups, except of the last, can form adjacency pairs. For that reason, they are divided into 2 sub-groups: the first and second parts. The first parts are used to give commands, ask questions, etc. The second parts express reactions to commands, answers to questions. Acts from the 8th group can supplement both the first and second parts.

A simplified formal grammar determining our dialogue acts system is as follows (cf. Koit 2001). The terminals (dialogue act names) are written in capitals.

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interaction ::= (transaction)+
transaction ::= (exchange)+
exchange ::= organisational-exchange | conversational-exchange
organisational-exchange ::= ritual | repair | CONTINUER
ritual ::= CALL | RESPONDING-THE-CALL | GREETING | RESPONDING-THE-
GREETING | THANKING | RESPONDING-THE-THANKING | LEAVE-TAKING | RESPONDING-
THE-LEAVE-TAKING
repair ::= hearer-initiated-repair | self-repair
hearer-initiated-repair ::= INITIATING-REPAIR | CARRING-OUT-REPAIR |
INITIATING-REPAIR | CARRING-OUT-REPAIR | EVALUATION
initiating-of-repair ::= NON-UNDERSTANDING | RE-QUESTION | SPECIFYING-
CONDITONS-OF-THE-ANSWER
self-repair ::= REFORMULATION
conversational-exchange ::= directive-exchange | question-exchange
directive-exchange ::= directive's-pre-member | directive's-re-member
directive's-pre-member ::= ORDER | REQUEST | PROPOSAL | WISH | CALL-UP |
OFFER | REQUEST-TO-WAIT
directive's-re-member ::= FULFILMENT | REFUSAL | AGREEMENT | POSTPONING-
THE-ANSWER | FULFILMENT-WITH-RESERVATIONS | YOU-ARE-WELCOME
question-exchange ::= question's-pre-member | question's-re-member
question's-pre-member ::= CLOSED-YES/NO-QUESTION | OPEN-YES/NO-QUESTION
| WH-QUESTION | SPECIFYING-THE-CONDITIONS-OF-ANSWER
question's-re-member ::= AGREEMENT-(YES) | AGREEMENT-(NO) | NON-AGREEMENT
| open-answer | POSTPONING-THE-ANSWER | ANSWER-AS-AN-ALTERNATIVE
open-answer ::= GIVING-INFORMATION | INDICATING-THE-ABSENCE-OF-
INFORMATION

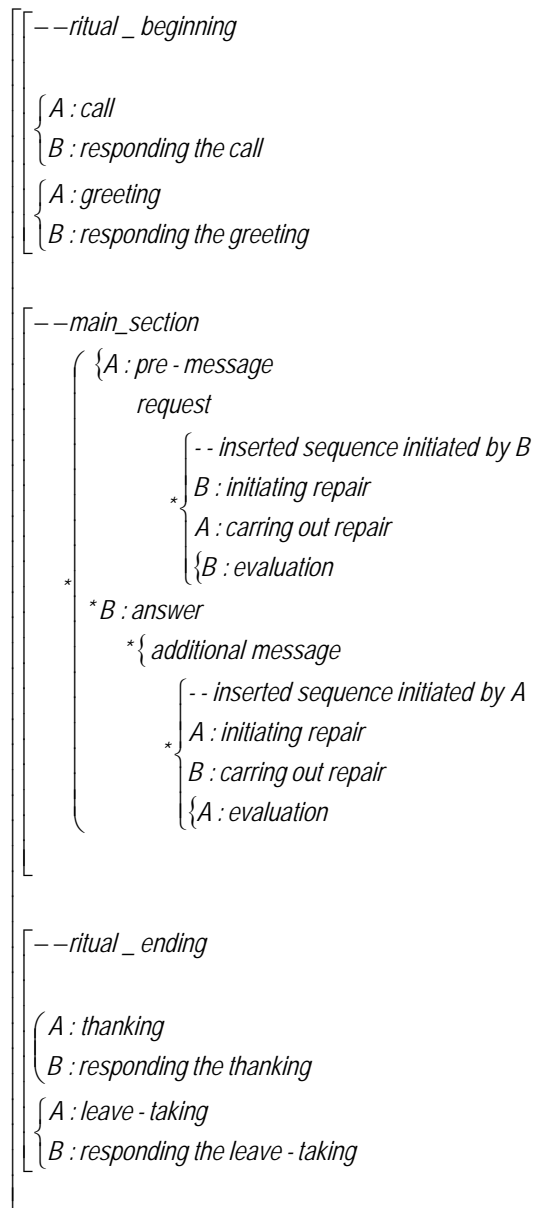
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Our typology does not allow to annotate dialogues on several levels as it is possible, for example, in DAMSL (Allen et al., 1997). However, some levels can be differentiated indirectly. Communicative status is indicated by the dialogue act REFUSAL which marks a non-interpretable or unfinished utterance. Information level is expressed by the conversational exchanges (as opposite to organisational ones). The role of forward-seeking functions is played by the first parts (pre-members) and the role of backward-seeking ones by the second parts (re-members) of adjacency pairs. Our scheme is more detailed as DAMSL. For example, the group of rituals consists of 34 acts (there are only 2 acts in DAMSL – opening and closing). Such particularity is very useful for study of human-human conversation even though it makes the annotation process more difficult. If we had only one goal – training a question-answering system – then we could to be satisfied with a more superficial typology of acts. But our primary goal is to study human-human conversation.

Our studies are currently centred on information seeking dialogues. We are using our system for annotating our corpus. Supposedly, the typology can be reduced in process of the work.

## Dialogue Acts in Information Dialogues

For this paper, we annotated 10 spoken (telephone) and 10 WOZ dialogues from our corpus. It is possible to outline the structure of information-seeking dialogue as consisting of four parts with different functions (Fig. 1).



**Figure 1.** The structure of information dialogue. Notations: ( – adjacency pair, [ – connects the whole dialogue or its section, { – dialogue act, adjacency pair or triad which is optional, \* – dialogue act, adjacency pair or triad which can be repeated, -- – start of comment.

The four parts are

- a ritual beginning (greeting, introducing etc.);
- a ritual ending (thanking, farewell);
- requesting and giving information (answering questions, giving telephone numbers, etc.);
- solving communication problems (misunderstanding, inaudibility, unreliability of information) in cooperation of partners. This part often follows after the first question and forms an inserted sequence within the first adjacency pair, also it can be repeated within the following adjacency pairs.

Ritual parts can be missed in conversations. It is usual in WOZ dialogues that the user (A) does not greet the computer (B), (s)he starts interaction with request. A's information request is expressed by directive's or question's pre-member (usually, open yes/no question, wh-question or wish). Pre-messages can be added to request (for example, 'I have a question'). B's answer is expressed as directive's or question's re-member,

usually as open answer: giving information. B often asks adjustable questions to specify the conditions of answer.

Let us consider two examples from our corpus (cf. Examples 1 and 2). The first dialogue is a telephone conversation and the second one is a WOZ dialogue. In the last case, the user put in his/her questions from the keyboard, and got answers from the wizard on the screen. The ritual beginning and ending parts are put out in the examples.

**Example 1.** A – client, B – a travel clerk. (Translated from Estonian.)

<i>No</i>	<i>Utterance</i>	<i>Dialogue act</i>
1	A: I'm interested in trips to Scandinavian states.	WISH
2	B: Yes?	YOU ARE WELCOME
3	More precisely?	SPECIFYING THE CONDITIONS OF ANSWER, POSTPONING THE ANSWER
4	A: Which variants do you have	WH QUESTION, POSTPONING THE ANSWER
5	to Sweden, Norway?	ADDITIONAL INFORMATION: SPECIFICATION
6	B: mmm... You can buy tickets by us.	ANSWER AS AN ALTERNATIVE
7	A: So.	ACKNOWLEDGEMENT, SIGNAL OF NEW INFORMATION
8	B: Plane and ship tickets.	ANSWER AS AN ALTERNATIVE, ADDITIONAL INFORMATION: SPECIFICATION
9	Unfortunately, we don't offer a whole travel packet.	OPEN ANSWER: ANOTHER
10	A: So.	ACKNOWLEDGEMENT, SIGNAL OF NEW INFORMATION
11	B: I mean a group trip.	ADDITIONAL INFORMATION: SPECIFICATION
12	A: mmm	CONTINUER

Various adjacency pairs appear in our dialogues: in the first example, A's wish (1st utterance) is closed by B's open answer (9), A's open question (4) is closed by B's answer as alternative (6), etc. In the second example, A's open question (1st utterance) is closed by B's open answer (8-11). Any adjacency pair can contain other pairs within. In the second example, the pair open question – open answer contains a pair adjustable question – open answer: giving information (utterances 4 and 5). An utterance can hold more than one function, as utterance 3 in the first example (postponing the answer that closes the utterance 1, and adjustable question that opens a new adjacency pair).

Some of dialogue acts do not occur in WOZ dialogues, for example, checking contact, continuer, taking up of attitudes. In our experiments, clients seldom asked questions which could be answered shortly, i.e. giving information about one or two trips. For that reason the computer asked very many adjustable questions followed by an open answer: giving information. In some degree, the questions were necessary for the wizard to extend the time for information retrieval.

**Example 2.** A – user, B – WOZ. (Translated from Estonian.)

<i>No</i>	<i>Utterance</i>	<i>Dialogue act</i>
1	A: When will the bus depart from N. to Tallinn,	OPEN QUESTION
2	in order that to arrive in Helsinki by ship at 12 o'clock?	ADDITIONAL INFORMATION
3	B: Wait please!	REQUEST TO WAIT
4	Are you interested in a certain week-day?	SPECIFYING THE CONDITIONS OF ANSWER
5	A: I am interested in workdays	OPEN ANSWER: GIVING INFORMATION
6	B: Do you agree to spend a night in Tallinn?	SPECIFYING THE CONDITIONS OF ANSWER
7	A: Yes.	AGREEMENT (YES)
8	B: The bus departs at 9.10 p.m. from N.	OPEN ANSWER: GIVING INFORMATION
9	Arrives at 10 p.m. in Tallinn.	OPEN ANSWER: GIVING INFORMATION
10	The ship departs at 8 a.m. from Tallinn, arrives at 10.30 a.m. in Helsinki,	OPEN ANSWER: GIVING INFORMATION
11	or departs at 9.30 a.m., arrives at 12.	OPEN ANSWER: GIVING INFORMATION
12	Do you need an earlier bus from N.?	CLOSED YES/NO QUESTION
13	A: No.	NON-AGREEMENT
14	Thank you.	THANKING

The wizard asked such adjustable questions as 'Do you prefer a certain time-interval?', 'Do you prefer a certain weekday?', 'Are you interested in certain arrival time?' and so on.

The wizard often needed relatively long time to compile answers. In order that the user did not suspect of an error of the program or slow Internet-connection, the wizard used the dialogue act request to wait in the form 'Wait please!'.

### Communicative Strategies in Information Dialogues

Let us depart from the notion of communicative strategy, considered in (Jokinen 1996a,b) as a part of the Constructive Dialogue Model (CDM). The departure point of the CDM is in general communicative principles which constrain cooperative and coherent communication. Dialogue participants are engaged in a cooperative task whereby a model of the joint purpose is constructed. Contributions are planned as reactions to the changing context. Communicative strategy is used by a participant to build up the next turn as a reaction to partner's previous one. Thus, communicative strategies express the coherence of the dialogue similarly as adjacency pairs of dialogue acts. Four context factors are used in CDM to determine communicative strategies:

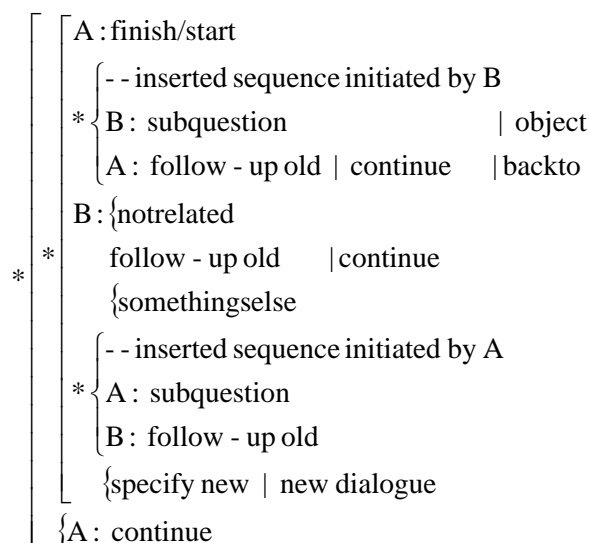
- 1) expectations – is the turn expected or not;
- 2) the central conception – does the partner's turn keep the topic or not (related or unrelated);
- 3) goals – are the speaker's goals fulfilled or not;
- 4) initiatives – has the speaker initiative or not.

The first two parameters are hearer-related and the last two speaker-related.

All the context factors have binary values (1 or 0) in CDM which gives  $2^4=16$  communicative strategies. Every strategy can be represented by a vector of factors with coordinate values 1 or 0, for example, finish/start (vector 1111, i.e. expected-related-fulfilled-speaker), new request (0010, i.e. non-expected-unrelated-fulfilled-partner), subquestion (0101), follow-up old (1100), object (0001), etc.

By means of communicative strategies changing initiatives, achieving goals, changing topics, digressing from normal talk can be traced in dialogue structure.

We annotated dialogue strategies in 10 spoken and 10 WOZ dialogues. The same information-seeking dialogues were analysed as for dialogue acts. The more frequent strategies were follow-up-old (represented by the vector 1100, i.e. expected-related-unfulfilled-partner), finish/start (1111), subquestion (0101) in spoken as well as in WOZ dialogues. Wizard often implemented the strategy unrelated (0000) ('Wait please!' in our example) which is unusual in spoken dialogues. From the other side, there are more changes of topic in telephone conversations as the WOZ dialogues. The user more strictly keeps the topic when interacting with the computer. Likewise, the initiative more often goes from one participant to the other in telephone conversations. Wizard tried to keep initiative and control interaction. The general structure of information



dialogue is represented on Figure 2. The ritual beginning and ending parts are omitted.

**Figure 2.** The structure of information dialogue: communicative strategies. Notations: [ – connects the whole dialogue or its section; { – an optional strategy or a sequence of strategies, \* – strategy or a sequence of

strategies which can be repeated, | – variants of strategies; -- – start of comment.

Let us go back to the examples and use now communicative strategies for expressing the structure of dialogue (Examples 3-4).

**Example 3** (cf. Example 1). A – client, B – a travel clerk.

No Utterance	Vector of factors	Strategy
1 A: I'm interested in trips to Scandinavian states.	1111	finish/start
2 B: Yes?	1100	follow-up-old
3 More precisely?	0101	subquestion
4 A: Which variants do you have		
5 to Sweden, Norway?	1101	backto
6 B: mmm... You can buy tickets by us.	0101	continue
7 A: So.	1100	follow-up-old
8 B: Plane and ship tickets.	1100	follow-up-old
9 Unfortunately, we don't sell a whole travel packet.	1100	follow-up-old
10 A: So.	1100	follow-up-old
11 B: I mean a group trip.	1100	follow-up-old
12 A: mmm	0001	object

**Example 4** (cf. Example 2). A – user, B –WOZ.

No	Utterance	Vector of factors	Strategy
1	A: When will the bus depart from N. to Tallinn,		
2	in order that to arrive in Helsinki by ship at 12 o'clock?	1111	finish/start
3	B: Wait please!	0000	unrelated
4	Are you interested in a certain week-day?	0101	subquestion
5	A: I am interested in workdays	1100	follow-up-old
6	B: Do you agree to spend a night in Tallinn?	0101	subquestion
7	A: Yes.	1100	follow-up-old
8	B: The bus departs at 9.10 p.m. from N.		
9	Arrives at 10 p.m. in Tallinn.		
10	The ship departs at 8 a.m. from Tallinn, arrives at 10.30 a.m. in Helsinki,		
11	or departs at 9.30 a.m., arrives at 12.	1100	follow-up-old
12	Do you need an earlier bus from N.?	0111	new dialogue
13	A: No.		
14	Thank you.	1110	follow-up-new

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## Discussion and Conclusion

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When constructing the next utterance, a participant must act cooperatively and follow certain conversational norms. The reason is that dialogue can be considered as a negotiation process where each participant is responsible for continuation of communication. When we are speaking in terms of communicative acts, it means that there are certain acts that typically can follow an act, and if a speaker does not choose one act from this set then it can be treated as a violation of the norm. From the other side, when we are speaking in terms of communicative strategies, then context factors determine the next strategy, and similarly, they guarantee the coherence of interaction.

A many-to-one mapping can be determined from the set **D** of dialogue acts to the set **S** of communicative strategies. The strategies where the speaker has initiative correspond to the first parts of adjacency pairs, and any act sets up a new goal. For example, wish and open question represent the finish/start strategy, specifying the conditions of answer – the subquestion strategy, opposing – the continue strategy, etc. Therefore, when interacting with a user, the dialogue system which uses information both of dialogue acts and communicative strategies, is able to respond to the user more adequately.

In our previous work, we have considered argumentation dialogues and determined communicative strategy as an algorithm for achieving a certain communicative goal (Koit, Oim 2000a,b). We also determined communicative tactics as algorithms for building the next utterances. Tactics of enticement, persuasion and threatening were considered. Thus our communicative tactics correspond to communicative strategies in (Jokinen 1996a,b). So far, we were interested in such conversations where participants could have

antagonistic goals. The information-seeking communication, in opposite, is cooperative. Starting conversation, one of participants, A, has a communicative goal 'A get information P'. The communicative goal of the (cooperative) partner B is this same. This type of dialogues clearly will be the area where in the next few years already systems will be required that would be practically reliable, but at the same time could follow the rules of natural human communication.

Our further work will be concentrated on a formal model which integrates both a dialogue grammar and communicative strategies with our previous (a kind of BDI) model, and implementation of the model in information-seeking interactions.

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