Route instruction dialogues with a robotic wheelchair

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Our aim is to enable natural and intuitive spoken dialogue between users and the Bremen robotic wheelchair "Rolland" (Röfer & Lankenau 1998), in order to instruct the robot to move to other places autonomously. The purpose of our interdisciplinary work is to develop specific functionalities matching potential users' intuitive expectations. Our current focus is on a detailed qualitative analysis of the discourse flow between human and robot, using a realistic interaction scenario with uninformed users that is tailored to the actual technological requirements. This approach is useful to establish and improve the relationship between implemented functionalities and humans' intuitive reactions at being confronted with an autonomous transportation device.

In earlier work (Shi & Tenbrink 2005) we identified a range of potential problems and devised a dialogue model to address them. Our dialogue modelling approach (see Ross et al. 2005) is based primarily on the COnversational Roles model (Sitter & Stein 1992) combined with the information state based approach (Traum & Larsson 2003). Figure 1 shows a depiction of a clarification subdialogue initiated by the robot, a part of the dialogue model that we start from in the present study. Following an utterance by the user, the robot can request something or inform the user; or it can make a suggestion, which can be rejected or accepted by the user. Following such a rejection or a request by the robot, the user instructs the robot, reaching the final state of this specific subdialogue.

Based on this model, we carried out a second study, this time in a Wizard-of-Oz scenario, to test the communicative success of a number of systematic robot reactions. Here we present the results of this study, outlining the range of problems that could successfully be handled by the robotic reactions, and pointing to a number of novel problems that arise precisely because of the robotic output. Our results show that high-level or generic robotic reactions will lead to increased confusion, while specific and aligned clarification questions enable smooth and efficient dialogue between humans and robots. This leads to an improved dialogue model.

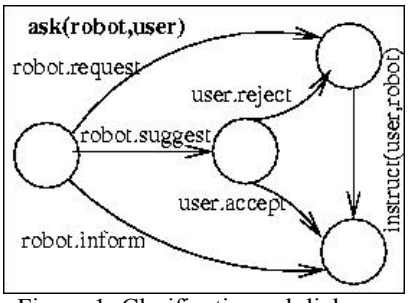

Figure 1: Clarification subdialogue

Our scenario resembles a situation in which new wheelchair owners need to acquaint themselves with their new device, since they are confronted with a robotic wheelchair without being informed in detail about its functionalities. Our experimental participants (17 German and 11 English native speakers) were told that the robot is able to augment its internal map by using the verbal information given by the users while moving around. They were first asked to familiarize the wheelchair with an environment (here: a university hallway with offices). After that, they instructed the robot to drive to one of the rooms they just encountered. In this way, we elicited route instructions related to a specific, relatively simple indoor setting, directed at a robot currently under development in our research group (the SFB/TR 8, funded by the DFG). In our study, the robot did not move autonomously, and the robotic utterances were triggered by a human "wizard" (unseen by the participant) according to a specifically devised schema. Using a range of preformulated utterances, the wizard thus produced a reasonably natural dialogue with the user without necessitating natural language generation while still sounding "automatic" (like a robot).

Our analysis shows that our proposed dialogue model is successful in encouraging the user to provide missing information and to use a suitable level of granularity. In fact, some of the dialogues turned out to be entirely unproblematic, they appeared to be completely natural and did not exhibit any communication problems whatsoever.

However, we also found that even slight confusions and temporal misplacements of the robot's utterances can lead to severe communication problems and distortions of the user's

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spatiotemporal representation. For example, getting back to the mental position in the route description is a problem if the robot's utterances are conceived as slightly incoherent. Therefore, clarification questions from the robot need to be formulated and placed with specific care. The clarification attempts by the robot work best for the discourse flow when they can be integrated into the user's current mental representation of the spatial as well as the discourse situation. Thus, it is essential for the robot to align with the human's utterances to a high degree. This may be even more important than in the interaction between humans: Since humans are specifically unsure about the robot's capabilities, they sometimes turn to solutions that would be unnatural in a human-human interaction situation (Fischer 2006). For instance, in our data, some speakers returned to the very beginning of the spatial description in reaction to a mere clarification question. Such a discourse behaviour is very difficult to model even in very sophisticated models of clarification requests such as Schlangen (2004).

A further source for confusion is when the robot asks for clarification in an area where the user has good reasons to expect that it should have sufficient knowledge. Such cases can easily arise if knowledge already conveyed by the user could not be integrated properly by the system. Therefore, it is important that the robot informs the user about its current state of knowledge in as much detail as possible, and suggests a solution concerning how to proceed further. This will be specifically helpful in the case of spatiotemporal sequencing confusions. Also, it is important that the robot acknowledges what it has understood so far, to let the user know where exactly there is an information gap that needs to be filled in.

As a result, the dialogue model can be suitably extended. The precise discourse history is important since specific requests providing information about successfully integrated knowledge are more useful than generic clarification questions. In our improved model, we substitute the three simple dialogue acts, robot.request, robot.inform and robot.suggest (Figure 1) by subdialogues. Each subdialogue uses the current information state consisting of the discourse history and the internal map representation (denoted as [H,M]). Figure 2 represents the 'request' subdialogue as an example. First, the robot acknowledges the part of the instruction that it has understood, based on [H,M]. The user can react by rejecting this account and providing a further instruction which is integrated in the robot's internal model, in which case the robot does not formulate the request in the intended way. However, if the user does not react or reacts by accepting the robot's description, the robot continues by requesting information about entities, boundaries, orientations, or segments, depending on the current requirements, in a way that is aligned to the users' descriptions as much as possible (using the dialogue history). The dialogue will then continue with the user providing the missing information.

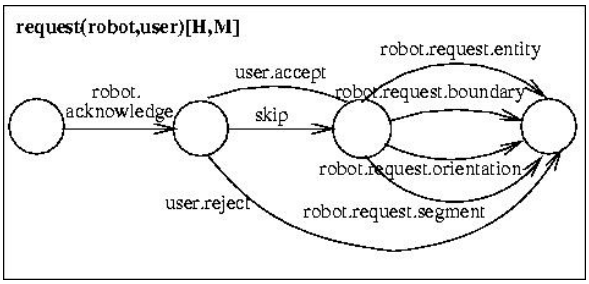

Figure 2: 'Request' subdialogue

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Non-verbal Information in Communication: A Study of Interaction in a Tourist-information Setting

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A preliminary analysis is done to characterize the overall tendency of communication by the occurrences of non-verbal behaviors throughout an entire interaction event. Based on the previous findings in cross-modal interaction(Argyle et al. (1976), Kendon (1967), Clark (1996), etc), we analyze the occurrences of non-verbal behaviors such as gaze, pointing, nodding, and body-posture in a tourist-information setting. Analyses show that an interaction event can be categorized by the occurrence pattern of non-verbal behaviors of the participants.

1 Tourist-information Experiment

An experiment was conducted in a tourist-information setting. Subjects (22 university students) who played the "customer" role were asked to obtain information on sightseeing spots from a professional information clerk (female, 30 years old). The information was given through the communication between a customer and a clerk in front of 7 information display panels with short descriptions and pictures of the spots. Subjects were able to walk around freely within the area. Nineteen successfully recorded sessions were analyzed in this paper.

Body motions and locations were measured by a set of Vicon Motion Capture System. The directions of the subjects' gazes were measured by EMR-8B head-mount eye-trackers of Nac Image Technology Inc.. Each subject wore an eye-tracker, a close proximity microphone, and markers for the motion capture device.

The number and total duration of the following situations were recorded for each subject: a) utterances, b) gazes at the parter or gazes at a panel, c) followed gaze in which a gaze at a panel was overlapped or followed within 0.5 seconds by the partner's gaze.

Also the number of the following situations were recorded for each subject: a) eye movements within each panel, b) nods, c) finger-pointings, d) occurrences of states when the distance between the head and a panel was less than 1000 mm.

2 Analysis1: Correlation between Non-verbal Behaviors

The correlation of the non-verbal behaviors of the customers and the clerk is analyzed from the viewpoint of mutual effects in joint activities.

Strong correlations are found between customers' gaze at the clerk and the clerk's gaze at the customers, both in number ($\rho = .664$, p < .01) and total duration($\rho = .637$, p < .01).

On the other hand, strong negative correlations were found between the total duration of joint gaze at display panels and gaze at the partner, again both in number (customer's gaze: $\rho = -.732$, p < .01; clerk's gaze: $\rho = -.562$, p < 01) and total duration (customer's gaze: $\rho = -.746$, p < .01; clerk's gaze: $\rho = -.635$, p < 01). Although joint gaze and gaze at a partner are both considered to play important roles in establishing common ground in communication, these activities are imcompatible, and so the participants must choose one of them in each occasion according to their communication styles and information aquisition strategies in this task setting.

Strong correlations were observed between the number of gazes at the partner and the number of the gazer's nods (customer's gaze: $\rho = .631$, p < .01; clerk's gaze: $\rho = .678$, p < .01). This is due to the tendency of people to nod while looking at their partner.

No strong correlations were found between the customers' utterances and the clerk's, either in number or total duration. This may be a result of the asymmetry in the amount of information between the customers and the clerk produced by the task setting.

A strong negative correlation was observed between the number and the total duration of the

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clerk's utterances($\rho = . - .546$, p < .01), whereas a strong positive correlation was observed between the number and the total duration of the customers' utterances. ($\rho = .955$, p < .01) This may be due to the fact that the customers' utterances are mainly spontaneous ones like questions or answers, while the clerk's utterances are mainly well-planned ones following the script. A large number of clerk utterances likely indicates that she felt some difficulty in communication and her speech was cut into short utterances; otherwise, it would have been long and fluent.

The number of the clerk's gazes at the customers as well as that of the clerk's nods also shows a strong negative correlation with the number of the clerk's utterances(gaze: $\rho = -.645$, p < .01; nods: $\rho = -.612$, p < .01) , and these results also support the possibility of difficult communication.

3 Analysis 2: Factor Analysis

In this section, we conduct a factor analysis of the occurences of their non-verbal behaviors based on the results. The number of occurrences of the behaviors that showed significant correlations were identified and standardized by the time of interaction. Factors were extracted by the principal factor method, and promax rotation was adopted. The factors with loading value of more than 0.5. were subjected to interpretation, and four factors were extracted by giving consideration to the decay of the eigenvalues. These factors were named as follows.

Customer-led: The Customer-led Factor is characterized by high loading of the customers' positive interaction activities such as utterances(.567), gaze at the clerk(.530), nods(.742), and closing up(.492). High loading on the Clerk's pointing(0.871) means active information exchange involving obvious non-verbal cues. The number of customer gaze movements also shows high loading(.838), and this indicates the customers' active attitude in interaction.

Cooperative: The Cooperative Factor is characterized by strong negative loading on the number of the clerk's utterances(-.932). The analysis in the previous section suggests that the small number of the clerk's utterances indicates fluent interaction between the clerk and the customer. The numbers of customers' gazes at the clerk(.627) and the clerk's gazes at the customers(.677) also show high loading. The number of the clerk's nods shows high loading(.579) only in this factor, and this could be regarded as a sign of smooth and cooperative interaction between the clerk and the customers.

Non-interactive: The Non-interactive Factor can be characterized by high loading on the customers' gaze at a display panel(.898). The numbers of followed gazes also show high loading in both directions, but especially high in the customer-first case(customer-first: 0.893; clerk-first: .559). This shows the customers' tendency to acquire information at their own pace. On the other hand, the number of customers' pointings shows strong negative loading(-.610). This indicates that the customers are not active in interacting with the clerk.

Clerk-led: The Clerk-led Factor can be characterized by high loading on the numbers of clerk's gazes at a panel(.855), at a customer(.601), the clerk's moving her face close to a panel(.763), and the clerk's gaze movements(.693). This shows the clerk's positive attitude in appealing to a customer.

4 Summary

We have analyzed the nonverbal behaviors in a tourist-information setting. A factor analysis of non-verbal behaviors revealed four factors of communication style from the viewpoint of interaction. These results shed some light on how to characterize communication based on the activity level and the initiative-taking pattern of interaction by analyzing the non-verbal cues of the participants.

Acknowledgments

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Compliments in virtual dialogs

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Abstract

This paper studies the realization of the compliments by native Russian and German speakers in electronic communication (Internet forums). Whereas the native German speakers spelled their compliments in a standard way and used normative vocabulary, the native Russian speakers mostly used the colloquial and jargon expressions and spelling.

1 Introduction

Beginning from the Manes und Wolfson's (1981) study of compliments in American English, numerous studies of compliments have been conducted with the aim to characterize their use in direct communication. Based on the recordings of natural talk, the studies of German compliment sequences (Golato, 2005) proved that compliments can not be analyzed irrespectively of the communicative situation in which they occur. In certain cultures, realization of compliments in public and private communicative situations differs significantly (Fukushima, 1990).

Whereas the direct interaction can be either public or private, the forms of communication occurring in Internet contain features of both public and private communication. The aim of the present study is to find out which pragmatic norms dominate in virtual compliments.

2 Methodology

A random selection of about 80 Russian and German forums (education-, popular-science-, art-, and literature-related) was searched for positive assessments of certain persons. In both Russian and German forums related to the photographic art compliments were found more often than in the others; correspondingly, 20 top-liner photo forums resulted from the searches with Google and Yandex were selected. On the corresponding web-sites voting was organized to select the top-rated pictures, which should remain in the gallery. Viewer's ratings could be accompanied with comments. 128 Russian and 123 German compliments were found. Judging by the nicknames, the most of the forum participants were males in both cultures.

3 Results

Table 1 contains the expressions which occurred more than once in at least one of the cultures.

No	expression	Ru	De
1 very	очень sehr	25	25
2	!!!(+)	23	14
3 nice(-ly)	красив- (о, ый) schön	14	19
4 such (what a)	так (-ой), как (-ой) so (-lch, ein, was…für ein)	21	10
5 fine	класс Klasse	4	24
6 super	супер (-ский) super	14	14
7 I like it	нравится, понравилось, нра gefällt	15	11
8 good (well)	хорош- (о, ий) gut	13	12
9 great	здорово toll	8	15
10 wonder	чудо wunder (-)	1	9
11 interesting	интересн- (о, ый) interessant	6	2
12 wow	вау wow	3	5
13 impressive	впечатляет überzeugend, beeindruckend, eindrucksvoll	3	5
14 absolutely	абсолютно, совершенно absolut	0	8
15 unique	исключительн- (о, ый) einzigartig	3	4
16 excellent	отличн- (о, ый) ausgezeichnet	5	2
17 really	действительно echt	1	6
18 brilliant	гениальн- (о, ый) genial	0	7
19 cool	круто, сильно stark	0	6
20 perfect	безупречн- (о, ый) perfekt	0	5
21 pleasant	симпатичн- (о, ый) sympathisch	3	0
22 imposing	великолепн- (о, ый) großartig	0	3
23 crazy	с ума сойти, обалдеть Wahnsinn	0	3

Table 1. Numbers of occurrence of different expressions in Russian and German compliments

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The numbers shown in the Ru and De columns of the Table 1 were compared using the chi-square test. Certain equivalent expressions occurred in both languages with similar frequencies (No 1-3, 6-9 in Table 1). Some words or expressions occurred with significantly different frequencies (No 4 and 5) or were repeatedly used in only one language (in the latter case the chi-square test could not be performed).

As follows from the data presented above, 159 expressions of assessment were repeatedly found in the Russian compliments and 213 in the German ones (the totals of the corresponding columns of Table 1, single occurrences not counted). This suggests that the cliché constructions are more frequently used by German authors of compliments than by Russian ones (the difference is very significant). The conventionality of assessment expressions could also be traced at the syntactical level: though most of the sentences used in assessments were incomplete, there was a significant difference between 23 Russian and 37 German assessments realized only by means of full sentences.

The average length of Russian and German positive assessments was 6.4 and 12.5 words, correspondingly. That can only partially be explained by the absence of the definite and indefinite articles in Russian language. Syntactic compression of assessments was significantly higher in Russian than in German: 30 assessments consisting of a single word were found among Russian compliments, and only 7 – among German ones.

In Russian, the compression means typical for the Internet jargon were utilized as well, e.g. the single word *очень (very)* without an adjective or adverb used as an expression of assessment. Among the Russian compliments, 68 were made using the colloquial or Internet jargon words and/or spelling, i.e. *фЫлософски* (jargon spelling) ~ *philosophically*. All of the German compliments were realized using the standard spelling, only 4 of them contained colloquial expressions; all of the 3 neologisms found were placed in inverted commas. Thus, the frequencies of the slang use in Russian and in German Internet compliments were significantly different.

The most of the compliments were paid on the quality of the photo or author's skills; nevertheless, there were found 38 Russian and only 2 German positive assessments of not the author's work but of the persons, objects, or places pictured, the difference that should be considered as very significant. Moreover, only those assessments have been responded.

4 Discussion

Both Russian and German compliments have three primary functions:

a) contacting a person;
b) flirting with a person;
c) appraising the achievements of a person.

The third function (appraising the achievements) was dominating in the compliments found in the forums related to photographic art. However, the positive assessments of the photographed persons, objects, or places (which occurred mostly in Russian forums) were definitely made to contact other forum participants. That function was successfully realized in most cases. The less frequent use of cliché compliment expressions suggests that the function of contacting is more important for Russian compliments than for German ones, since the use of uncommon expressions when making new acquaintances is typical for Russian private communication. Probably, the frequent use of colloquial and jargon words and spelling in Russian compliments was also aimed to make them look more original and to induce verbal reaction to them.

5 Conclusion

Realized in more conventional way, the German compliments could be considered as public-oriented communicative tactics; the Russian compliments were both public- and personally-oriented.

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DISCUS: a dialogue simulation and context update system

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In this abstract we present DISCUS (Dialogue Simulation and Context Update System), a research tool for simulating dialogues between a user and a system in terms of context update of the system's information state. DISCUS has been developed to test an algorithm for context updating, that builds on Dynamic Interpretation Theory (DIT), (Bunt, 2000). In DIT, meanings of dialogue utterances are viewed as intended context–changing effects that are determined by the dialogue act(s) being performed with the utterance. Dialogue acts in DIT are organized in a multidimensional dialogue act taxonomy (Bunt, 2006). DIT establishes four levels of understanding, that reflect the extent to which an utterance has been processed successfully by the Addressee: *perception*, *interpretation*, *evaluation*, and *execution*. The processing levels are also reflected in the dialogue act types in the auto- and allo-feedback dimensions.

The starting point for the model for context update are the preconditions of the dialogue acts, which represent the motivation and ability for an agent to perform a dialogue act. The preconditions are specified in terms of properties of the information state of the speaker. The model makes explicit how every dialogue act contributes to changing the information state, it defines the types of effects that an utterance provokes in dialogue participants, and it establishes the operations that cause the change of state in the context (Keizer and Morante, 2006). Additionally, the model can determine when information has been grounded.

The primary use of the tool is to simulate the update of the context model of a dialogue system participating in a dialogue with a user. As the update algorithm itself assumes dialogue acts as input, the tool abstracts away from the processes of natural language understanding and generation. That is, both system and user utterances are represented in terms of dialogue acts, except for user utterances for which the system's level of processing reached is too low: processing problems on the levels of interpretation or perception will prevent the system from being able to associate the utterance with a dialogue act.

The functionality of the tool consists in: 1) allowing the researcher to simulate dialogues between a dialogue system (S) and a user (U), and 2) automatically updating the system's context model by applying the algorithm, and presenting it on the screen.

The interface of the tool (see Figure 1 for a screenshot) allows the researcher to specify system utterances in terms of dialogue acts and user utterances in terms of the level of understanding reached by the system and, provided that level is interpretation or execution, a dialogue act.

The components in the bottom part of the GUI can be used to specify the speaker of the utterance simulated, the system's understanding level reached (in case of a user utterance), a literal text representation of the utterance, and the communicative function (CF) and semantic content (SC) of the dialogue act performed in the utterance. At this moment, the SC is specified in a rather simplistic way by means of at most four slots, in which the parameters for the SC can be specified, depending on the CF. For example, the SC of a dialogue act with CF YN-QUESTION is specified with one parameter, representing the proposition the question is about: "will it rain tomorrow?" is represented as YN-QUESTION(rain_tomorrow); a dialogue act with CF WH-QUESTION requires two parameters, representing the property the

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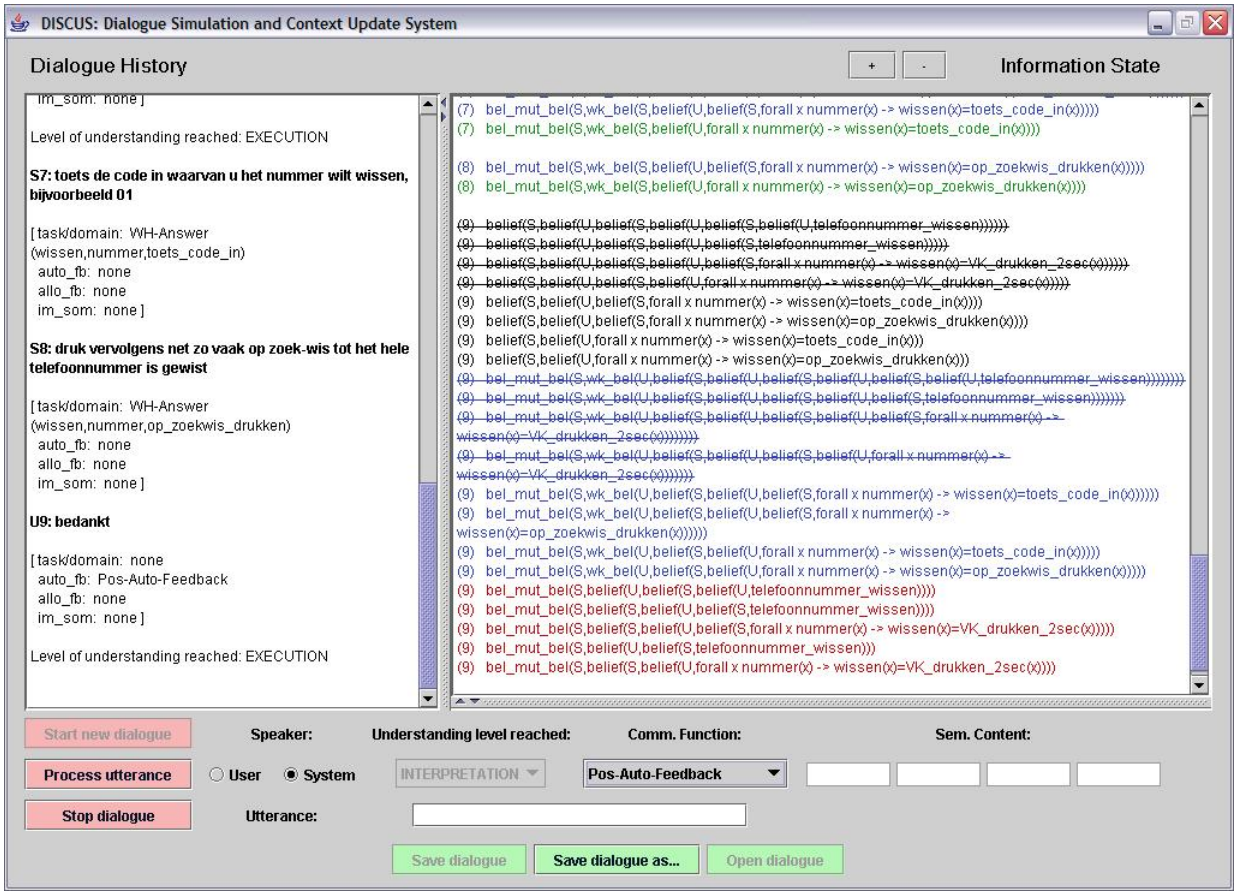

Figure 1: DISCUS Graphical User Interface.

value of which is asked for and the entity to which the property applies: "When does the train to Berlin leave?" is represented as WH-QUESTION(`depart_time,train_Berlin`).

The text panel in the top left part of the GUI displays the simulated dialogue (Dialogue History). For each utterance in the dialogue the literal utterance and speaker (S or U), the dialogue act information along four dimensions, and in case of user utterances, the processing level reached by the system, are indicated.

The text panel in the top right part of the GUI displays the beliefs and goals in the context model (Information State). The various kinds of beliefs (beliefs about understanding, adopted beliefs, beliefs about mutual beliefs about understanding and adoption, and strengthened beliefs) are displayed in different colors; cancelled beliefs get a 'strikethrough' font. The information state panel can also be split in two, allowing to show any pending beliefs.

Besides using the GUI components to simulate dialogues and monitor the context model, the entered simulations can also be saved to file in an XML-format. Upon opening existing simulations, the context model is regenerated. In this way, a fixed set of simulations, covering a wide range of dialogue act patterns, can be used to efficiently test different context update models.

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