

Proactive Spoken
Dialogue Interaction
In Multi-Party Environments
Promotionskolloquium



Example of a Next Generation Dialogue Interaction

U1	Look, it's snowing outside!
U2	What about we take a break?
U1	Yes, I am getting hungry anyway..
U2	So, why don't we take a little walk to a restaurant ?
U1	OK. Good idea! [turning to computer] Hey, is there anything nearby ?
S	The closest one is Restaurant Stifter Stuben which is 4 bus stops away and offers German food.
U1	Alright. Where exactly is it?
S	It is located in Mähringer Weg 54. Would you like to see the menu?
..	..

Multi-Party Capability

- Modelling of Human-Human and Human-Computer interaction

Proactiveness

- Interaction triggered by dialogue flow

Context-Awareness

- Situative and dialogue oriented

Memory

- Dialogue history
- Interaction with previous knowledge

Cooperativity

- Notification of conflict
- Alternative solution

Thesis Objectives

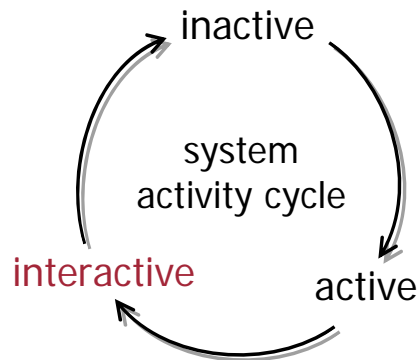
Development of a next generation interaction assistant:

- Proactive multi-party **dialogue management**
- **Corpus development** and analysis
- Usability and user acceptance **evaluation**

Interaction Assistant

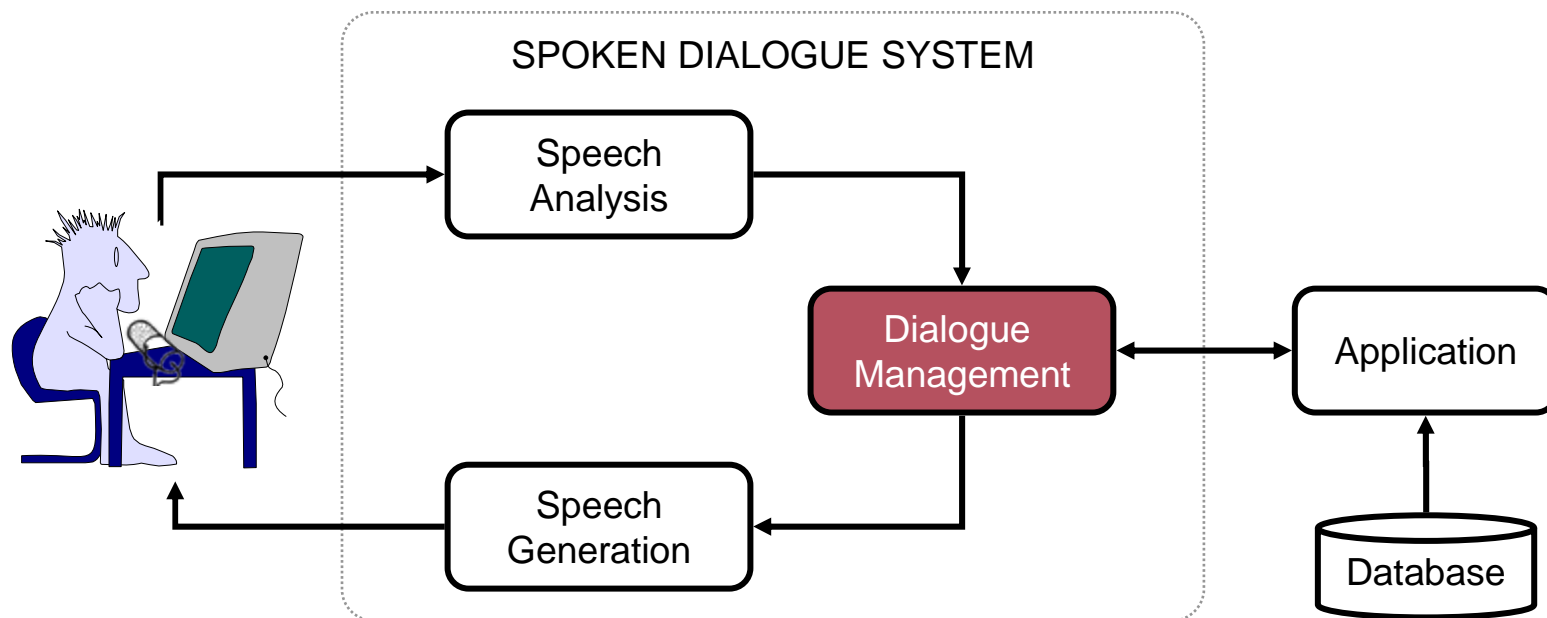


avatar



- Task: Cooperative problem solving in example domain of restaurant search
- Knowledge about > 100 restaurants in and around Ulm
- Speech input - multi-modal output
 - animated avatar, speech, menu, map, bus schedule
- Different levels of attentiveness (passive vs. active listening)

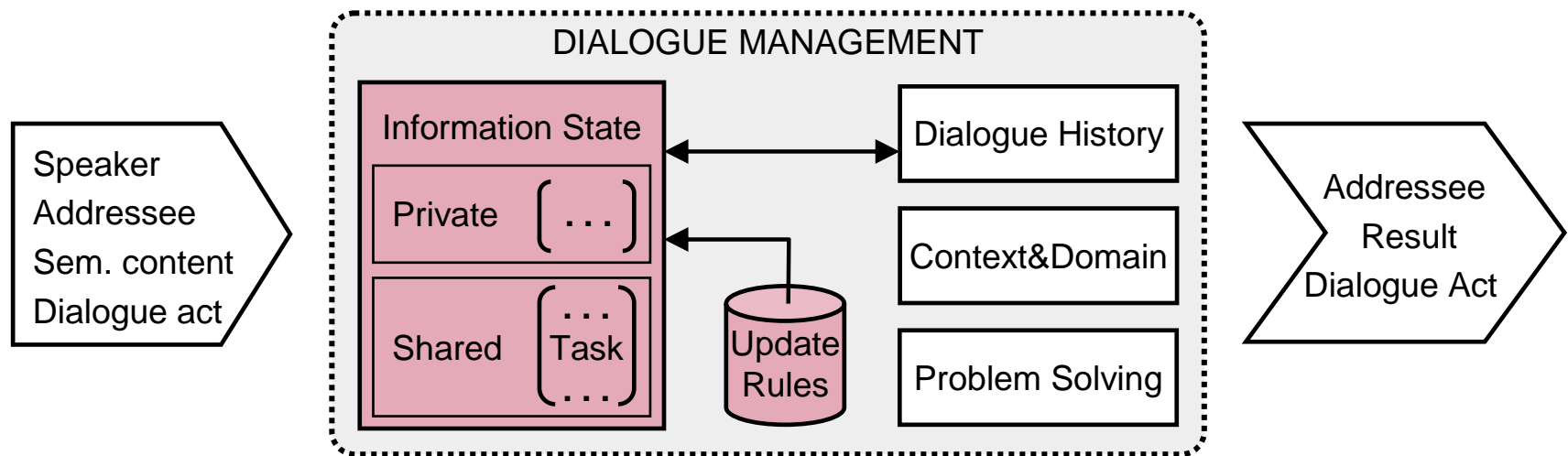
Spoken Dialogue System Overview



Tasks of dialogue management:

- Integration of input
- Interaction with application (including problem solving)
- Determination of system reaction (output)

Dialogue Management: Information State Update Approach



Information state update approach (e.g. Larsson 2002):

- Dialogue as a state of information that is updated with every utterance

Existent extension for multi-party interaction:

- Additional dialogue partner introduced as
 - second addressee: interaction expected
 - side-participant: interaction not possible

Dialogue Management: Information State Update Approach

Own approach:

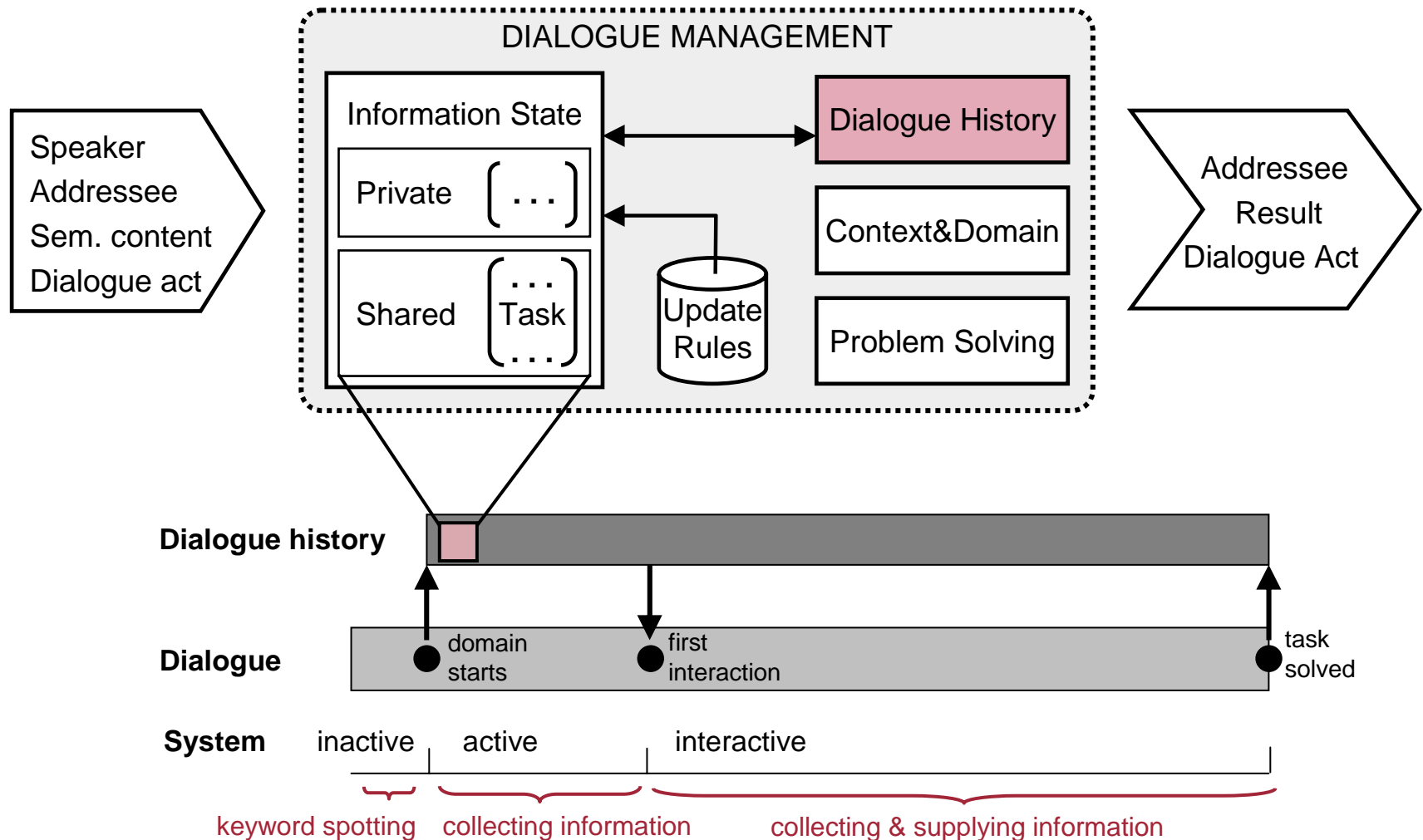
Enabling multi-party interaction

- Enable interaction by side-participant
 - **Proactive side-participant**: interaction possible
- Organisation of contributions by different dialogue partners
 - **One common ground**

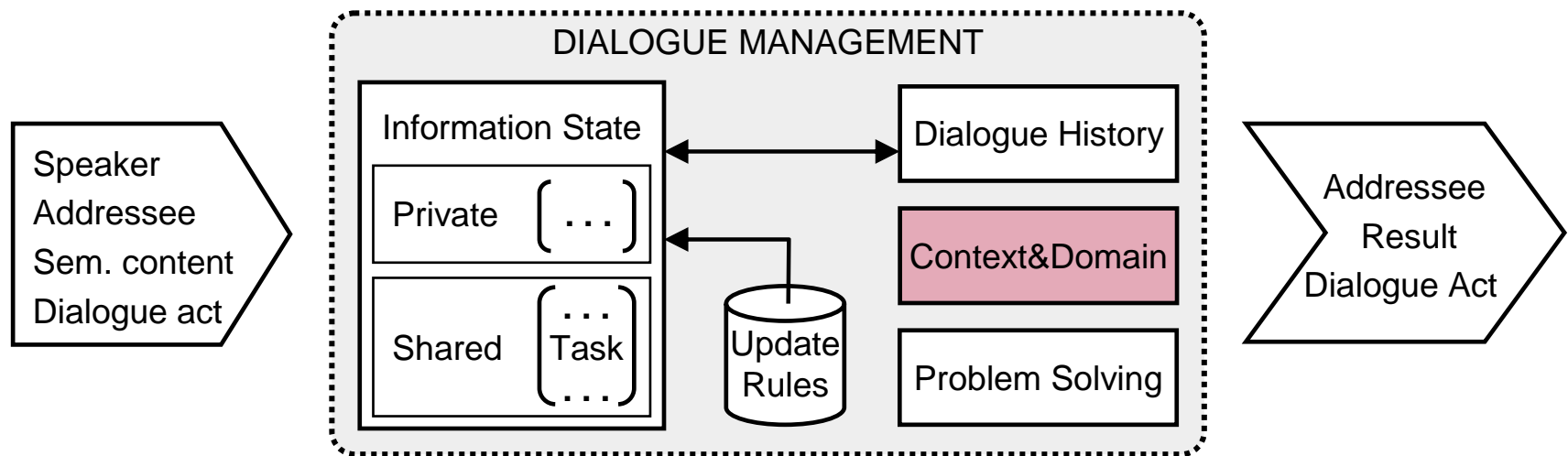
Enabling proactive system interaction

- System is always ready to interact
 - **Optimistic grounding and integration strategy**
- System detects suitable moments for contribution of relevant information
 - **Proactive interaction points**
- **Dialogue history**

Dialogue Management: Information State Update Approach



Dialogue Management: Information State Update Approach



Ontology as knowledge source

Constraint based problem solving

- Constraint = user preference
 - Example: „I feel like **Indian** today.“ -> [**food,Indian**]
- Set of constraints used for database query
- Possible problem:
 - **Over-constrained** situation -> query yields no result

Discourse-Oriented Constraint Prioritisation Algorithm

Problem:

- **Over-constrained** situation → no result

Common solution:

- Relaxation of **least important** constraint
- Semantic analysis (SA) for prioritisation
 - Single-user situation:
 - Analysis of how constraint is introduced, e.g. using keywords (*maybe, definitely,..*)
 - Multi-party situation:
 - Complex and difficult
 - SA already performed by additional dialogue partner

Assumption:

- **The longer a constraint is valid in the dialogue, the more important it is.**

Solution:

- Prioritisation according to the order of introduction of constraints
→ **Discourse-Oriented Constraint Prioritisation** algorithm (**DOP**)

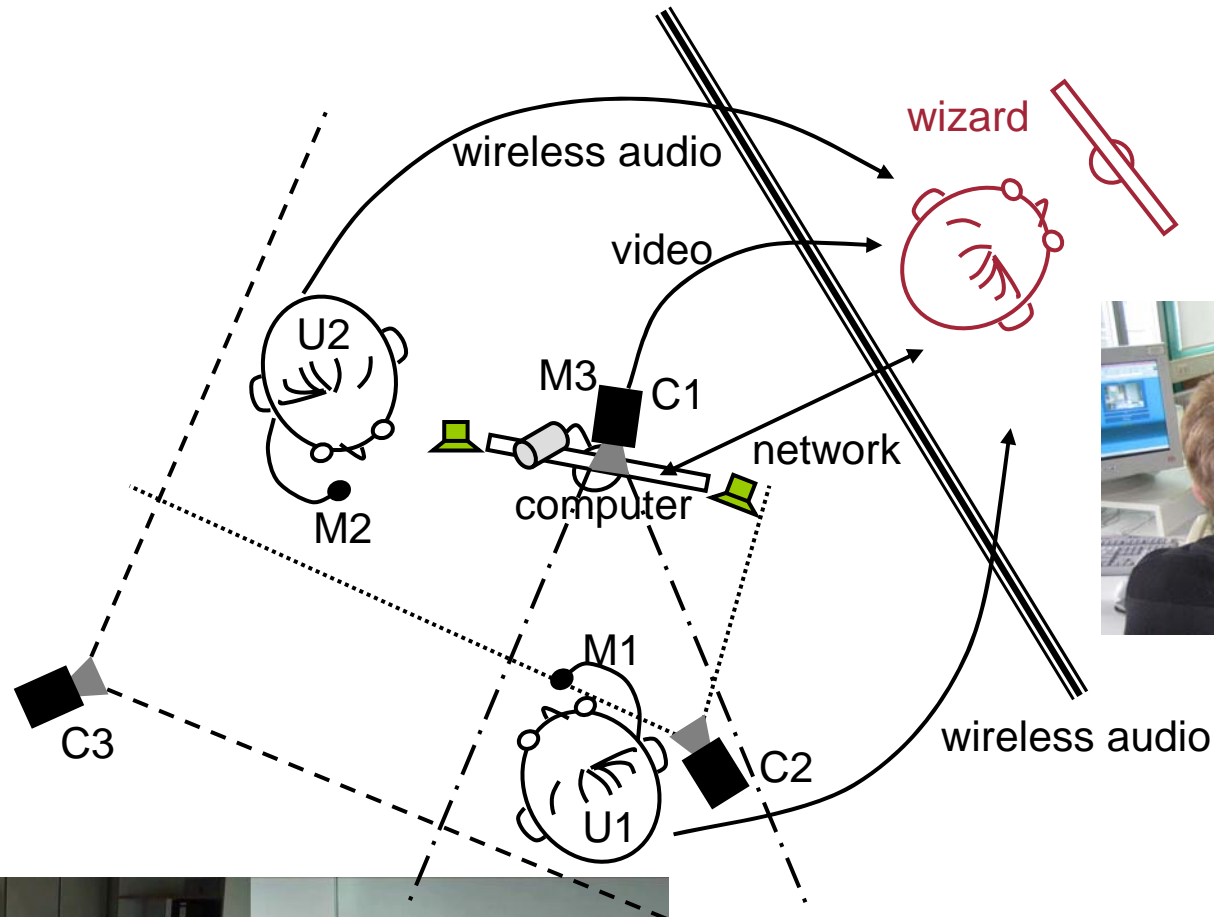
Outline

- Proactive multi-party dialogue management

- Corpus development

- Usability and user acceptance evaluation

Wizard-of-Oz setup for data collection



PIT Corpus

- Data recordings in 2006 / 2007
- Participants: 152 (35% female, 24 yrs avg.)
- Duration: 13:45 h total, 11 min dialogue avg.
- Basis for dialogue management development and evaluation



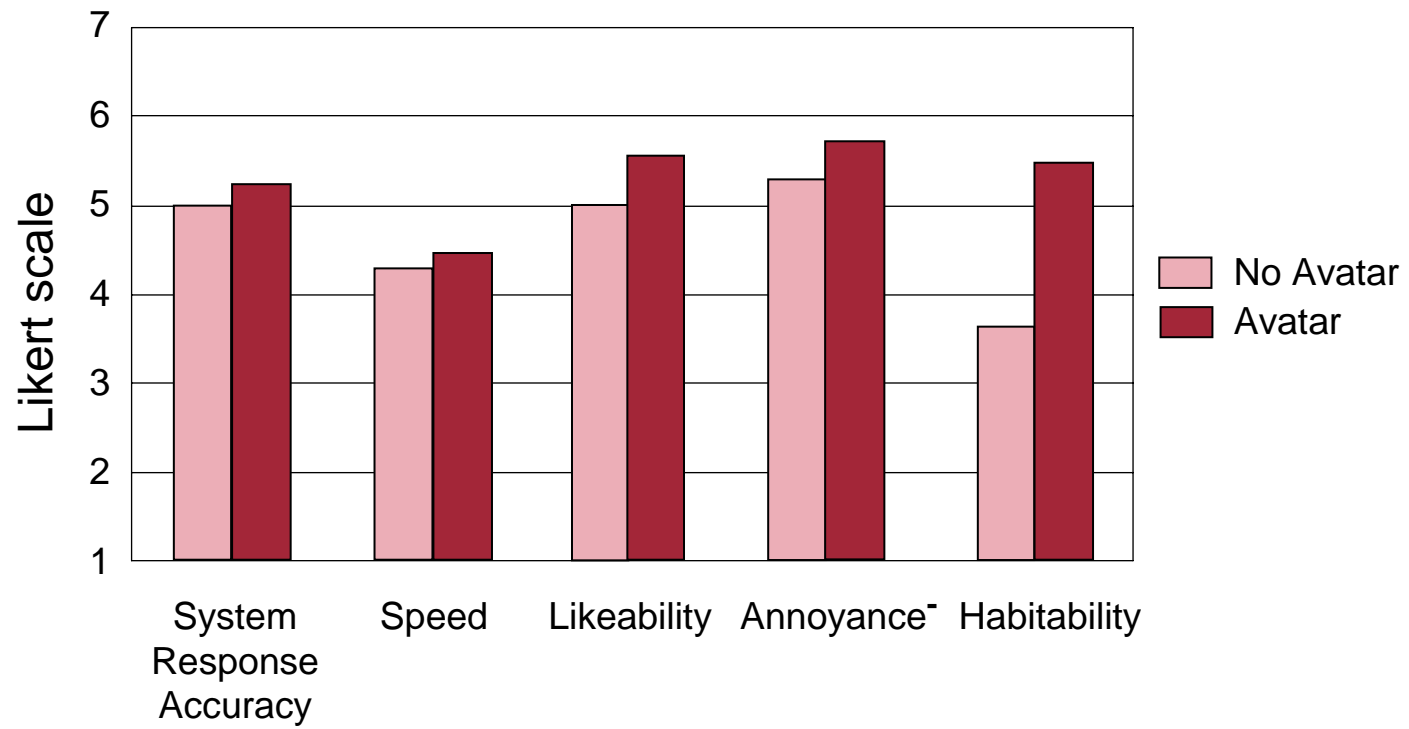
	I	II	III				total
Dialogues	19	20	14	11	5	7	76
Avatar	-	+	+	-	+	-	51.3%
Emotion eliciting strategy	-	-	-	-	+	+	15.8%

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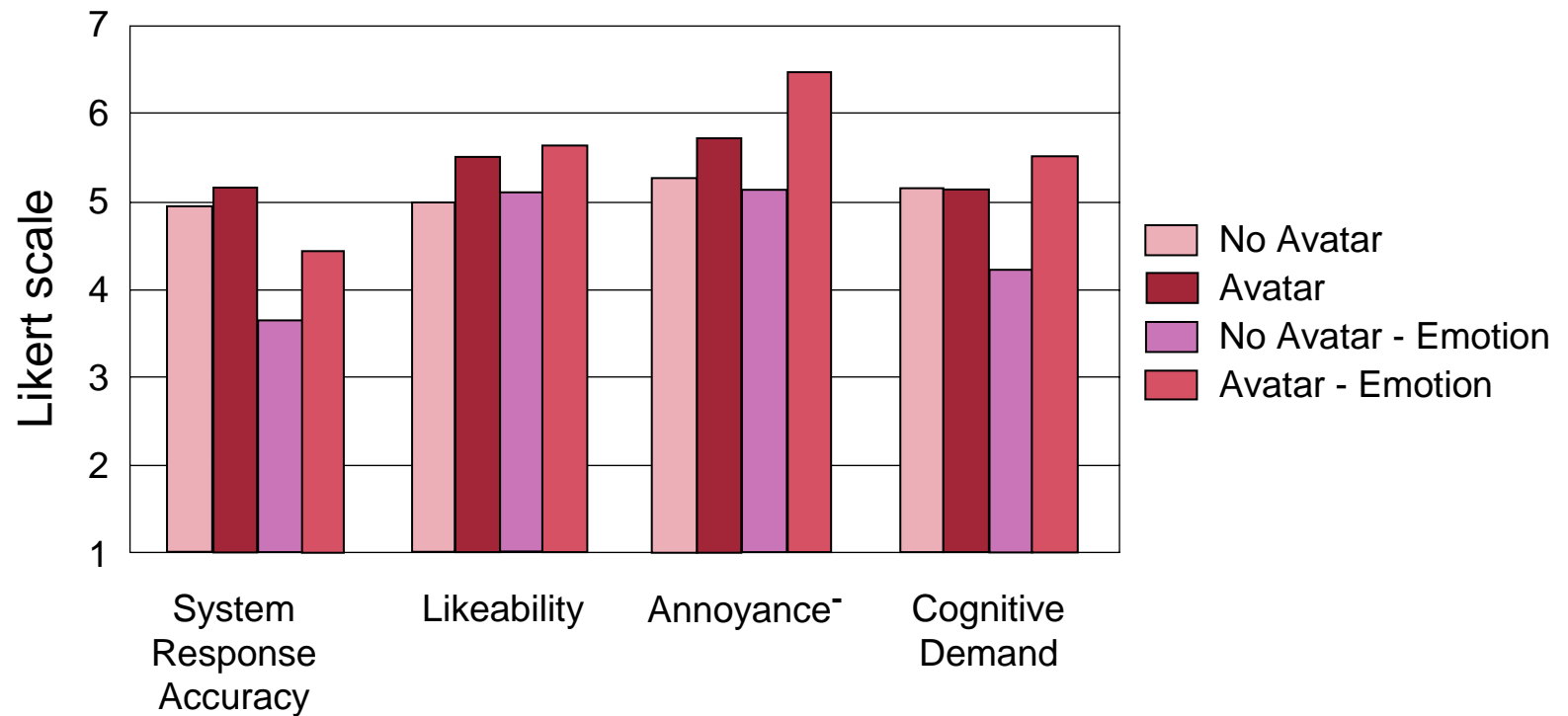
Effect of Avatar on Usability

- Perfect system interaction
- Avatar vs. no avatar



Effect of Emotion Eliciting Strategy on Usability

- Perfect vs. erroneous system interaction
- Avatar vs. no avatar

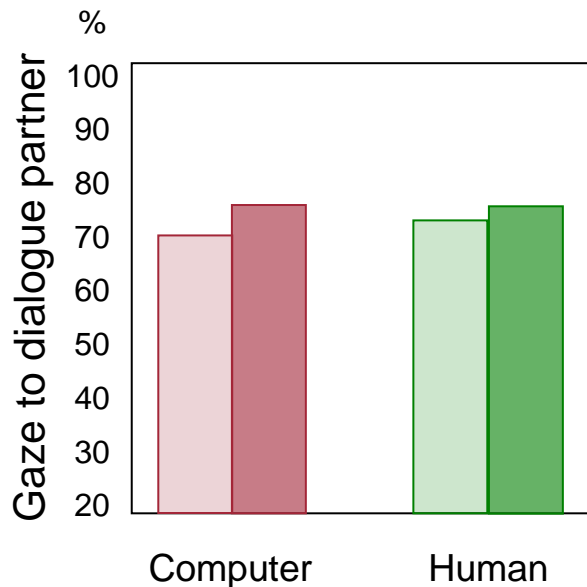


Acceptance of Dialogue partner

- Gaze direction analysis to assess user's attention towards computer vs. human dialogue partner
- 20 hand-annotated dialogues
- Only three-party interaction phase without screen display

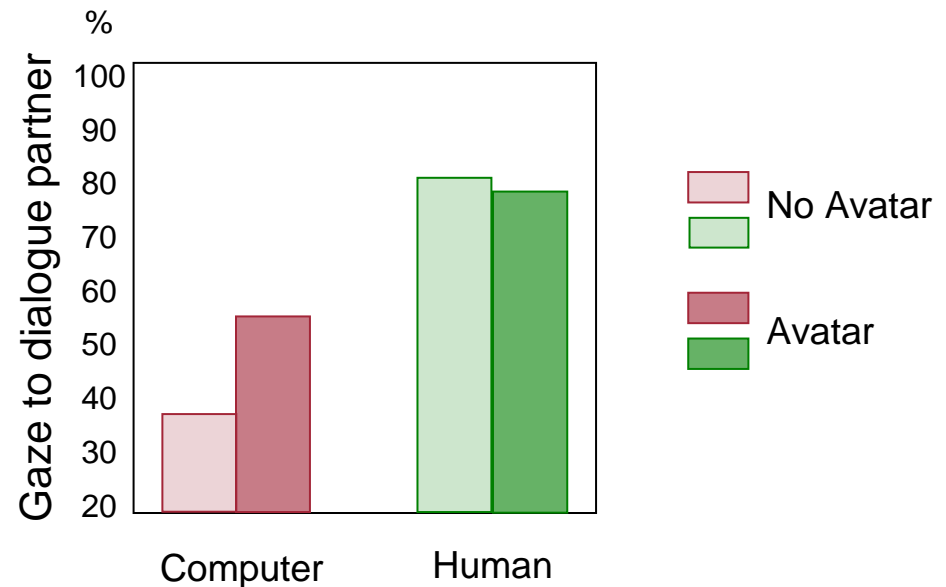
- **Addressing behaviour:**

User addresses and looks at dialogue partner



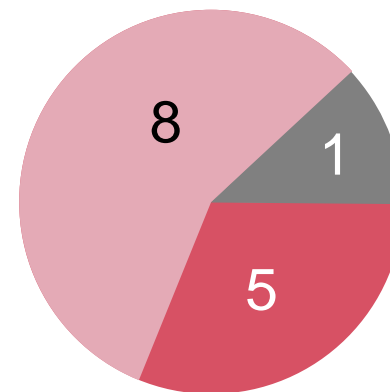
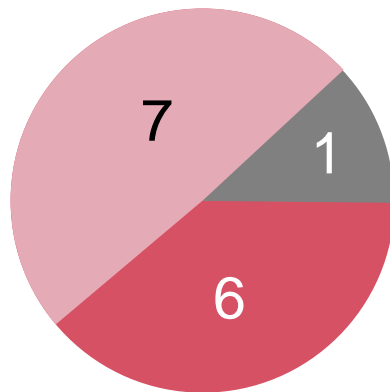
- **Listening behaviour:**

User looks at dialogue partner who is speaking



Performance of Discourse-Oriented Prioritisation (DOP)

- 14 over-constrained situations in dialogues
- Determination of relaxation candidate = constraint that users relaxed in dialogue
- Comparison DOP vs. users
- DOP vs. manual semantic analysis



■ Same relaxation candidate

■ Different relaxation candidate

■ No relaxation necessary → proposal of suitable alternative

Thesis Contributions

Theoretical

- Development of proactive multi-party dialogue management approach including dialogue history and human-human interaction modelling
- Development of discourse-oriented prioritisation approach

Practical

- Implementation of developed dialogue system components
- Implementation of Wizard environment
- Development, annotation and analysis of PIT Corpus as a testbed for theories and modelling

Experimental

- Evaluation of usability using questionnaires
- Assessment of user acceptance using gaze direction analysis
- Evaluation of discourse-oriented prioritisation approach

* Thanks to the other PIT project members for collaboration!

Future work

Multi-party dialogue management

- Adoption to other domains

Automatic gaze direction tracking

- Parallel input / output modalities

Emotion recognition

- Detect and handle user emotions

System as personal assistant

- User modelling

Publications

Selected publications:

- **P.-M. Strauß**, H. Hoffmann, W. Minker, H. Neumann, G. Palm, S. Scherer, F. Schwenker, H.C. Traue, W. Walter, U. Weidenbacher (2006) *Wizard-of-Oz Data Collection for Perception and Interaction in Multi-User Environments*; International Conference on Language Resources and Evaluation (**LREC**), Genoa (Italy)
- **P.-M. Strauß**, H. Hoffmann, S. Scherer (2007) *Evaluation and User Acceptance of a Dialogue System Using Wizard-of-Oz Recordings*; 3rd IET International Conference on International Environments (IE), Ulm (Germany)
- S. Scherer, **P.-M. Strauß** (2008) *A Flexible Wizard of Oz Environment for Rapid Prototyping*; International Conference on Language Resources and Evaluation (**LREC**), Marrakesh (Morocco)
- **P.-M. Strauß**, S. Friedmann, T. Heinroth (2008) *Discourse Motivated Constraint Prioritisation for Task-Oriented Multi-Party Dialogue Systems*; 12th Workshop on the Semantics and Pragmatics of Dialogue (LonDial), London (UK)
- **P.-M. Strauß**, H. Hoffmann, W. Minker, H. Neumann, G. Palm, S. Scherer, H.C. Traue, U. Weidenbacher (2008) *The PIT Corpus of German Multi-Party Dialogues*; International Conference on Language Resources and Evaluation (**LREC**), Marrakesh (Morocco)
- W. Minker, J. Pittermann, A. Pittermann, **P.-M. Strauß**, D. Bühler (2009) *Challenges in Speech-Based Human-Computer Interfaces*; **International Journal of Speech Technology**
- W. Minker, T. Heinroth, **P.-M. Strauß**, D. Zaykovskiy (2009) *Interaction in Intelligent Environments*; In: Human-Centric Interfaces for Ambient Intelligence, Chapter 18, Elsevier.

- First Author of **6** conference papers
- Co-Author of **2** journal papers, **1** book chapter, **4** conference papers

References

Information State Update Approach, e.g.

- Larsson, S. and Traum, D. R. (2000). Information state and dialogue management in the TRINDI dialogue move engine toolkit. *Natural Language Engineering*, 6(3-4):323-340.
- Larsson, S. (2002). Issue-based Dialogue Management. PhD thesis, Göteborg University, Sweden.

Multi-Party Information State Update Approach

- Kronlid, F. (2008). Steps Towards Multi-Party Dialogue Management. PhD thesis, Göteborg University, Sweden.
- Ginzburg, J. and Fernandez, R. (2005). Action at a distance: the difference between dialogue and multilogue. In *Proceedings of the 9th Workshop on the Semantics and Pragmatics of Dialogue (DIALOR)*, Nancy, France.

Evaluation:

- Hone, K. S. and Graham, R. (2000). Towards a tool for the Subjective Assessment of Speech System Interfaces (SASSI). *Natural Language Engineering*, 6(3-4):287-303.

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