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Adaptive Dialogue Management in Human-Machine Interaction

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- **Research in the domain of affective computing is usually primarily concentrated on detection of emotional user behavior.**

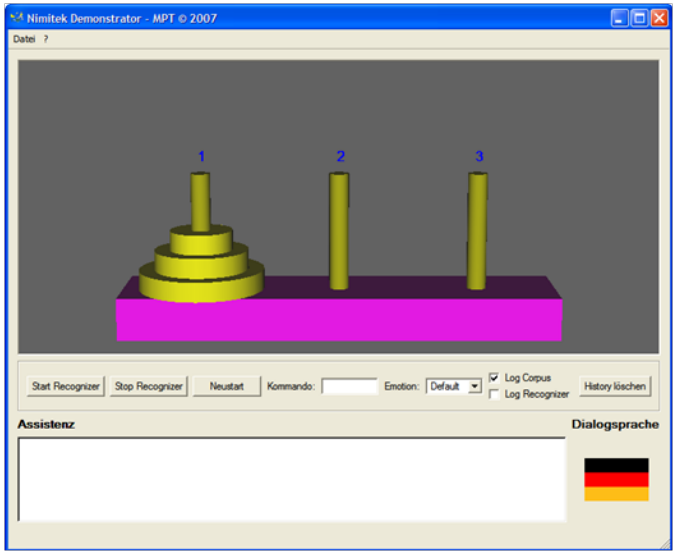
- **However, less attention is devoted to another important research question:**

  - *How to enable dialogue systems to overcome problems in the interaction related to affected user behavior*?

- **This talk addresses the latter question.**

- **We introduce an approach to adaptive dialogue management:**
  - We discuss theoretical considerations, …
  - … and exemplify them for the NIMITEK prototype spoken dialogue system for supporting users while they solve problems in a graphics system.

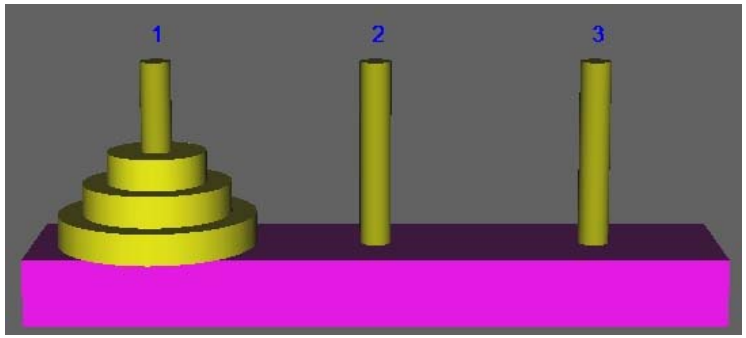
- **The dedicated task:**
  - the Tower of Hanoi puzzle.



- **The main idea:**
  - The system should dynamically adapt its dialogue strategy according to the current state of the interaction.

- **The state of the interaction is a composite of five interaction features:**
  1. the state of the task,
  2. the user's command,
  3. the focus of attention,
  4. the state of the user,
  5. the history of interaction.

- **Tower of Hanoi puzzle:**
  - the state of the task is defined by the positions of the disks.



- **More generally, the state of the task is observable:**
  - it can be explicitly defined and evaluated with respect to how it corresponds to expected final state.

- **Six types of users' commands:**
  - valid command (i.e., the instructed move is allowed according to the rules of the puzzle),
  - illegal command (i.e., the instructed move violates the rules of the puzzle),
  - semantically incorrect command (e.g., the user instructs a non-existing move, etc.),
  - help command (i.e., the user explicitly asks for support),
  - switching between interface languages (German or English),
  - unrecognized command (e.g., not recognized by the speech recognition module, etc.).

- **The focus of attention:**
  - in each moment of the interaction, the focus of attention is placed on the currently most salient entity from the interaction domain.

- **An example:**
  - solving the Tangram puzzle.

- **The sequence of the subject's commands:**
  - In the first command, the subject selects a Tangram piece.
  - Afterwards, she instructs only actions that should be performed over the selected piece without explicitly referring to the selected piece itself.

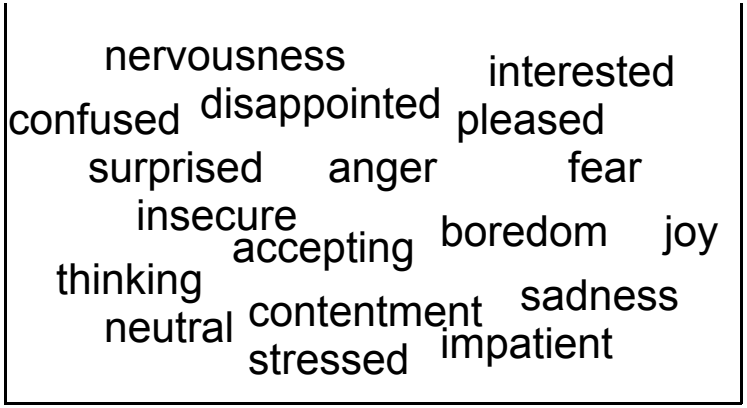
- **Utterances produced by the subject are elliptical:**
  - she omits to utter information that is already known by the system and, in the same time, brings new information in the focus of attention.

- **We introduced a model of attentional state on the level of the user command:**
  - we use it to process user's commands of different syntactic forms,
  - (the model is not discussed in more detail here)
  - in each moment of the interaction, the focus of attention is placed on the currently most salient entity from the interaction domain.

- **Three emotional states of the user:**
  - negative, neutral and positive.
- **The question:**
  - what the non-neutral user states exactly represent in the given scenario?
- **To find an answer:**
  - evaluation of the NIMITEK corpus with respect to its emotional content.

The NIMITEK corpus of affected user behavior in human-machine interaction is available for research purposes upon request.

- **Phase 1 – Data-driven evaluation:**
  - 6 evaluators (3 German native speakers and 3 non-German speakers),
  - evaluators were advised to introduce labels according to their own perceptions.
- **Introduced labels:**



- **Phase 2 – Evaluation with predefined labels:**
  - 5 evaluators (native German speakers),
  - evaluators used labels from the ARISEN model.

Introduced labels	***Classes***
anger, nervousness, stressed, impatient	**A**nnoyed
fear, insecure, confused	**R**etiring
sadness, disappointed, accepting, boredom	**I**ndisposed
joy, contentment, pleased	**S**atisfied
thinking, surprised, interested	**E**ngaged
neutral	**N**eutral

negative

positive

- **Negative state:** the user is …
  - frustrated due to problems that occurred in the interaction,
  - discouraged because she does not know how to solve a given task,
  - or there is a lack of interest in the user's attitude to solve the task.

- **Positive state:** the user is …
  - motivated to solve the task and/or
  - satisfied with the development of interaction.

- **The history of interaction:**
  - collects relevant information related to the interaction from its beginning.

- **Every time when a new event arises in the interaction, a new entry is added in the history of interaction, containing:**
  - current values of other interaction features,
  - description of the currently applied dialogue strategy,
  - time of making the entry.

- **The main idea:**
  - The system should dynamically adapt its dialogue strategy according to the current state of the interaction.

- **Dynamical adaptation of the dialogue strategy is determined by three decision making processes:**
  - When to provide support to the user?
  - What kind of support to provide?
  - How to provide support?

Decision 1: When to provide support to the user?

- The user does not understand the rules of the puzzle.
- The user does not know how to solve the puzzle.
- The user's instruction cannot be recognized.
- The user explicitly asks for support.
- The user is inactive.
- etc.

Decision 2: What kind of support to provide?

- Task-Support: related to the task itself,

  e.g., explaining the rules of the puzzle and helping to find its solution.

- Interface-Support: related to the interface language,

  e.g., helping to formulate a valid command.

- User-Support: related to the engagement of the user,

  e.g., motivating a discouraged or apathetic user.

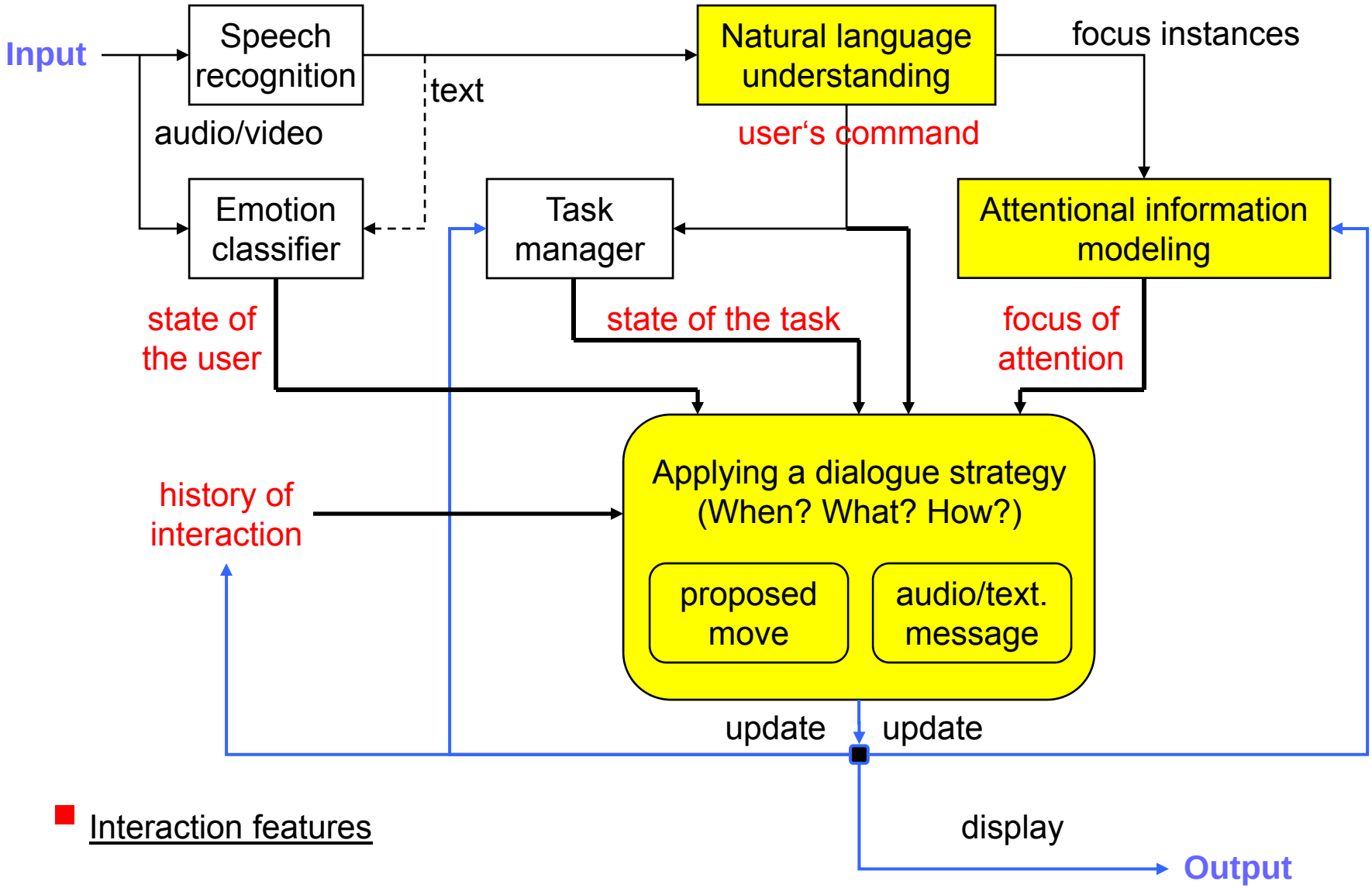
Decision 3: How to provide support?

- The manner of providing support is determined by the state of the user.
- A user in negative emotional state needs a more informative support.

  - An example: user instructs a wrong move.

… just a warning might be enough ...

… the next correct move should probably be proposed …


Input
Speech recognition
text
audio/video
Natural language understanding
focus instances
user's command
Emotion classifier
Task manager
Attentional information modeling
state of the user
state of the task
focus of attention
history of interaction
Applying a dialogue strategy (When? What? How?)
proposed move
audio/text. message
update
update
Interaction features
display
Output

An example

Conclusion

- **We addressed the research question:**
  - *How to enable dialogue systems to overcome problems in the interaction related to affected user behavior*?

- **We introduced an approach to adaptive dialogue management in human-machine interaction…**

- **… and exemplified it for the NIMITEK prototype system.**

- **However, underlying concepts are designed to be task-independent.**

Thank you for your attention!

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