Language Technology II: Dialogue Design, Evaluation, Learning

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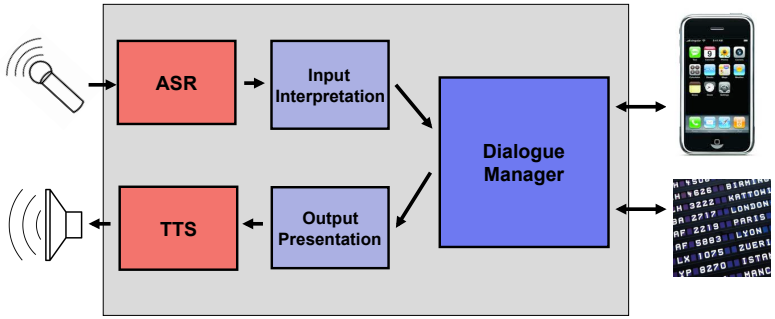
Manfred Pinkal

Dialog System: Basic Architecture



Input Interpretation

- NL input is mapped to shallow semantic representations:
  - „Take me to the third floor, please“; „Third floor“; „Floor number three“; „Three“ express the same information in the context of the question „Which floor do you want to go?“
  - „5:15 p.m.“, „17:15“ „a quarter past five“ express the same time information

Input Interpretation and Language Models

- How do we get from user input to representations of the relevant information that drives the dialogue manager?
- We use interpretation grammars.
- The status of interpretation grammars is different dependent on the different kinds of language models used in the ASR component of the dialogue system.
- Two basic methods:
  - Hand-coded Recognition Grammars
  - Statistical Language Models (SLMs)

Recognition Grammars

- Hand-coded Recognition Grammars
  - Typically written in BNF notation (Context-free grammars)
  - Typically shallow “semantic grammars” with no recursion
  - Are compiled to regular grammars/finite automata (by ASR system) without loss of information

- An example:

  $turn = [please] turn | turn $direction ;

  $direction= (back|backward)| $side;

  $side = [to the](left | right)

Recognition Grammars with Interpretation Tags

- An example:

  $turn = [please] turn {$.action="turn"}

  | turn $direction {$.direction=$direction} {$.action="turn"};

  $direction= (back|backward) {"backward"}| $side {$.side=$side};

  $side = [to the](left {"left"} | right {"right"})

- Recognition grammars with interpretation tags have double function. They (1) constrain the language model and (2) interpret the recognised input.

Properties of recognition grammars

- Allow quick and easy specification of application-specific and dialogue-state specific language models
- Thereby drastically reduce search space for recognizer
  - Example: $yn_answer = yes | no
- But: Strictly constrain recognition results to the language specified in the grammar.
- Keyword Spotting
  - Working with wildcards

  Example:

  $turn = GARBAGE* turn | turn $direction GARBAGE* ;

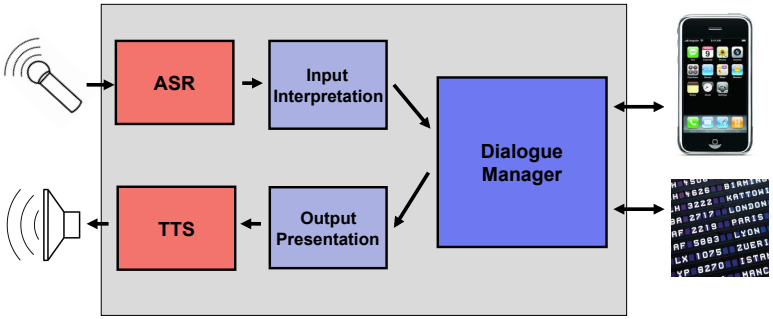
  $direction= (back|backward)| $side;

  $side = GARBAGE* (left | right)
  - No relevant lexical information is lost, but recogniser perfomance decreases

Interpretation Grammars for SLMs

- Statistical Language Models (SLMs) are
  - trained on text or transliterated dialogue corpora
  - based on n-gram (typically trigram) probabilities
- Interpretation grammars for SLMs look like recognition grammars with interpretation tags.
- But they work different : They parse the speech recogniser output (typically on the best chain)
- SLMs are permissive with respect to the sequences they (in part erroneously) predict.
- Therefore permissive parsers are needed, which may skip material (assigning a penalty for edits).
- An example: An Earley parser building up a chart, and selecting the best path (w.r.to the number of omitted words).

Dialog System: Basic Architecture



Output Presentation: Generation

- Template-based generation for speech output:
  - The next flight to $AIRPORT will leave at $DAYTIME.

Dialog Design

"...If you'd like to hear all of your options again, press 49. If you've forgotten why you called in the first place, press 50."

Dialog Design: Best Practise Rules

- Do not give too many options at once.
- Guide the user towards responses that maximize
  - clarity and
  - unambiguousness.
- Guide users toward natural 'in vocabulary' responses.
  - *How can I help you? vs.*
  - *Which floor do you want to go?*
  - *You can check an account balance, transfer funds, or pay a bill. What would you like to do?*
- Keep prompts brief to encourage the user to be brief.

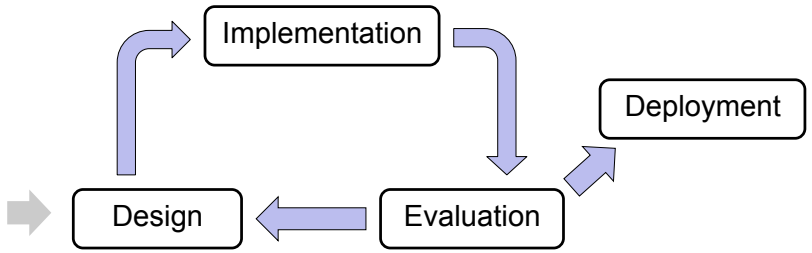
Dialog Design: Best Practise Rules

- Allow for the user not knowing
  - the active vocabulary
  - the answer to a question or
  - understanding a question.
- Design graceful recovery when the recognizer makes an error.
- Allow the user to access (context-sensitive) help at any state; provide escape commands.
- Assume errors are the fault of the recognizer, not the user.

Dialog Design: Best Practise Rules

- Assume a frequent user will have a rapid learning curve.
- Allow shortcuts:
  - Switch to expert mode/ command level.
  - Combine different steps in one.
  - Barge-In

Dialogue Evaluation



Modes of Dialogue Evaluation

- Technical evaluation
- Usability evaluation
- Customer evaluation

Levels of Evaluation

- Technical evaluation
  - Typically component evaluation
  - ASR: Word-Error Rate, Concept Error Rate
  - TTS: Intelligibility, Pleasantness, Naturalness
  - Linguistic Coverage: OOV, OOG rate ("out of vocabulary", "out of grammar")
  - Dialogue flow, turn level: Frequency of timeouts, rejects, help requests, barge-ins
- Usability evaluation
- Customer evaluation

Different levels of evaluation

- Technical evaluation
- Usability evaluation
  - Typically an end-to-end “black box” evaluation
  - Main criteria are:
    - Effectiveness (Are dialogue goals fully/partially accomplished?)
    - Efficiency (Dialogue duration? Number of turns?)
    - User satisfaction
- Customer evaluation

Evaluation of User Satisfaction

- SASSI („Subjective Assessment of Speech System Interfaces“): A Conceptual Framework for designing User Questionnaires
- Dimensions of user satisfaction:
  - System Response Accuracy: User‘s perception of the system as accurate and doing what they expect
  - Likeability: User‘s rating of the system as useful, pleasant, friendly
  - Cognitive demand: The perceived amount of effort needed to interact with the system and feelings arising from this effort
  - Annoyance: User‘s rating of the system as repetitive, boring, irritating, and frustrating
  - Habitability: The extent to which users knew what to do and what the system was doing
  - Speed: How quickly the system responded to user inputs

Different levels of evaluation

- Technical evaluation
- Usability evaluation
- Customer evaluation
  - Costs
  - Platform compatibility
  - Maintenance properties
  - Scalability
  - Portability

Example: The TALK Project

TALK Evaluation

TALK Evaluation

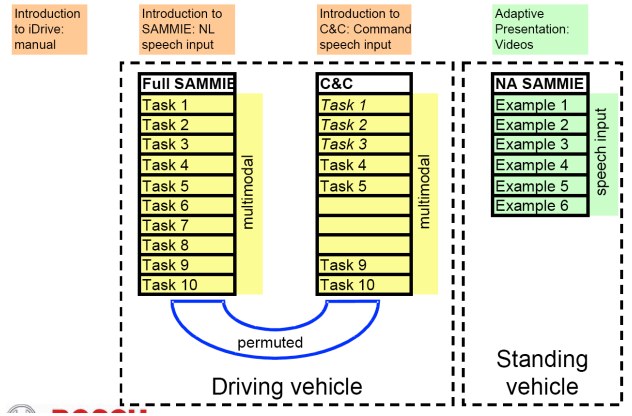
- Sample of 21 subjects
  - 11 from TALK baseline evaluation 2005
  - 6 from other experiments (VICO, other)
  - 4 new
- 7 female / 14 male
- Average age 36,2 (20 - 50)
- Some / much MP3 experience
- Enough driving experience for safety reasons
- One experimental session lasted 3 hours, i.e. 2 subjects / day

TALK Evaluation

Setup in the BMW test car

TALK Evaluation

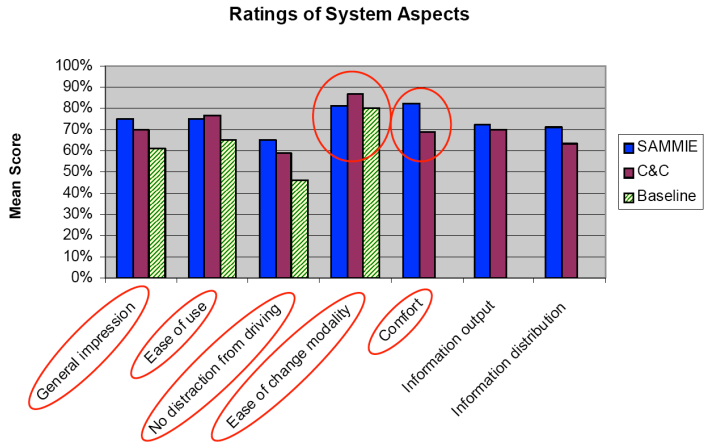
Experimental Session



10 Dialogue Tasks

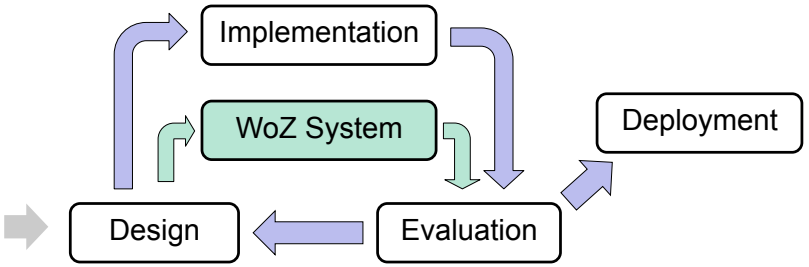
- 1. Ask for the existing albums
- 2. Play back the song ´Der Weg´by ´Herbert Grönemeyer´
- 3. Find out the songs on the playlist ´Pur Klassiker´
- 4. Browse and search for the album ´Live´von ´Pur´and play it back
- 5. Find and play back a Swing song by ´Michael Buble´
- ...

TALK Evaluation



TALK Evaluation

Wizard-of-Oz Simulation



Wizard-of-Oz Studies

- Experimental setup, where a hidden human operator (the “wizard”) simulates (part of) a dialogue system.
- Subjects are told that they interact with a real system.

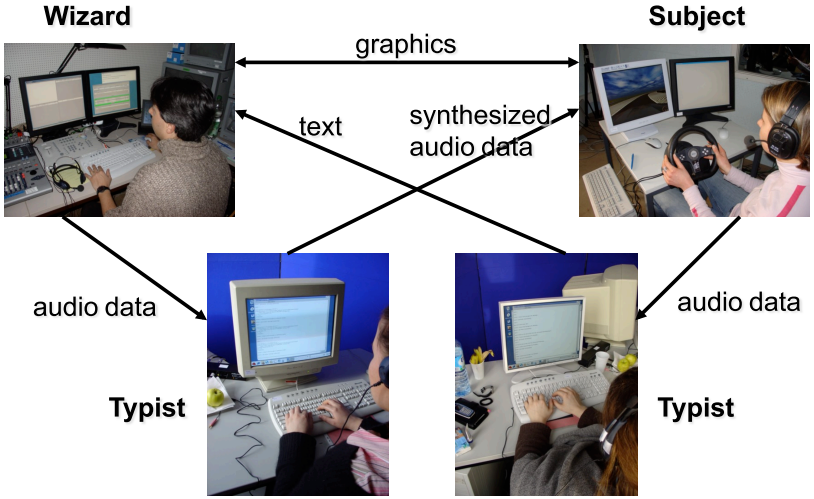
Wizard-of-Oz Studies

- The challenge of providing a convincing WoZ environment:
  - Produce artificial speech output by typing + TTS
  - Induce recognition errors by introducing artificial noise, or presenting input to wizard in a typed version, randomly overwriting single words
  - Constrain natural, conversationally smart wizard reactions by predefining possible system actions and output templates, which the wizard must use.
  - Computer systems are much more efficient in database access, mathematical calculation etc.: Provide the wizard with appropriate interfaces for quick mathematical calculation and database lookup.

An example: WoZ Study in TALK

- Domain: MP3 Player
- Scenario: In-car and In-home
- Multimodal dialogue:
  - Input by speech and ergo-commander/ Keyboard
  - Output by speech and graphics (display)
- Example tasks for subjects:
  - Play a song from the album "New Adventures in Hi-Fi" by REM.
  - Find a song with “believe” in the title and play it.

Information Flow



WoZ Studies: Benefits

- Evaluation of system design at an early stage, avoiding expensive implementation.
- Full control over and systematic variation of speech recognition performance.
- Collection of domain- and scenario-specific language data at an early stage data that can be used
  - for a qualitative analysis of the dialogue behavior of subjects
  - to train or adapt statistical language models
- Systematically exploration of dialogue strategies by varying instructions to the wizard.