Cognitive Models

Presenter

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Cognitive Models

Roadmap

• Introduction to cognitive models
• Categorization of cognitive models
• Goal and task hierarchies
  ✓ Fundamentals
  ✓ Example: GOMS
• Linguistic cognitive models
  ✓ Fundamentals
  ✓ Example: Backus–Naur Form (BNF)
Introduction to cognitive models

• They represent users of interactive systems
• They represent/model aspects of user:
  e.g. understanding, knowledge, intentions, processing
• The emphasis of cognitive models is on formulating aspects of user behaviour

Note:
• Task analysis- to determine the relevant external actions a user performs in some work domain
• Dialog description/notations- to specify and analyze the communication between the user and system
Categorization of cognitive models

Criterion 1: Competence vs. Performance:

• Competence models:
  They represent *expected* behaviour

• Performance models:
  They represent and analyze *routine* behaviour
Categorization of cognitive models

Criterion 2: Their computational flavour/the interaction framework (see below):

1. Formulation of goals and tasks - Goal and task
2. Articulation translation closer to User - Linguistic
3. Articulation translation further from the User/at human motor level) – Physical and device

...3... 2...1...
Categorization of cognitive models

If we were to have a cognitive model (for describing the *User*) having similarity to the language for describing the *System* (see in the diagram), then:

- **Pro**: makes the communication and analysis of the combined/integrated software application easier
- **Con**: encourages a mechanical view of the user
Categorization of cognitive models

1. Goal and task hierarchies

2. Linguistic

3. Physical and device

4. Cognitive architectural
Cognitive models

We will focus on

1. **Goal and task hierarchies**
   [+ eg GOMS (Goals, Operators, Methods and Selection)]

2. **Linguistic**
   [+ eg BNF (Backus–Naur Form)]

3. Physical and device

4. Cognitive architectural
1. Goal and task hierarchies

- *Mental processing* is such that *goals* are achieved by solving *subgoals* in a divide-and-conquer manner

- Example: sales report
  - produce sales report
    - gather data
      - find book names
      - do keywords search of names database
      - ... *further sub-goals*
    - sift through names and abstracts by hand
      - ... *further sub-goals*
    - search sales database - *further sub-goals*
    - layout tables and histograms - *further sub-goals*
    - write description - *further sub-goals*
Goals vs. tasks

- Goals are intentions; what you would like to be true
- Tasks are actions; how to achieve goal(s)
Issues for goal hierarchies

- **Granularity**
  - Where do we start?
  - Where do we stop?

- **Routine learned behaviour, not problem-solving**
  - Unit task [it is the most abstract task; doesn’t require problem-solving skills on the part of the user; it often requires sophisticated problem-solving skills on the part of the designer to determine it]

- **Conflict**
  - More than one way to achieve a goal

- **Error**
  - How does the model take into account the fact that users err?
Techniques for goal and task hierarchies

- Goals, Operators, Methods and Selection (GOMS)
- Cognitive Complexity Theory (CCT)
- Hierarchical Task Analysis (HTA)

[We will focus on GOMS]
GOMS

Goals
- what the user wants to achieve; ‘memory points’ for the user

Operators
- the basic actions user must perform in order to use the system; the lowest level of analysis; usually at a lower level than unit tasks

Methods
- Decomposition/breakdown of a goal into subgoals/operators

Selection
- means of choosing between competing Methods
GOMS example

GOAL: CLOSE-WINDOW
  [select GOAL: USE-MENU-METHOD
    . MOVE-MOUSE-TO-FILE-MENU
    . PULL-DOWN-FILE-MENU
    . CLICK-OVER-CLOSE-OPTION
  GOAL: USE-CTRL-W-METHOD
  . PRESS-CONTROL-W-KEYS]

For a particular user eg John:

Rule 1: Select USE-MENU-METHOD unless another rule applies
Rule 2: If the application is GAME, select CTRL-W-METHOD
Problems with goal hierarchies

• largely post hoc and thus risks being defined by computer dialog rather than the user
• expert vs. novice: GOMS defines its domain to be that of expert use (would it be more appropriate to use goal structures that develop out of the user’s own use of the system?); however in CCT, expert use seems to be useful (e.g., for representing a very early state of knowledge)
• How cognitive are they?
2. Linguistic notations

- Understanding the user's behaviour and cognitive difficulty based on analysis of language between user and system.
- Similar in emphasis to [human] dialogue models
- Linguistic techniques for cognitive modeling:
  - Backus–Naur Form (BNF)
  - Task–Action Grammar (TAG)

[We will focus on BNF]
Backus-Naur Form (BNF)

- Very common notation from computer science
- A purely syntactic view of the dialogue
- Terminals
  - lowest level of user behaviour e.g. CLICK-MOUSE, MOVE-MOUSE
- Non-terminals
  - ordering of terminals
  - higher level of abstraction e.g. select-menu, position-mouse
Example of BNF

- Basic syntax:
  - nonterminal ::= expression

- An expression
  - contains terminals and nonterminals
  - combined in sequence (+) or as alternatives (|)

- draw line ::= select line + choose points + last point
- select line ::= pos mouse + CLICK MOUSE
- choose points ::= choose one | choose one + choose points
- choose one ::= pos mouse + CLICK MOUSE
- last point ::= pos mouse + DBL CLICK MOUSE
- pos mouse ::= NULL | MOVE MOUSE+ pos mouse
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Questions

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Thanks