

Cognitive models

- · goal and task hierarchies
- · linguistic
- · physical and device
- architectural

Cognitive models

- understanding
- knowledge
- intentions
- processing
- Common categorisation:
 - Competence vs. Performance

· They model aspects of user:

- Computational flavour
- No clear divide

Goal and task hierarchies

- · Mental processing as divide-and-conquer
- · Example: sales report produce 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 intentions what you would like to be true
- tasks actions how to achieve it
- GOMS - goals are internal
- HTA - actions external
 - tasks are abstractions

Issues for goal hierarchies

- Granularity
 - Where do we start?
 - Where do we stop?
- · Routine learned behaviour, not problem solving
 - The unit task
- · Conflict
 - More than one way to achieve a goal
- Error

HUMAN-COMPUTE INTERACTION



HUMAN-COMPUTER INTERACTION

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Selection (GOMS)

- · Goals, Operators, Methods and
- Cognitive Complexity Theory (CCT)
- Hierarchical Task Analysis (HTA) -Chapter 15

GOMS

- what the user wants to achieve

Operators

- basic actions user performs

Methods

- decomposition of a goal into subgoals/operators

Selection

- means of choosing between competing methods

GOMS example

For a particular user:

Rule 1: Select USE-MENU-METHOD unless another

rule applies
Rule 2: If the application is GAME,
select CTRL-W-METHOD

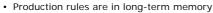
Cognitive Complexity Theory



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- Two parallel descriptions:
 - User production rules
 - Device generalised transition networks
- · Production rules are of the form:
 - if condition then action
- · Transition networks covered under

Example: editing with vi



· Model working memory as attribute-value mapping:

(GOAL perform unit task) (TEXT task is insert space) (TEXT task is at 5 23) (CURSOR 8 7)

· Rules are pattern-matched to working memory,

e.g., LOOK-TEXT task is at %LINE %COLUMN is true, with LINE = 5 COLUMN = 23.

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HUMAN-COMPUTER INTERACTION Four rules to model inserting a space Active rules: SELECT-INSERT-SPACE INSERT-SPACE-MOVE-FIRST INSERT-SPACE-DOIT INSERT-SPACE-DONE New working memory (LOOK-TEXT task is at %LINE %COLUMN)

dialogue models

Notes on CCT

- · Parallel model
- · Proceduralisation of actions
- Novice versus expert style rules
- Error behaviour can be represented
- Measures
 - depth of goal structure
 - number of rules
 - comparison with device description

Problems with goal hierarchies

- · a post hoc technique
- · expert versus novice
- · How cognitive are they?

Linguistic notations



- · Understanding the user's behaviour and cognitive difficulty based on analysis of language between user and system.
- Similar in emphasis to dialogue models
- Backus-Naur Form (BNF)
- Task-Action Grammar (TAG)

Backus-Naur Form (BNF)



- · Very common notation from computer science
- · A purely syntactic view of the dialogue
- · Terminals

 - lowest level of user behavioure.g. CLICK-MOUSE, MOVE-MOUSE
- Nonterminals

 - ordering of terminalshigher 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 (|)

Measurements with BNF



- · Number of rules (not so good)
- Number of + and | operators
- · Complications
 - same syntax for different semantics
 - no reflection of user's perception
 - minimal consistency checking



Task Action Grammar (TAG)

- · Making consistency more explicit
- · Encoding user's world knowledge
- · Parameterised grammar rules
- Nonterminals are modified to include additional semantic features

Consistency in TAG

• In BNF, three UNIX commands would be described as:

```
 \begin{array}{ll} \text{copy} & ::= cp + \text{filename} + \text{filename} \mid cp + \text{filenames} + \text{directory} \\ \text{move} & ::= mv + \text{filename} + \text{filename} \mid mv + \text{filenames} + \text{directory} \\ \text{link} & ::= ln + \text{filename} + \text{filename} \mid ln + \text{filenames} + \text{directory} \\ \end{array}
```

 No BNF measure could distinguish between this and a less consistent grammar in which

link::= In + filename + filename | In + directory + filenames

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Consistency in TAG (cont'd)

- consistency of argument order made explicit using a parameter, or semantic feature for file operations
- Feature Possible values
 Op = copy; move; link
- Rules

```
file-op[Op] ::= command[Op] + filename + filename | command[Op] + filenames + directory command[Op = copy] ::= cp command[Op = move] ::= mv command[Op = link] ::= In
```

Other uses of TAG

- · User's existing knowledge
- Congruence between features and commands
- These are modelled as derived rules



Physical and device models

- The Keystroke Level Model (KLM)
- Buxton's 3-state model
- Based on empirical knowledge of human motor system
- User's task: acquisition then execution.

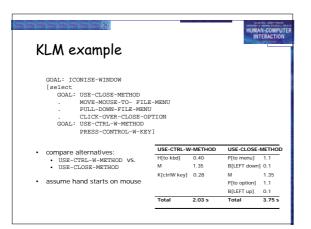
 these only address execution
- · Complementary with goal hierarchies

Keystroke Level Model (KLM)

- · lowest level of (original) GOMS
- six execution phase operators
 Physical motor: K keystrokir
 - K keystroking P - pointing H - homing
 - H homing D - drawing
 - Mental M mental preparation
 - System R response
- times are empirically determined.
 - Texecute = TK + TP + TH + TD + TM + TR

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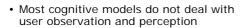
Architectural models

 All of these cognitive models make assumptions about the architecture of the human mind.

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- Long-term/Short-term memory
- · Problem spaces
- Interacting Cognitive Subsystems
- Connectionist
- ACT

Display-based interaction



- Some techniques have been extended to handle system output (e.g., BNF with sensing terminals, Display-TAG) but problems persist
- Exploratory interaction versus planning

