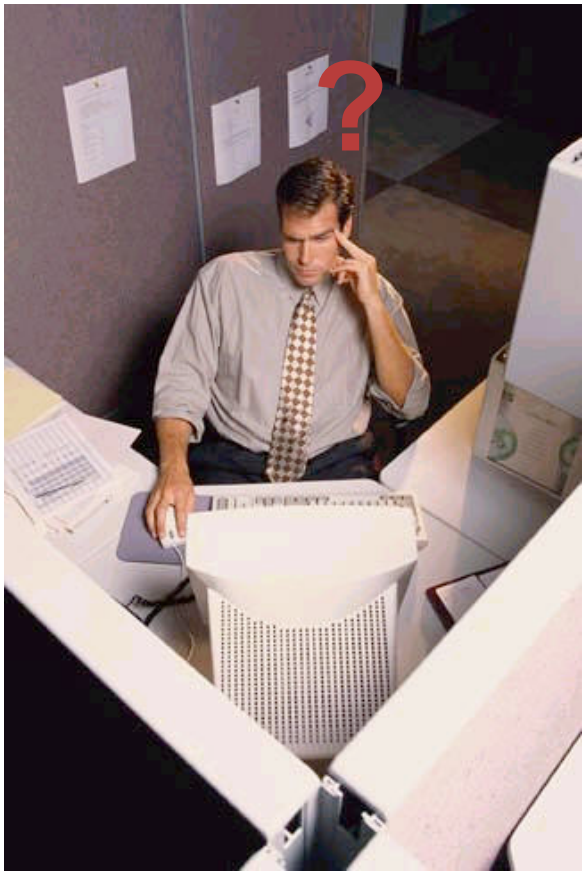
Human-Computer Interaction

Termin 4:
Reasoning and Acting



Deductive Reasoning

- Derive logically necessary conclusion from given premises

  e.g. If it is Friday then she will go to work

  → It is Friday, therefore she will go to work.

- Logical conclusion not necessarily true:

  e.g. If it is raining then the ground is dry

  → It is raining, therefore the ground is dry

- When truth and logical validity clash …

  e.g. Some people are babies. Some babies cry.

  → Some people cry

  Invalid since we are not told that all people are babies.

- People bring world knowledge to bear

Inductive Reasoning

- Induction:
  - generalize from cases seen to cases unseen

    e.g. all elephants we have seen have trunks, therefore all elephants have trunks

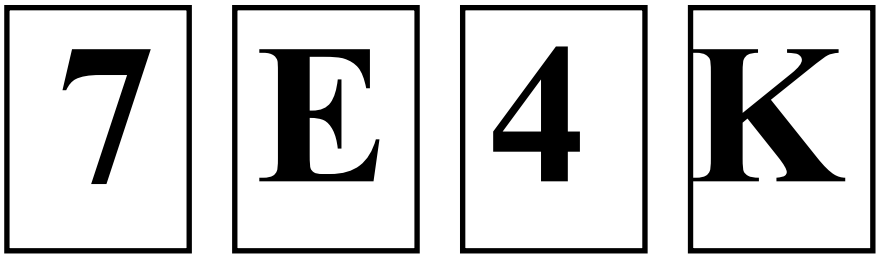
- Unreliable:
  - can only prove false not true (you never know)

  … but useful!

- Humans not good at using negative evidence (confirmation bias), attempt to confirm the claim, while forgetting that it is also important to try and falsify it.

  e.g. Wason's cards

Wason's cards



If a card has a vowel on one side, it has an even number on the other

How many cards do you need to turn over to prove or disprove this?

…. and which cards?

Abductive reasoning

- reasoning from event to cause

  e.g. Sam drives fast when drunk.

  If I see Sam driving fast, assume drunk.

- Unreliable:
  - can lead to false explanations
  - generates hypotheses

Problem solving

- Process of finding solution to unfamiliar task using knowledge

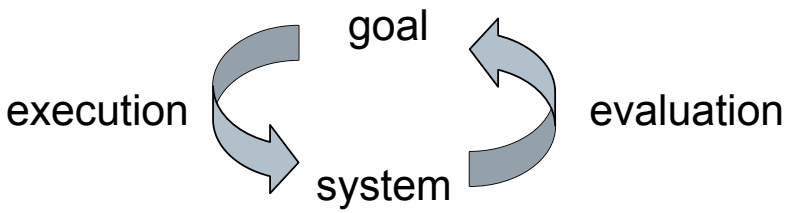
- *Problem space* theory
  - problem space comprises problem states
  - problem solving involves generating and testing states using legal operators
  - heuristics may be employed to select operators e.g. *means-ends analysis*
  - operates within human information processing system, i.e., suffers from STM limits etc.
  - largely applied in AI, mostly in well-defined and well-understood areas, e.g. puzzles or chess, rather than knowledge intensive areas

Problem solving – analogy, skill

- Analogical mapping
  - novel problems in new domain?
  - use knowledge of similar problem from similar domain
  - difficult if domains are semantically different

- Skill acquisition
  - skilled activity characterized by *chunking*
  - a lot of information is chunked to optimize STM, e.g., chess masters plan not single moves but „manoeuvers“
  - conceptual rather than superficial grouping of operator applications (that solve sub-problems)
  - information is structured more effectively

Example



You are sitting reading as evening falls

Goal - need more light

Intention - switch on desk lamp or ask for it or…

Actions - reach over, press lamp switch

Result - light is either on or off

Interpret - light is off? Maybe bulb has blown

→ goals - change bulb

Evaluate - light is on? Is it enough?

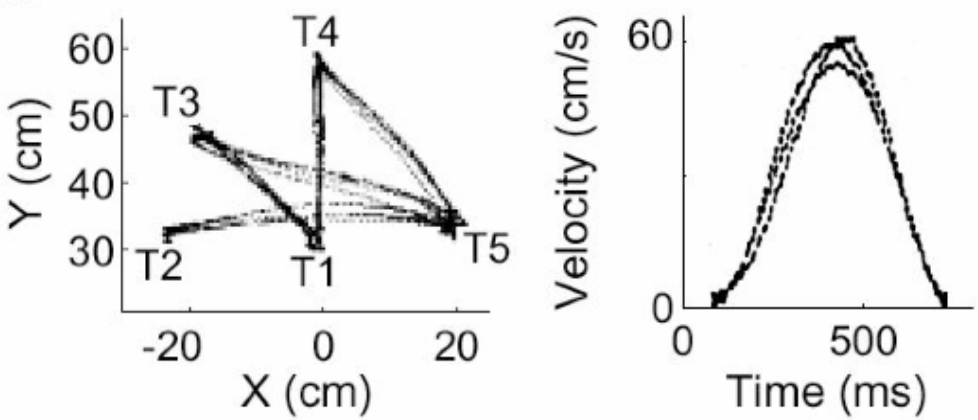
→ goals - switch on main ceiling light too

Sensory-motor Interaction

- Time taken to respond to stimulus =
  reaction time + movement time
- movement time: depend on age, fitness, etc.
- reaction time: dependent on stimulus type
  - visual ~ 200ms
  - auditory ~ 150 ms
  - pain ~ 700ms
  - combined ~ quickest response!
- reduced reaction time decreases accuracy in the unskilled operator, but not in the skilled operator.

Movement

- goal-directed hand movement consists of segments
  - linear or curved, bell-shaped velocity profiles
  - constant plane of movement in 3D
- movement time depends on difficulty of the movement
  - distance to target (D)
  - size of target (S)



Uno, Kawato & Suzuki, 1989

Use *metaphors*

- relate computing to other real-world activity
- evoke a *mental model* of the system's structure and functions
- must be consistent!
- relate to user‘s experiences
- facilitate learning and retention of interface

Interaction metaphors we see today

- *Desktop metaphor*: currently predominant
- *Book metaphor*: for big documents, e.g. hypertext
- *Filing cabinets*: for online documentation, system settings, etc.
- *Office metaphor*: for collections of programs/tools
- *Library metaphor*: for large collections of documents
- *Building metaphors*, etc.: for virtual worlds
- *Animated agent* metaphor: for guidance and recommendation
- *Composite* metaphors: combine metaphors, e.g. office + file cabinet + desktop

Use *affordances*

- *"refers to the properties of objects -- what sorts of operations and manipulations can be done to a particular object"*
  (D. A. Norman 1988, The Psychology of everyday things)
- A „door" affords opening, a „chair" affords support
- *perceived affordance*: the extent to which objects visually suggest their affordance

mug handle

'affords' grasping

Perceived affordances

- for physical objects
  - shape and size suggest actions (pick up, twist, throw…)
- for screen objects
  - button–like object 'affords' mouse click
  - physical-like objects suggest use
- culture of computer use
  - icons 'afford' clicking
  - or even double clicking … not like real buttons!

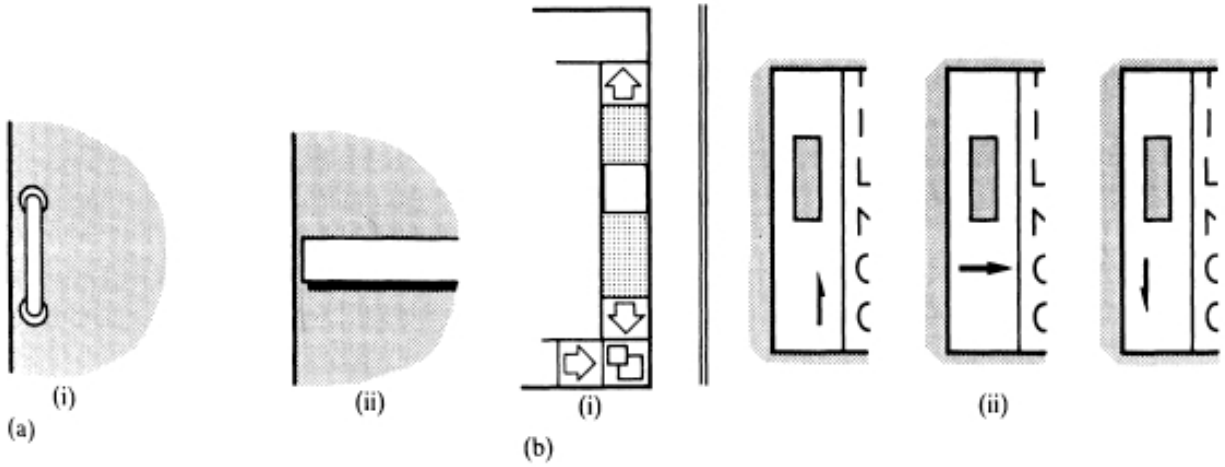


Figure 4.5 The affordance of objects (Gaver, 1991). (a) Door handles; (b) scroll bars (© 1991, Association for Computing Machinery, Inc. reprinted by permission).