Human-Computer Interaction

Lecture 4: Inference-based approaches

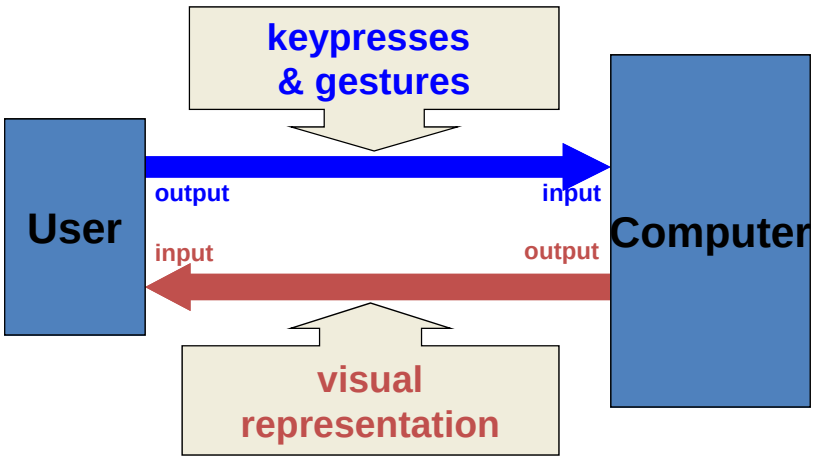
WHAT MAKES SYSTEMS 'INTUITIVE'?

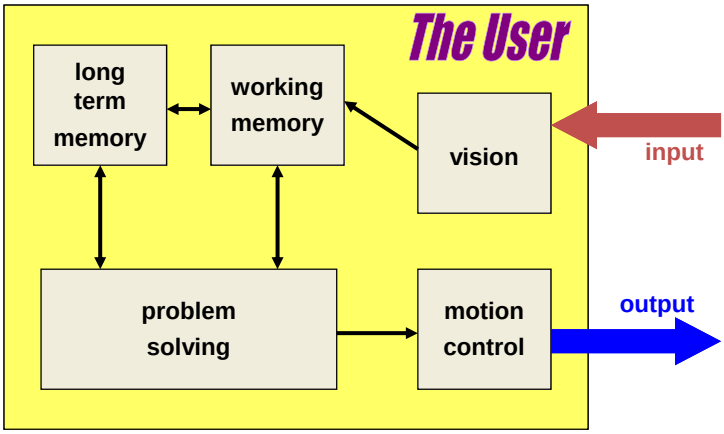
From Part 1a Software Design …

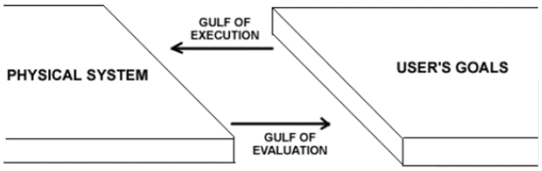
The psychological approach

- Anticipate what will happen when someone tries to use the system.
  - Design a "conceptual model" that will help them (and you) develop shared understanding.
- The gulf of execution:
  - System users know ***what*** they want to achieve, but can't work out ***how*** to do it.
- The gulf of evaluation:
  - Systems fail to give suitable feedback on what just happened, so users never learn what to do.
- See Norman: *Design of Everyday Things*.
  - Far more detail to come in Part II HCI course

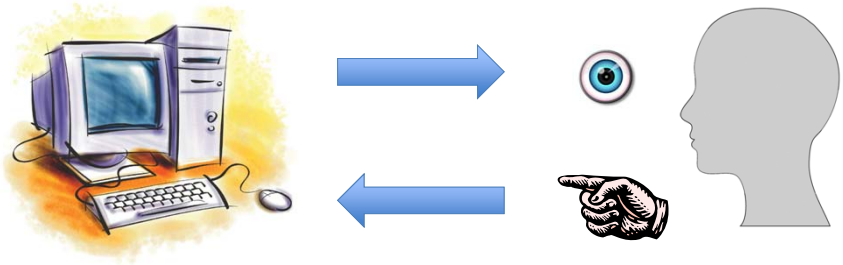
The human operator as a black box




The User
long term memory
working memory
vision
input
problem solving
motion control
output

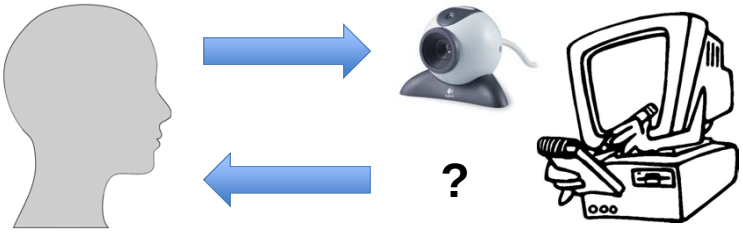

GULF OF EXECUTION
PHYSICAL SYSTEM
USER'S GOALS
GULF OF EVALUATION

What is going on inside that thing?



How can I get it to do what I want?

What is going on inside that thing?



How can I get it to do what I want?

MENTAL MODELS

Mental models

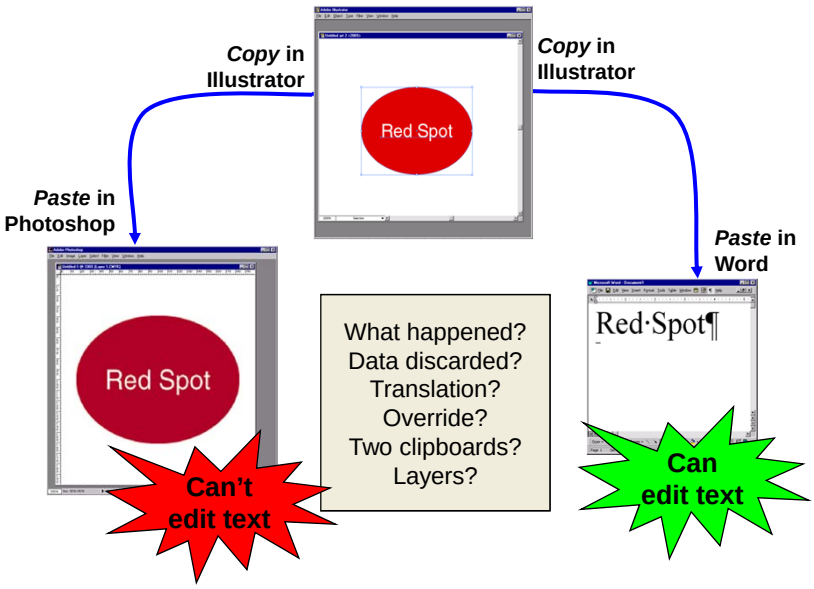
- Study of the mental representations used for everyday problem-solving by ordinary people
- Can be more or less structured:
  - From narrative descriptions in a user persona
  - To AI-style cognitive models of state-space planning
- The mental model of the user is not the mental model of the designer …
  - but can be influenced by the designer.

User's model

Designer's model?

Designer's model

Solving problems with mental models



Think-aloud studies

- Attempt to study a user's mental model directly in a controlled task
  - Originally for research into "problem-solving"
- Subject talks continuously while performing task.
  - Transcribed as a *verbal protocol* for detailed study
- Also used to "evaluate" software when no alternative designs are available
- Or even when you don't have any software at all!
  - (how?)

Wizard-of-Oz implementation

- Originally invented to evaluate artificially intelligent dialogue systems
  - User typed on a real computer, but computer answers were simulated by a 'man behind the curtain'
- With a paper prototype, it's not necessary to hide behind a curtain!
  - Just ask the user to 'click' by pointing on your paper prototype
  - Simulate the system response by sticking on another Post-it note 'window', or replacing the piece of paper
- Paper can be more or less 'low-fidelity'

Computer tools for lo-fi prototyping

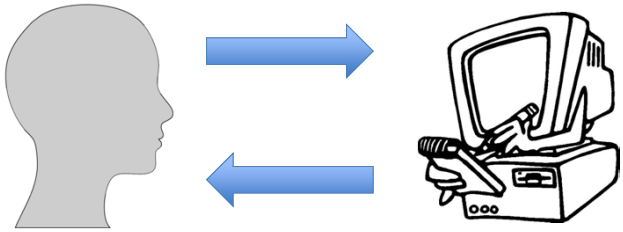
- Some of the WoZ functions can use a computer:
  - e.g. DENIM from University of Washington
  - Take photographs of your paper sketches
  - Display the rough pencil drawings on the screen
  - Define control areas and 'buttons'
  - Simulation tool changes to other sketch screens in response to user actions
- Variants
  - SILK – 'sketch' by drawing on the screen itself
  - Or just load sequence of photos on an iPod and flick through them
- The 'sketchy' appearance helps users comment

Storyboard or 'click-through' prototypes

- Doesn't allow user interaction, but does help them imagine what the system will be like to use.
- PowerPoint is the most commonly used tool
  - Load a series of screen mockups
  - Move the mouse pointer over the screen as though you are controlling it
  - Point at a button and click
  - (but of course, Powerpoint will always go to the next slide, regardless of where the pointer is when you click)

USER MODELS (≠ MENTAL MODELS)

What is going on inside that thing?



How can I get it to do what I want?

(BAYESIAN) USER MODELS

A probabilistic view of user interaction

- Machine:
  - I know how to do several things.
  - I wonder which one the user wants me to do?
- User:
  - This machine can do a whole bunch of stuff.
  - What is most likely to make it do the right stuff?
- Machine:
  - I think the user has made a mistake
- User:
  - I think the machine has made a mistake

Bayes theorem (for Bayesian inference)

Posterior probability of **H**ypothesis *after* taking new **E**vidence into account

Prior inferred probability of this **H**ypothesis *before* new **E**vidence became available.

If Hypothesis is true, how *likely* is it that we would see this Evidence?

$$P(H|E) = \frac{P(E|H)}{P(E)} P(H)$$

What is the probability of seeing E, under all possible hypotheses?

H: Hypothesis
E: Evidence

Bayesian inference inference of user intention

Probability that user wants to delete all files, given that they just typed 'rm –rf'

(Prior) probability that user wanted to delete all files *before* we saw this.

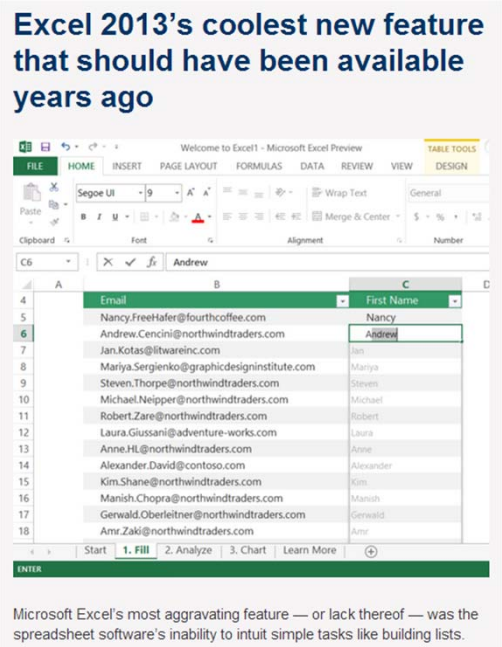
If user does want to delete all files, how *likely* is it that they would type 'rm –rf'?

$$P(D|R) = \frac{P(R|D)}{P(R)} P(D)$$

What is the probability user would type 'rm –rf', under all possible hypotheses?

D: User wants to **D**elete all their files
R: User has typed '**r**m –rf'

Flash Fill: programming by example



Dasher as a user model