Lecture 3: Goal-oriented interaction

Using cognitive theories of planning, learning and understanding to understand user behaviour, and what they find hard.
Overview of the course

- Theory driven approaches to HCI
- Design of visual displays
- **Goal-oriented interaction**
- Designing efficient systems
- Designing smart systems (guest lecturer)
- Designing meaningful systems (guest lecturer)
- Evaluating interactive system designs
- Designing complex systems
A *Metatheory* (in first-wave HCI): User interaction can be modelled as search
Reminder from Prolog course:
problem solving using graph search

From Rice & Beresford
Turn the problem into a graph
Encode as Prolog facts to solve

route(a,g).
route(g,l).
route(l,s).

... 
travel(A,A).
travel(A,C) :- route(A,B),travel(B,C).

solve :- start(A),finish(B), travel(A,B).
HCI example of a **User Goal:**

“How much did my use of Google Cloud Platform cost me last month?”
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Why Google Cloud Platform?
What search algorithm is being used here?
Breadth first/Depth first?
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Why Google Cloud Platform?
Click targets
[Simplified] Cognitive Walkthrough

- Goal
- Availability
- Match
- Feedback

See: https://www.colorado.edu/ics/sites/default/files/attached-files/93-07.pdf

For a detailed description
Finding your bill?

- Goal
- Availability
- Match
- Feedback

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Why Google Cloud Platform?
Example: Walkthrough of an API (demo)

- Goal
- Availability
- Match
- Feedback

(Macvean et al, 2016)
Example problem: Discovery

Goal
I want to delete a file

Availability
Type “File.” and auto complete gives

Match
There’s a conceptual mismatch on whether file is a static method or you have to get a file and then delete it

Feedback

(Macvean et al, 2016)
Example problem: ‘yak shaving’

Goal
- To write a line to a file
  - Open a file
  - Complete a future to get the file
  - Convert a string to a bytebuffer
  - Iterate over the bytebuffer
  - Write the block
  - Complete on the future for writing
  - Close the file
  - Complete the future for closing the file

Availability

Match

Feedback

Too many subgoals that need completing

(Macvean et al, 2016)
The cost of thinking:
Heuristics and Biases
12 + 24 * 3 = 84
(Example from Richard Young)
How many times should the calculator user press AC?
Classical theories of metareasoning

● Optimal search
  ○ Find the best possible solution within stated constraints on resources

● Bounded rationality
  ○ Computation is one of the constraints

● Satisficing
  ○ Find a satisfactory solution within computation constraints
Neuro-economic models of reasoning

• Behavioural economics, popularly known as “Nudge”
• Original basis in “prospect theory” (Kahneman & Tversky)
  • General theory of decision making
  • Construct a utility model, based on outcome of possible actions
  • Weight estimated values by likelihood
  • Choose action with optimal utility
  • May include future value discounting
• In practice, the optimisation is more likely to involve satisficing, due to reasoning with bounded rationality constraints
  • In Kahneman’s terms “thinking fast and slow”
Bounded rationality in humans

- Apply *heuristics* rather than searching for optimal plan
  - Availability heuristic - reason based on examples easily to hand
  - Affect heuristic – base decision on emotion rather than calculating cost / benefit
  - Representativeness heuristic - judge probability based on resemblance
- Apply *biases* to ensure estimation error within tolerable bounds
  - Loss aversion - losses hurt more than gains feel good
  - Expectation bias - researchers (even in HCI) find results they expected
  - Bandwagon effect - do what other people do
- And many others!
Behavoural economics in programming

- “Attention Investment theory” of abstraction use
  - Automation requires abstract specification
    - e.g. defining a regular expression for search and replace
  - Benefit of automation is saving time and concentration in future
  - But abstract specification (programming) takes time and concentration!
    - And powerful abstractions (programs) can go wrong powerfully
  - User may prefer repetitive manual operations - safe and incremental
- So utility function will compare future saving of attention from programming vs costs of concentrating on a risky strategy
  - Biases such as loss aversion will apply
  - Bounded rationality will apply, since deciding what to do takes even more concentration
The limitations of goal based HCI
It assumes the user doesn’t make mistakes

- Would need a cognitive model of why error occurred
  - Information loss due to cognitive limitations
  - Incorrect mental model
  - Misleading design
- Need description of user journey that accounts for problem identification, diagnosis, debugging, testing, iteration etc
It assumes the user has the right goal

- Persuasive design is a field of HCI that addresses goal formation
- Applications:
  - Reduce energy consumption
  - Promote exercise
  - Manage diet and nutrition
  - Smoking cessation
- May include “nudge” to account for biases
  - But paternalistic / patronising
It assumes the user knows what the goal is

• Not true when the purpose is an experience (third wave HCI)
• Not true in “exploratory design”

• More attention to this later in the course
• Some problems can’t be decomposed into actions
• Sometimes actions have side effects
Wicked problems
A Wicked Problem:

Slowing climate change
More Wicked Problems

- Stopping the spread of antibiotic-resistant diseases
- Halting nuclear proliferation
- Ending homelessness in Cambridge
- Avoiding species extinction
- Colonizing Mars
Rittel-Webber Characteristics 1-5 of 10

1. There is no definitive formulation of a wicked problem
2. Wicked problems have no stopping rule
3. Solutions to wicked problems are not true-or-false, but good-or-bad
4. There is no immediate and no ultimate test of a solution to a wicked problem
5. Every solution to a wicked problem is a “one-shot operation”; because there is no opportunity to learn by trial-and-error, every attempt counts significantly
Rittel-Webber Characteristics 6-10 of 10

6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, **nor is there a well-described set of permissible operations** that may be incorporated into the plan.

7. Every wicked problem is essentially unique.

8. Every wicked problem can be considered to be a symptom of another problem.

9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution.

10. **The planner has no right to be wrong.**
Research problem:
“How might you design software to help solve wicked problems?”