Cognitive Task Analysis 2
Plan for Today

• Quick reviews of:
  – Original cognitive task analysis: Newell & Simon’s “Human Problem Solving” in 1972
  – Some highpoints of Clark paper

• Discussion
  – Review readings prompted by Assistment questions & by reading reports

• Connect CTA to your own research
  – What tasks would you analyze?
To do for next time

• See discussion forum for Jan 24
  – Read 1, skim 2, post
  – Indicate some task(s) in your domain of interest on which you could do a CTA
Newell & Simon

- First deep analysis of performance on complex tasks (taking about 30 mins)
- To understand & improve learning we need to understand performance
  - “the study of learning, if carried out with theoretical precision, must start with a model of a performing organism” (p. 7)
- Empirical, not experimental
  - Means?

What drives human performance?

• Newell & Simon asked:
  – “whether a theory of problem solving (or thinking, or learning) is really a theory about human beings or a theory about the nature of the task environment” (p. 14)

• Simon’s ant on the beach metaphor
Task Environment

• Number scrabble example
  – Point: External representations (part of the “task environment”) can greatly change human performance

• Task environment contains
  – Possible stimuli, what student can see
  – Possible actions, what student can do

• Can behavior be described in terms of mental connections of the following simple form:
  – If some stimulus, then some action

• What do you think?
N&S knowledge components

• No, not quite! Need to include goals!
• Behavior can be described in terms of mental connections (“knowledge components”):
  – If some goal & some stimulus then some action or new goal
• A set of such “production rules” make up a “production system”
Example production system of playing tic-tac-toe

FIGURE 3.4
production system for playing tic-tac-toe

tic-tac-toe-strategy:
1. side-to-move = opponent → stop.
2. \(\langle\text{own-winning-pattern}\rangle \Rightarrow \text{blank-square}\) → play (blank-square).
3. \(\langle\text{opponent-winning-pattern}\rangle \Rightarrow \text{blank-square}\) → play (blank-square).
4. \(\langle\text{own-forking-pattern}\rangle \Rightarrow \text{intersection-square}\) → play (intersection-square).
5. center = blank → play (center).
6. \(\langle\text{opponent-on-side}\rangle\) → find corner = blank; play (corner).
7. \(\langle\text{opponent-on-corner}\rangle\) → find opposite of corner; play (opposite).
Problem Space

- The “space in which problem solving activities take place”
  - Essentially what are the production rules to choose from & in what combinations can they be carried out
  - Feasible to define for a “task domain”
    - Example task domains: chess, logic theorem proving, generating a good argument, translating German to English

- Productions:
  - Operate on “states” of the environment
  - Produce an “action” that results in a new state
  - The problem space is all the possible states & actions
Clark’s CTA Families

- Strategies for knowledge elicitation (empirical)
  - Observation and interviews
    - Informal
  - Process tracing
    - More structured
  - Conceptual techniques
    - Formal, with fixed protocols for interaction with participants

- Formal models (theoretical)
  - Simulations of task performance or “cognitive models”
Clark’s steps

- Collect preliminary knowledge
- Identify knowledge representations
- Apply focused knowledge elicitation methods
- Analyze and verify data acquired
- Format results for intended application
Knowledge representations schemes

• Clark’s
  – Concept maps
  – Flow charts
  – Semantic nets
  – Learning hierarchy

• Other’s
  – Goal trees
  – If-then rules written in English
  – Cognitive modeling, like ACT-R
Reviewing purpose & steps...
CTA Purpose

• Many ed research methods are about *how to teach*
• CTA is primarily about *what to teach*
  – How come that’s not obvious?
General Steps In CTA

• What are instructional objectives?
  – Standards, existing tests, signature tasks
• Literature review
• Specify space of tasks
• Do either or both:
  – Theoretical task analysis: Create a model that is sufficient to deal with space of tasks
  – Empirical task analysis: Do think aloud, difficulty factors assessment, expert interviews...
Connecting to your research

• What domain would you do a CTA in?
• What tasks would you analyze?
• How would you do it?
  – Empirical or theoretical/rational?
  – Descriptive, prescriptive?
  – Which technique?
• How might you represent your results?
• How would you use your results to redesign instruction?