COURSE ORGANIZATION
SPIRIT OF THE UNDERTAKING

6.871— Knowledge Based Systems
Lecture 1
Randall Davis & (sometimes) Howard Shrobe
1995

Readings

1. *Feigenbaum, E.A., Knowledge Engineering. The Applied Side of Artificial Intelligence, Annals New York Academy of Sciences, 91-107.*
2. *Newell, A., The Knowledge Level, AIMag, Summer 1981, pp. 1-20+.*
3. *Topolski A S, Reece D K, Packaging Advisor™: An expert system for rigid plastic food package design, in* Proc Innovative Applications of AI*, 1989, Schoor and Rappaport (eds.), pp. 348–357.*

Slide 1

COURSE CHARACTER

- Technical 95%, Other 5%
  - Learning how to DO it
  - Largely engineering examples
  - The need to see beneath the surface
- Background
  - Considerable high level language experience
- Mixed Group
  ⇒ the challenge in choosing examples
  ⇒ the occassional need to explain the obvious
- Course is continually being improved
  - Feedback of all sorts is enormously helpful
  - Questions, suggestions encouraged

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COURSE ORGANIZATION

- Lectures
  - Slide copies (typically)
- Extensive reading assignments
  - We trimmed, selected carefully, and *annotated*
    ⇒ You really do have to read them.
  - 1 hour lecture, 30 min discussion
- Ask questions, challenge, etc.
- Term project
  - Work alone or in pairs (*not* triples)
  - Build a small system, a utility package, a shell, ...
- The Seventh International Workshop on KBS
  - Project report and *individual* term paper
  - Clearly written, concise, 20 - 30 pages
  - What did you learn
- Tools: KAPPA-PC, JOSHUA, CLASSIC, PARMENIDES ...
- Homework
- Grade based on term project, lecture participation, homework

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LOGISTICS

- Info sheet
- Course notes: 10-180; 38-501.
- Syllabus
- Personnel: Davis, Shrobe, Bolotski, LaFrance

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(WHY) IS THIS INTERESTING?

- Knowledge-Based Systems work
  - * DENDRAL, MYCIN, INTERNIST-I: comparable to human experts
  - * PROSPECTOR: $100M worth of molybdenum
  - * R1/XCON: from 85% to 97.5% performance
  - * American Express: 20% operational savings, $10M's in added revenue
  - * DuPont
  - * Manufacturer's Hanover: Inspector
- Applied AI leads to advances in basic science
  - * Rule-based systems: MYCIN, R1 etc.
  - * Causal reasoning: CASNET, ABEL, QUAL, SHERLOCK, etc.
  - * Reasoning at multiple levels: HEARSAY, MOLGEN, ABEL, CADUCEUS, ...
  - * Reasoning under uncertainty
  - * Case-based reasoning
  - * Knowledge acquisition/learning
  - * Explanation

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CHARACTER OF THE PROBLEMS ATTACKED

- Balancing your checkbook

vs.

- Getting out of the supermarket

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WHAT ARE KNOWLEDGE-BASED SYSTEMS

- Knowledge based vs ?
- Wherein arises intelligence?
  - * GPS and the lessons of the 60's
  - * *Improvements more often involve bringing to bear specific knowledge on selected subproblems of an application than developing a new complete theory for it.* [Szolovits, AIM]
- Wherein arises expertise?
- *KEY IDEA:*
  `||EXPERT - AVERAGE PERSON|| = KNOWLEDGE`
- *KEY IDEA:* explicit representation of that knowledge
  - * (The barge story again.)

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INTELLECTUAL ORIGINS

What makes for expertise?
Can human thought be formalized?
(How) Can we get a machine to be smart?

And what is AI, anyway?

- AI is a great intellectual adventure
  - * Cf cosmology, physics, biology
- AI is making machines that solve problems requiring intelligence
- AI is symbolic computing
- AI is applied epistemology

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INTELLECTUAL ORIGINS

- 2000 years ago
  - Aristotle and the art of rhetoric
  - The syllogisms
- 17th century: Leibnitz and the "algebra of thought"
- 19th century: Boole's logic and *The Laws of Thought*
- 19th century: Babbage and the Analytical Engine
  Lady Lovelace conjectures that it *"would weave algebraic patterns the way the Jacquard loom weaved patterns in textiles".*
- 20th century: Shannon's insight about switching circuits

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INTELLECTUAL ORIGINS

- What is it we seek to embody in the machine?
  - Mind?
  - Thought?
  - Intelligence?
  - Rationality?
  - Neuroanatomy?
- And how do we know whether we got there?
- Can a machine think?
- Can the person next to you think?

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WHAT IS

- Thought?
- Intelligence?
- Rationality?
- Knowledge?

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Newell and Simon
The Physical Symbol System Hypothesis

A physical symbol system has the necessary and sufficient means for general intelligent action

Physical Symbol System consists of:

- A set of symbols
- a set of expressions (symbol structures)
- a set of procedures that operate on expressions to produce other expressions: *Create, Modify, Reproduce and Destroy*

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Newell and Simon
The Knowledge Level Hypothesis

The Knowledge Level Hypothesis: There exists a distinct computer systems level which is characterized by knowledge as the medium and the principle of rationality as the law of behavior.

(Roughly: content independent of form)

Principle of rationality: if an agent has knowledge that one of its actions will lead to one of its goals, then the agent will select that action.

Knowledge: Whatever can be ascribed to an agent, such that its behavior can be computed according to the principle of rationality.

- Knowledge is closely linked to rationality.
- Knowledge is competence-like notion.

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CHARACTER OF KNOWLEDGE

- Most of what we know knowledge is non-numeric.
- Most of what we know is heuristic.

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CHARACTER OF KNOWLEDGE

- Empirical, experiential knowledge: rules of thumb, heuristics
- Design knowledge: theory, model, causal understanding
- Common-sense knowledge

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KNOWLEDGE-BASED SYSTEMS: CURRENT STATE

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KBS = || Expert Knowledge - Common Sense ||
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