Course Organization
Spirit of the Undertaking

6.871: Knowledge-Based Systems

Spring 2005

Randall Davis

Logistics

- Info sheet, syllabus
- Personnel:
  - Lecturers: Davis (and friends)
- Course notes:

  - 1st installment ready now

- You are responsible for what happens in lecture.
- *No open laptops.*

Course Character

- Learning how to do it
  - Largely engineering examples
  - The need to see beneath the surface

- Background
  - 6.034 (or equivalent)
  - Considerable high level language experience

Course Character

- Course continually being improved
  - Feedback of all sorts is enormously helpful
  - Question, suggestions encouraged

Course Organization

- Lectures: slide copies (typically)

- Extensive reading assignments: read them (really)

- Ask questions

- Homework

Course Organization

- Term project: alone or in pairs (not triples)
  - Tools: Joshua, KAPPA-PC, M4, GRASS
  - The nth International Workshop on KBS
  - Oral report and individual term paper
  - Clear, concise, 20-30 pp.
  - What did you learn?

- Course grade based on term project, homework, lecture participation

Course Outline

- Intro & Background
- The Spirit and Pragmatics of KBS
- Knowledge Representations and Reasoning
- Problem Solving Paradigms
- Research Issues
- Project Presentations

(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
  - The clever (?) paper clip

In 1995, in Singapore...

Crime Case Closed Infamous Crimes

Nick Leeson and Barings Bank

The week before Nick Leeson disappeared he had kept throwing up at work.

Colleagues did not know why but were soon to find out.

The ego of a 28-year-old trader on the Singapore Monetary Exchange and the greed and stupidity of a 233-years-old bank had combined to distroy an investment empire and in the process stunned the world.

Trader Is Said to Have Defrauded Irish Bank of $750 Million

Dublin, Feb. 6 – A trader for the Baltimore – based treasury arm of Allfirst, an American retail subsidiary of Allied Irish Banks P.L.C. (news/quote), defrauded Ireland's largest financial institution of $750 million over the last year through bogus foreign exchange trading, and he has since disappeared, the bank said today.

The 40 – year – old trader, John Rusnak, failed to show up for work on Monday morning and has not been seen since he was interviewed about the matter at Allfirst offices on Friday. The Federal Bureau of Investigation interviewed his wife over the weekend, and the bank believes he is still in the Baltimore area.

The suspected theft would be the largest international fraud case since 1995, when Nick Leeson gambled $1.17 billion on foreign exchange trades in Singapore and set off the collapse of England's historic Barings Bank. Allied Irish is unlikely to suffer the same fate; instead the bank will see profits after taxes for 2001 shrink to 401 million euros from 997 million euros in the previous year.

(Why) is this interesting?

- Applied AI leads to advances in basic science
    - Rule-based systems
    - Causal reasoning
    - Reasoning at multiple levels: Reasoning under uncertainty
    - Case-based reasoning

(Why) is this interesting?

- Applied AI leads to advances in basic science
  - Knowledge acquisition/learning
  - Explanation
  - Knowledge sharing

Character of the problems attacked

- Balancing your checkbook vs.
  Getting out of the supermarket

- Telling it what to *do* vs.
  Telling it what to *know*

  - Write down some relevant knowledge

  - Advice, not a procedure

Character of the problems attacked

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  ■ Knowledge leads to action,
    But knowledge is more fundamental

  – The barge story

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.

What are knowledge-based systems

- Wherein arises expertise?

- KEY IDEA:
  || EXPERT – AVERAGE PERSON || = KNOWLEDGE

- KEY IDEA:
  explicit representation of that knowledge
  - (The barge story again)

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?

Intellectual Origins

- AI is a great intellectual adventure
  - Cf cosmology, physics, biology
- AI is the exploration of the design space of intelligences
- AI is making machines that solve problems requiring intelligence
- AI is applied epistemology

Intellectual Origins

- 2000 years ago
  - Aristotle and the art of rhetoric
  - The syllogisms

- 17th century: Leibniz and the "algebra of thought"

Intellectual Origins

- 19th century: Boole's logic and The Laws of Thought

To see this image, please visit:
http://images.google.com/images?q=cgboole.gif

Intellectual Origins

- 19th century: Babbage and the Analytical Engine. Lady Lovelace conjectured that it "would weave algebraic patterns the way the Jacquard loom weaved patterns in textiles."

Portrait of Charles Babbage

To see this image please visit:

http://images.google.com/images?q=charles_babbage.full.jpg

Portrait of Lady Lovelace

To see this image please visit:

http://images.google.com/images?q=ladyada-big.gif

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Intellectual Origins

- *2000 years ago*
  - *Aristotle and the art of rhetoric*
  - *The syllogisms*
- *17th century: Leibniz and the "algebra of thought"*
- *19th century: Boole's logic and The Laws of Thought*
- *19th century: Babbage and the Analytical Engine*
- 20th century: Shannon's insight about switching circuits
- 20th century: Turing's ideas about thought and computation

Intellectual Origins

- What is it we seek to embody in the machine?
  - Mind?
  - Thought?
  - Intelligence?
  - Rationality?
  - Neuroanatomy?

Intellectual Origins

- And how do we know whether we got there?

- Can a machine think?

- Can the person next to you think?

What is

- Thought?

- Intelligence?

- Rationality?

- Knowledge?

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*

The Physical Symbol System 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.

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.

(Roughly: content independent of form)

The Knowledge Level Hypothesis

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.

Character of Knowledge

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

- Most of what we know is heuristic.
  - What's certain?
  - What's the alternative?

Character of Knowledge

- Empirical, experiential knowledge: rules of thumb, heuristics

- Design knowledge: theory, model, causal understanding

- Common-sense knowledge

Current State

KBS = || Expert Knowledge – Common Sense ||