Course Organization

Spirit of the Undertaking

6.871: Knowledge-Based Systems

Randall Davis

Logistics

- Info sheet, syllabus
- Personnel:
  - Lecturers: Davis (and friends)
  - TA: TBD
  - Class Secretary: Manokharan
- Course notes:
  - 11-004, ~12.50
  - 1st installment ready now
- Web page: courses.csail.mit.edu/6.871
- You are responsible for what happens in lecture.
- 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
  - 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

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 in added revenue
- DuPont
- Manufacturer’s Hanover: Inspector

(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

In 1995, in Singapore...

Crime Case Closed

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 age of a 28 year old trader on the Singapore Monetary Exchange and the greed and stupidity of a 233 year old bank had combined to destroy an investment empire and in the process showers the world.

(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
- 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

- 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

1815-1864

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."

1791-1871 1815-1852

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

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?
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 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)

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?

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

KBS = || Expert Knowledge – Common Sense ||