Course Objectives

This part of course introduces some main strategies and methods used in intelligent systems. The topics include the history and applications of artificial intelligence, logical reasoning, state space searching, heuristic searching, problem solving methods, knowledge-based systems.

Introduction to AI

Intelligence means:

a system can adapt itself to novel situations, has the capacity to reason, to understand the relationships between facts, to discover meanings, to recognize truth, and to learn.

Artificial intelligence is:

the science of making machines do things that would require intelligence if done by men.

Can machines think?

Answer: Turing test (1950).

- Measure the performance of an intelligent machine against a human being.

- Replace the question of intelligence by a clearly defined empirical test.

- Provide a basis for schemes used to evaluate AI programs.

Fig 1.1　　The Turing test.

THE
INTERROGATOR

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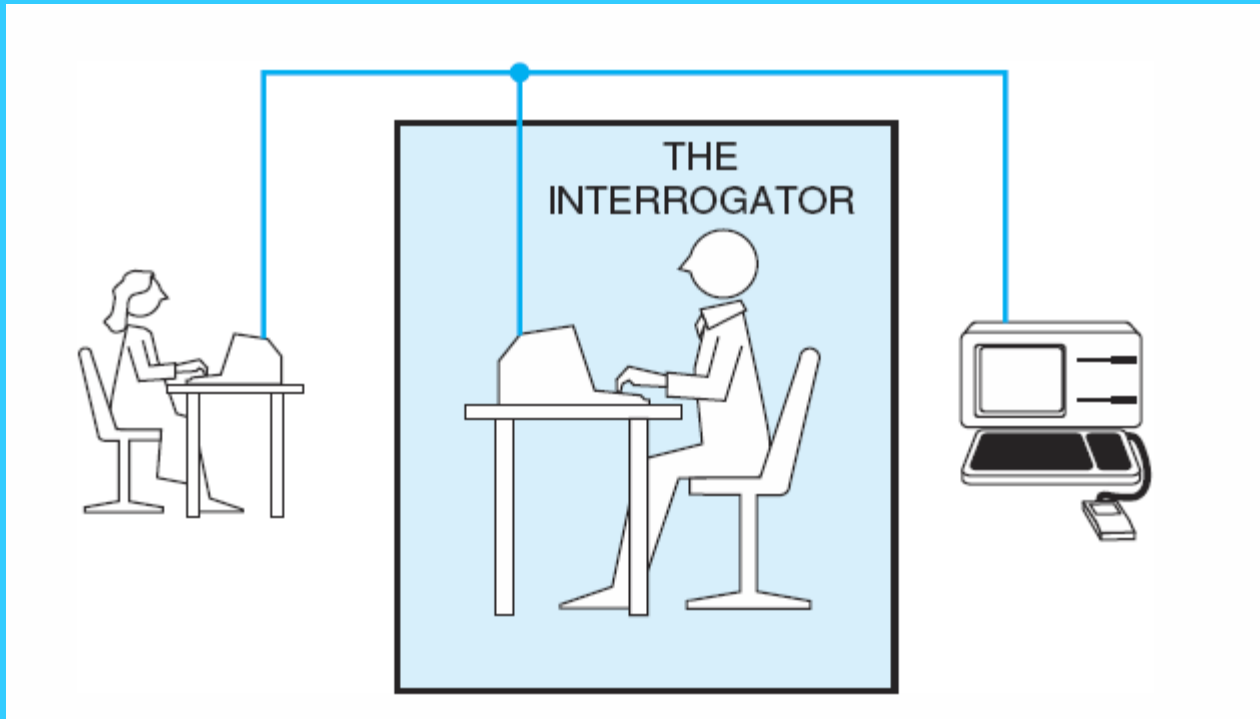
Two categories of AI research:

a) Mind as object and machine as tool

b) Computer as object and mind as model.

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Two approaches to AI

- The engineering approach -- to create a system that is able to deal intellectual tasks, regardless of whether the methods and techniques used are similar to those used by human.

- The modeling approach -- try to gain an understanding of the inside mechanisms of a real life system and to explain and predict its behavior, e.g., neural network.

Three basic motivations for research in AI

- To replace human intelligence.
- To establish theories of human intelligence in the form of simulation models.
- To assess the capabilities of present software and hardware for future development.

AI is particularly concerned with the automation of intelligent behavior

- As a young discipline, it is the collection of problems and methodologies studied by AI researchers.

- As an empirical science, it is the study of symbolic systems for the purpose of understanding and implementing intelligent activities.

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Two most fundamental problems of AI

- knowledge representation
- problem-solving technique, such as search

History of AI

- Pre-1950
  - Aristotle's philosophy and logic.
  - Descartes's view -- the structure of ideas about the world is not necessarily the same as the physical world.
  - Graph theory (Euler, 1735).
  - Boolean algebra (Boole, 1847).
  - First-order predicate calculus (Frege, 1879).
  - Neural net model (Warren McCulloch, 1943)
- 1950-1970:
  - LISP (John McCarthy, Dartmouth, 1960)
  - Frames - a knowledge representation (Marvin Minsky, Dartmouth, 1975)
  - Logic Theorist proves theorems in propositional calculus (A. Newell, J.C.Shaw, and H. Simon, 1957)
  - DENDRAL infers the structure of organic molecules (Edward Feigenbaum, CMU,later 1960)

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History of AI

- ## 1970-present
  - ### Knowledge representations
    - Scripts (Roger Schank & Robert Abelson, Yale, 1977)
  - ### Game playing (tic-tac-toe, chess, 16 puzzle):
    - Board games
    - Heuristic search techniques
    - Chess playing programs (David Slate & Larry Atkin, Northwestern, 1976)
  - ### Automated reasoning and theorem proving
    - Two approaches: proof finding and consequence finding.
    - General Problem Solver (Allen Newell & Herbert Simon, CMU, 1963).
    - The resolution principle (J.A. Robinson, 1965).
    - Formalize search algorithms.
    - Develop formal representation languages, such as predicate calculus, fuzzy logic

- Expert systems
  - Importance of domain-specific knowledge.
  - MYCIN diagnosing and prescribing treatment for spinal meningitis and bacterial infection of the blood (Stanford, mid-1970).
  - PROSPECTOR (Richard Duda, SRI, 1979)
- Natural language understanding
  - Attempt to deal with issues of semantic meaning as well as syntactic form.
  - Real understanding depends on the background knowledge about the domain of discourse and idioms and an ability to apply general contextual knowledge to resolve ambiguities.
  - Much of the current work is devoted to finding representational formalisms.
  - SHRDLU (Terry Winograd, 1973) for a "micro world"
  - HEARSAY (Raj Reddy, CMU, 1976)

- Planning and robotics
  - Generate plans based on specialized knowledge of some domain.
  - Hierarchical problem decomposition.
  - Error recovery -- automatic revision of plans corrects some unexpected problems.
  - SHAKEY -- one of the first robots (Bertram Raphael, SRI, early 1970)
- Machine learning
  - Winston's learning program (1975).
  - Learn from experience, analogy, examples, or by being told.

- Vision
  - Vision is a form perception based on optical sensing.
  - Perception is the construction and maintenance of an internal model of the external environment.
  - Image processing: pre-processing, feature extraction.
  - 3-D modeling and scene analysis
- Languages and environments for AI
  - High-level languages: LISP, PROLOG.
  - Object-oriented programming.
  - Shells of expert systems.

Important Features of Artificial Intelligence

1) The use of computers to do reasoning, pattern recognition, learning, or some other form of inference.

2) A focus on problems that do not respond to algorithmic solutions. This underlies the reliance on heuristic search as an AI problem-solving technique.

3) A concern with problem-solving using inexact, missing, or poorly defined information and the use of representational formalisms that enable the programmer to compensate for these problems.

4) Reasoning about the significant qualitative features of a situation.

5) An attempt to deal with issues of semantic meaning as well as syntactic form.

6) Answers that are neither exact nor optimal, but are in some sense "sufficient". This is a result of the essential reliance on heuristic problem-solving methods in situations where optimal or exact results are either too expensive or not possible.

7) The use of large amounts of domain-specific knowledge in solving problems. This is the basis of expert systems.

8) The use of meta-level knowledge to effect more sophisticated control of problem-solving strategies. Although this is a very difficult problem, addressed in relatively few current systems, it is emerging as an essential are of research.