Artificial Intelligence

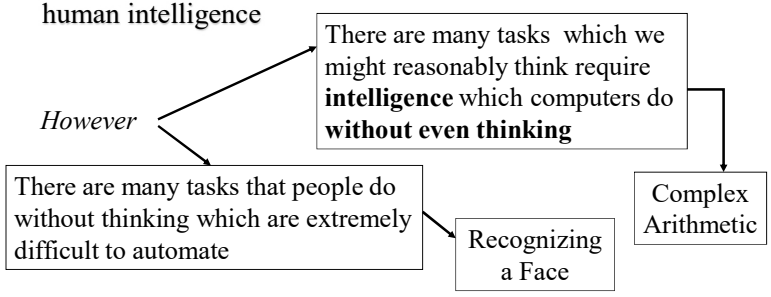
What is AI?

- **Intelligence:**
  "ability to learn, understand and think"
- AI is the study of how to make computers make things which at the moment people do better.
- Examples: Speech recognition, Smell, Face, Object, Intuition, Inferencing, Learning new skills, Decision making, Abstract thinking

AI Definitions

What is AI ?

- A broad field and means different things to different people
- Concerned with getting computers to do tasks that require human intelligence



AI Definitions

What is AI ?

Definitions organized into four categories

Think like human	**Think Rationally**
The exciting new effort to make computers **think** … machines **with minds**, in the full and literal sense. [Haugeland 85].	The study of the computations that make it possible to **perceive, reason,** and **act**. [Winston, 1992]
Act humanly	**Act rationally**
The study of how to make computers **do** things at which, at the moment, **people** are better. [Rich & Knight, 1991]	The branch of computer science that is concerned with the automation of **intelligent behavior**. [Luger and Stubblefield, 1993]

Think Like Human

The Cognitive Modeling approach

To develop a program that think like human , the way the human think should be known.

Knowing the precise theory of mind (**how human think**?)
→ expressing the theory as a computer program.

GPS (General Problem Solver) [by Newell & Simon, 1961]

Were concerned with comparing the trace of its reasoning steps to traces of human subjects solving the same problem rather that ***correctly solve problems***

Cognitive Science

Computer models from AI + Experimental techniques from psychology

→ *Construction of human mind working theories*

Act Like Human

The TURING Test Approach:

Alan Turing [1950] designed a test for intelligent behavior.
Ability to achieve human-level performance in all cognitive tasks, sufficient to FOOL an interrogator.

A human (interrogator) interrogates (without seeing) two candidates A and B (one is a human and the other is a machine).

Computer would need:

1. Natural Language Processing → Communication.
2. Knowledge Representation→store info before and during interrogation.
3. Automated Reasoning→ answer questions and draw new conclusions.
4. Machine learning→ adapt to new circumstances.

Think Rationally

The Law of Thought Approach

Aristotle and his syllogism (right thinking) :
always gave correct conclusions given correct premises

- Socrates is a Man. %Fact
- All men are Mortal. % Rule : if X is a Man then X is Mortal.
- Therefore Socrates is Mortal. % Inference

These laws of thoughts initiated the field of **LOGIC.**

Two main obstacles

1. Not easy to translate an informal knowledge into a formal logic.
2. It is usually the case that (say medium-size) problems can exhaust the computational power of any computer. Thus the need for heuristics.

Act Rationally

The Rational Agent Approach

An agent is something that perceives and acts

Laws of thought → correct inference

Making correct inferences is part of being rational agent

Act rationally = reason logically to the conclusion
↓
act on that conclusion

Correct inference is not always == rationality
e.g. reflex actions (acting rationally without involving inference)

Two main advantages

1. More general than "the laws of thought"(a mechanism to achieve rationality)
2. More amenable to scientific development than approaches based on [human] behavior/thought.

Typical AI Problems

AI tasks involve both :

- ***Mundane*** tasks which people can do very easily (understanding language)
- ***Expert*** tasks that require specialist knowledge (medical diagnosis)

Typical AI Problems

Mundane *tasks correspond to the following AI problems areas:*

- **Planning :** The ability to decide on a good sequence of actions to achieve our goals
- **Vision :** The ability to make sense of what we see
- **Robotics:** The ability to move and act in the world, possibly responding to new perceptions
- **Natural Language:** The ability to communicate with others in any human language

Typical AI Problems

Experts tasks *(require specialized skills and training) include :*

- Medical diagnosis
- Equipment repair
- Computer configuration
- Financial planning

Mundane tasks are generally much harder to automate

AI is concerned with automating both mundane and expert tasks.

The Foundations of AI

- Philosophy (423 BC – present):
  - Logic, methods of reasoning.
  - Mind as a physical system.
  - Foundations of learning, language, and rationality.
- Mathematics (c.800 – present):
  - Formal representation and proof.
  - Algorithms, computation, decidability, tractability.
  - Probability.

The Foundations of AI

- Psychology (1879 – present):
  - Adaptation.
  - Phenomena of perception and motor control.
  - Experimental techniques.
- Linguistics (1957 – present):
  - Knowledge representation.
  - Grammar.

A Brief History of AI

- The gestation of AI (1943 – 1956):
  - 1943: McCulloch & Pitts: Boolean circuit model of brain.
  - 1950: Turing's "Computing Machinery and Intelligence".
  - 1956: McCarthy's name "Artificial Intelligence" adopted.
- Early enthusiasm, great expectations (1952 – 1969):
  - Early successful AI programs: Newell & Simon's Logic Theorist, Gelernter's Geometry Theorem Prover.
  - Robinson's complete algorithm for logical reasoning.

A Brief History of AI

- A dose of reality (1966 – 1974):
  - AI discovered computational complexity.
  - Neural network research almost disappeared after Minsky & Papert's book in 1969.
- Knowledge-based systems (1969 – 1979):
  - 1969: DENDRAL by Buchanan
  - 1976: MYCIN by Shortliffle.
  - 1979: PROSPECTOR by Duda

A Brief History of AI

- AI becomes an industry (1980 – 1988):
  - Expert systems industry booms.
  - 1981: Japan's 10-year Fifth Generation project.
- The return of NNs and novel AI (1986 – present):
  - Mid 80's: Back-propagation learning algorithm reinvented.
  - Expert systems industry busts.
  - 1988: Resurgence of probability.
  - 1988: Novel AI (ALife, GAs, Soft Computing)
  - 1995: Agents everywhere.
  - 2003: Human-level AI back on the agenda.

Task Domains of AI

- Mundane Tasks:
  - Perception
    - Vision
    - Speech
  - Natural Languages
    - Understanding
    - Generation
    - Translation
  - Common sense reasoning
  - Robot Control
- Formal Tasks
  - Games : chess, checkers etc
  - Mathematics: Geometry, logic, Proving properties of programs
- Expert Tasks:
  - Engineering (Design, Fault finding, Manufacturing planning)
  - Scientific Analysis
  - Medical Diagnosis
  - Financial Analysis

AI Technique

- Intelligence requires Knowledge
- Knowledge possesses less desirable properties such as:
  - Voluminous
  - Hard to characterize accurately
  - Constantly changing
  - Differs from data that can be used
- AI technique is a method that exploits knowledge that should be represented in such a way that:
  - Knowledge captures generalization
  - It can be understood by people who must provide it
  - It can be easily modified to correct errors.
  - It can be used in variety of situations

The State of the Art

- Computer beats human in a chess game.
- Computer-human conversation using speech recognition.
- Expert system controls a spacecraft.
- Robot can walk on stairs and hold a cup of water.
- Language translation for web pages.
- Home appliances use fuzzy logic.
- And many more

Recommended References

- ***Artificial Intelligence, 3rd Ed.,***

  Elaine Rich & Kevin Knight, Tata McGraw Hill

- ***Artificial Intelligence: A Modern Approach, 3rd Ed.,***

  Stuart Russell & Peter Norvig