Artificial Intelligence: History and Methods

Course: CSE545

Artificial Intelligence

University of Louisville

Dr. Roman V. Yampolskiy

AI History (old)

- **Philosophy Foundations (400 B.C. – present)**
  - **Mind: dualism (Descartes), materialism (Leibniz), empiricism (Bacon, Locke)**
  - **Thought: syllogism (Aristotle), induction (Hume), logical positivism (Russell)**
  - **Rational agentry (Mill)**
- **Mathematical Foundations (c. 800 – present)**
  - **Early: algorithms (al-Khowarazmi, 9th century Arab mathematician), Boolean logic**
  - **Computability (20th century – present)**
    - **Cantor diagonalization, Gödel's incompleteness theorem**
    - **Formal computuational models: Hilbert's Entscheidungsproblem, Turing**
    - **Intractability and NP-completeness**

AI History (not too old)

- Computer Engineering (1940 – present)
- Linguistics (1957 – present)
- Stages of AI
  - Gestation (1943 – c. 1956), infancy (c. 1952 – 1969)
  - Disillusioned early (c. 1966 – 1974), later childhood (1969 – 1979)
  - "Early" (1980 – 1988), "middle" adolescence (c. 1985 – present)

Potted history of AI

1943	McCulloch & Pitts: Boolean circuit model of brain
1950	Turing's "Computing Machinery and Intelligence"
1952–69	Look, Ma, no hands!
1950s	Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
1956	Dartmouth meeting: "Artificial Intelligence" adopted
1965	Robinson's complete algorithm for logical reasoning
1966–74	AI discovers computational complexity Neural network research almost disappears
1969–79	Early development of knowledge-based systems
1980–88	Expert systems industry booms
1988–93	Expert systems industry busts: "AI Winter"
1985–95	Neural networks return to popularity
1988–	Resurgence of probability; general increase in technical depth "Nouvelle AI": ALife, GAs, soft computing
1995–	Agents, agents, everywhere . . .
2003–	Human-level AI back on the agenda

The history of artificial intelligence (birth)

The birth of artificial intelligence (1943 – 1956)

The first work recognised in the field of AI was presented by **Warren McCulloch** and **Walter Pitts** in 1943. They proposed a model of an artificial neural network and demonstrated that simple network structures could learn.

McCulloch, the second "founding father" of AI after Alan Turing, had created the corner stone of neural computing and artificial neural networks (ANN).

- The third founder of AI was **John von Neumann**, the brilliant Hungarian-born mathematician. In 1930, he joined the Princeton University, lecturing in mathematical physics. He was an adviser for the Electronic Numerical Integrator and Calculator project at the University of Pennsylvania and helped to design the **Electronic Discrete Variable Calculator**. He was influenced by McCulloch and Pitts's neural network model. When **Marvin Minsky** and **Dean Edmonds**, two graduate students in the Princeton mathematics department, built the first neural network computer in 1951, von Neumann encouraged and supported them.

- Another of the first generation researchers was **Claude Shannon**. He graduated from MIT and joined Bell Telephone Laboratories in 1941. Shannon shared Alan Turing's ideas on the possibility of machine intelligence. In 1950, he published a paper on chess-playing machines, which pointed out that a typical chess game involved about 10^{120} possible moves (Shannon, 1950). Even if the new von Neumann-type computer could examine one move per microsecond, it would take 3×10^{106} years to make its first move. Thus Shannon demonstrated the need to use heuristics in the search for the solution.

- In 1956, **John McCarthy**, **Marvin Minsky** and **Claude Shannon** organised a summer workshop at Dartmouth College. They brought together researchers interested in the study of machine intelligence, artificial neural nets and automata theory. Although there were just ten researchers, this workshop gave birth to a new science called ***artificial intelligence***.

The rise of artificial intelligence, or the era of great expectations (1956 – late 1960s)

- The early works on neural computing and artificial neural networks started by McCulloch and Pitts was continued. Learning methods were improved and **Frank Rosenblatt** proved the ***perceptron convergence theorem***, demonstrating that his learning algorithm could adjust the connection strengths of a perceptron.

- One of the most ambitious projects of the era of great expectations was the **General Problem Solver (GPS)**. **Allen Newell** and **Herbert Simon** from the Carnegie Mellon University developed a general-purpose program to simulate human-solving methods.
- Newell and Simon postulated that a problem to be solved could be defined in terms of ***states***. They used the mean-end analysis to determine a difference between the current and desirable or *goal state* of the problem, and to choose and apply *operators* to reach the goal state. The set of operators determined the solution plan.

- However, GPS failed to solve complex problems. The program was based on formal logic and could generate an infinite number of possible operators. The amount of computer time and memory that GPS required to solve real-world problems led to the project being abandoned.
- In the sixties, AI researchers attempted to simulate the thinking process by inventing *general methods* for solving *broad classes of problems*. They used the general-purpose search mechanism to find a solution to the problem. Such approaches, now referred to as ***weak methods***, applied weak information about the problem domain.

- By 1970, the euphoria about AI was gone, and most government funding for AI projects was cancelled. AI was still a relatively new field, academic in nature, with few practical applications apart from playing games. So, to the outsider, the achieved results would be seen as toys, as no AI system at that time could manage real-world problems.

Unfulfilled promises, or the impact of reality (late 1960s – early 1970s)

The main difficulties for AI in the late 1960s were:

- Because AI researchers were developing general methods for broad classes of problems, early programs contained little or even no knowledge about a problem domain. To solve problems, programs applied a search strategy by trying out different combinations of small steps, until the right one was found. This approach was quite feasible for simple **toy problems**, so it seemed reasonable that, if the programs could be "scaled up" to solve large problems, they would finally succeed.

Many of the problems that AI attempted to solve were **too broad and too difficult**. A typical task for early AI was machine translation. For example, the National Research Council, USA, funded the translation of Russian scientific papers after the launch of the first artificial satellite (Sputnik) in 1957.

- **The spirit is willing but the flesh is weak**
- **The vodka is good but the meat is rotten**

- In 1971, the British government also suspended support for AI research. Sir **James Lighthill** had been commissioned by the Science Research Council of Great Britain to review the current state of AI. He did not find any major or even significant results from AI research, and therefore saw no need to have a separate science called "artificial intelligence".

Why Study Artificial Intelligence?

- **New Computational Capabilities**
  - Advances in uncertain reasoning, knowledge representations
  - Learning to act: robot planning, control optimization, decision support
  - Database mining: converting (technical) records into knowledge
  - Self-customizing programs: learning news filters, adaptive monitors
  - Applications that are hard to program: automated driving, speech recognition

Why Study Artificial Intelligence?

- **Better Understanding of Human Cognition**
  - Cognitive science: theories of knowledge acquisition (e.g., through practice)
  - Performance elements: reasoning (inference) and *recommender* systems
- **Time is Right**
  - Recent progress in algorithms and theory
  - Rapidly growing volume of online data from various sources
  - Available computational power
  - Growth and interest of AI-based industries (e.g., data mining/KDD, planning)

Some Hard Questions…

- Who is liable if a robot driver has an accident?
- Will machines surpass human intelligence?
- What will we do with superintelligent machines?
- Would such machines have conscious existence? Rights?
- Can human minds exist indefinitely within machines (in principle)?

Questions?