A brief history of logic based AI

Yuanlin Zhang

Department of Computer Science
Texas Tech University

Artificial Intelligence

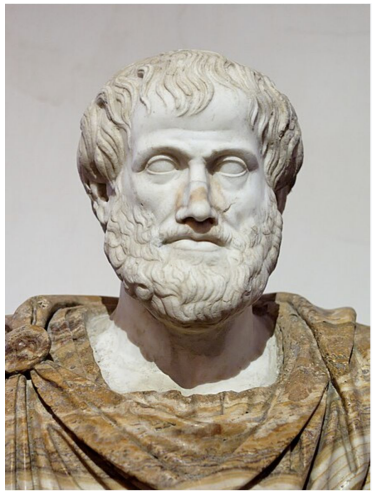
- Artificial Intelligence: use **computers** to achieve **human intelligence**
- Human intelligence
  - Mind - Conscious world - symbols / knowledge / Logic
  - Brain - Physical world - Network of Neurons

A brief history of AI

- The theme of the history is a persistent curiosity of human beings on mind/intelligence/thinking in thousands of years.

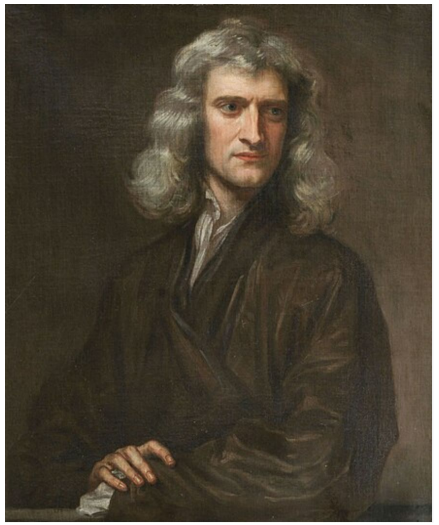
A brief history of AI

- **Aristotle**. Aristotle formally studied logic.
  - Aristotle is aware of the relationship between **natural language** and **thinking**, and his logic is from natural language. In 18th to 20th centuries, scholars connected his work to "**science of thinking**" or "**laws of thoughts**."



A brief history of AI

- **Newton**
  - Show that three Newton Laws explain many natural phenomenon.
  - Not directly related to mind. He demonstrated "deduction" in a powerful way.

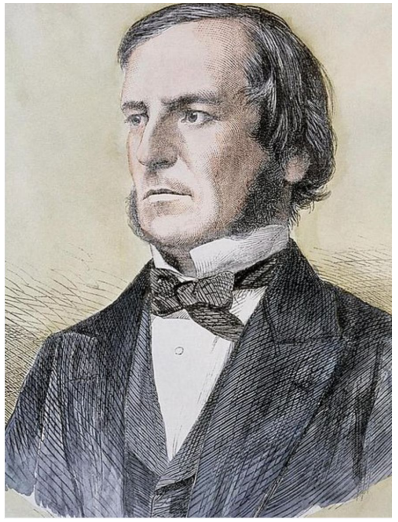


A brief history of AI

- **Leibniz**
  - Calculus (about 1675)
  - Computing: calculating machine (1673)
  - Logic: a system similar to George Boole's (1680)
  - (Logic, Computing) ‘He imagined that this machine, which he called “the great instrument of reason,” would be able to answer all questions and resolve all intellectual debate.’

A brief history of AI

- **George Boole**
  - Logic: “An Investigation into the **Laws of Thought**, on Which Are Founded the Mathematical Theories of Logic and Probabilities” (1854)

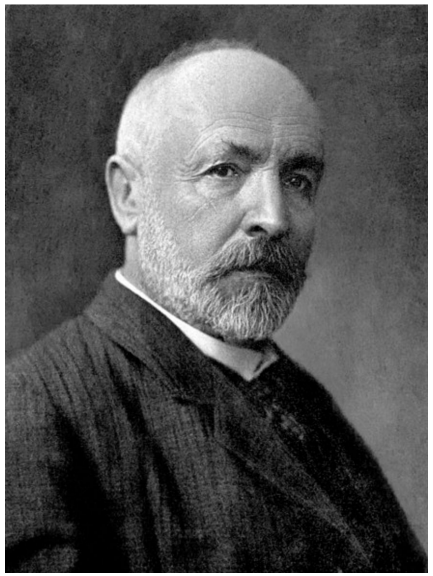


A brief history of AI

- **De Morgan**
  - Logic: introduce "relations" to logic, citing examples in natural language.

A brief history of AI

- **Cantor**
  - Set theory (1874-1884)



A brief history of AI

- **Frege**
  - Introduced relations and quantifiers to Logic (1879).
  - There was a math crisis in the 19th century. People realized a new and more rigorous **foundation for mathematics** was necessary.
  - He attempted to **precisely define every mathematical term** using logic and set theory.

A brief history of AI

- **Russell**:
  - $R=\{x:x\notin x\}$ (Russell paradox) (1902)
  - Russell and Whitehead: Principia Mathematica (1910 – 1913) result of an attempt to **define math concepts** based on logic.

A brief history of AI

- **Hilbert**: Hilbert’s Program to formalize all of mathematics in axiomatic form. (1900-1920)
- **Godel:** incomplete theorems (1931). They are interpreted by many as that Hilbert's program won't work.
- **Turing:** Turing machine (1936), giving a negative answer of one of Hilbert’s problems.

A brief history of AI

- First digital computers born, e.g., ENIAC (**John von Neumann** is a consultant) 1945
  - A machine enable people's effort on automating reasoning

A brief history of AI

Artificial Intelligence (artificial – using computing)

- **John McCarthy**. Coined AI (1951). Proposed to use Logic to achieve “intelligence” -- knowledge representation and reasoning.
- **Turing.** “Computing Machinery and Intelligence”, *Mind* (journal), 1950

A brief history of AI

Logic and Science

"*Development of Western science is based on two great achievements: the invention of the* ***formal logical system*** *(in Euclidean geometry) by the Greek philosophers, and the discovery of the possibility to find out causal relationships by systematic experiment (during the Renaissance*). **Albert Einstein** (1953)"

– from *Causality* by ***Judea Pearl*** (2000)

A brief history of AI

Computing – logic plays fundamental roles in computer science

- Theory of computer science
- Programming languages
- Software engineering
- ...

A brief history of AI

- Logic was invented --> Logic is used to describe the foundation of the math (math is a language for STEM subjects)
- Logic is from mind/thinking -> Logic based AI
- Logic is part of science (hypothesis in science need to be represented, logic is a way to go by Einstein :)