

Lecture 3

A Brief History of AI: Precursors, Gestation and Birth of AI

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Lecture Outline

- Scene Setting
 - Reviewing the Definition of AI
 - Principal Sub Areas of AI
- Historical Overview
 - Precursors (... – 1943)
 - Gestation and Birth (1943 – 1956)
 - Golden Early Years (1956-1969)
 - The First “AI Winter” (1966-73)
 - Rise of Knowledge-based and Expert Systems (1969-1989)
 - New Paradigms: Connectionism; Intelligent Agents; Embodied AI (1986 – present)
 - Scientific Method and Big Data (1987 – present)
- Reading: * = mandatory
 - *Russell and Norvig (2010), Chapter 1 “Introduction”
 - *Wikipedia: History of Artificial Intelligence. http://en.wikipedia.org/wiki/History_of_artificial_intelligence

Scene Setting

Reviewing the Definition of AI

- Last week we considered several definitions of AI:
 - McCarthy: *(AI) is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.*
 - Whitby: *Artificial Intelligence (AI) is the study of intelligent behaviour (in humans, animals and machines) and the attempt to find ways in which such behaviour could be engineered in any type of artifact.*

Scene Setting

Reviewing the Definition of AI

- These definitions presuppose some notion of “intelligence”
- While not agreeing entirely on what constitutes intelligence, psychologists concur that it includes the abilities to
 - Reason
 - Learn
 - Plan
 - Understand complex ideas
 - Solve Problems
 - Adapt to the environment

Scene Setting

Principal Sub Areas of AI

- These abilities correspond remarkably well with what have emerged as the principal sub areas of AI
 - Deduction, reasoning, problem solving
 - Knowledge representation
 - Planning
 - Learning
 - Natural language processing
 - Motion and manipulation
 - Perception

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This
week

- Precursors (... – 1943)
- Gestation and Birth (1943 – 1956)
- Golden Early Years (1956-1969)
- The First “AI Winter” (1966-73)

Next
week

- Rise of Knowledge-based and Expert Systems (1969-1989)
- New Paradigms: Connectionism; Intelligent Agents; Embodied AI (1986 – present)
- Scientific Method and Big Data (1987 – present)

Precursors (... – 1943)

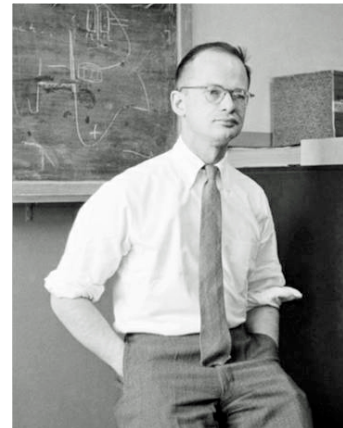
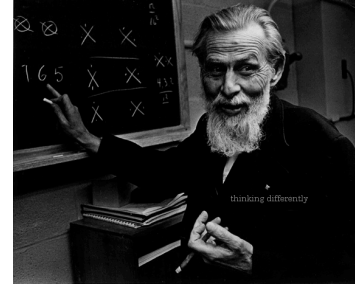
- We saw last week that stories/models of artificial beings manufactured or brought to life to function as assistants of various forms have pervaded human literature and preoccupied engineers for millenia and across many very different cultures
- By 1943 a number of developments had set the stage of the emergence of AI:
 - The appearance of the first electronic computers
 - Turing's foundational work relating deduction and computation, building on early 20th work on symbolic logic
 - Advances in understanding of the functions and activities of neurons in the brain

Gestation and Birth (1943 – 1956)

- McCulloch-Pitts Neuron (1943)
- Turing's "Computing Machinery and Intelligence" paper (1950)
- Logic Theorist (1955-56)
- Dartmouth Conference (1956)

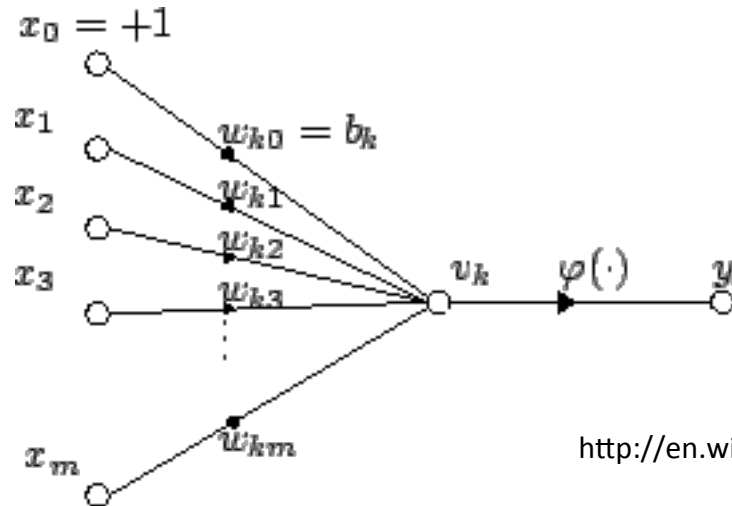
McCulloch-Pitts Neuron

- 1943 paper “A Logical Calculus of Ideas Immanent in Nervous Activity” generally recognised as the 1st work in AI
- Drew on
 - Knowledge of basic neurophysiology, esp. that the brain is a network of neurons that fire in all-or-nothing pulses based on inputs
 - Formal propositional logic (Russell and Whitehead)
 - Turing’s theory of computation



McCulloch-Pitts Neuron (cont)

- Proposed a model of an **artificial neuron**



http://en.wikipedia.org/wiki/Artificial_neuron

- Inputs (x_1, \dots, x_n), each with associated weight (w_{k1}, \dots, w_{kn}) are fed into neuron v_k
- Neuron computes weighted sum of inputs $\sum_{i=0}^n w_i x_i$ and passes it through a non-linear transfer function ϕ to give output y_k
- Typically ϕ is a step-like function which produces a 1 as output if the weighted sum of inputs exceeds a threshold defined by w_{k0} and 0 otherwise

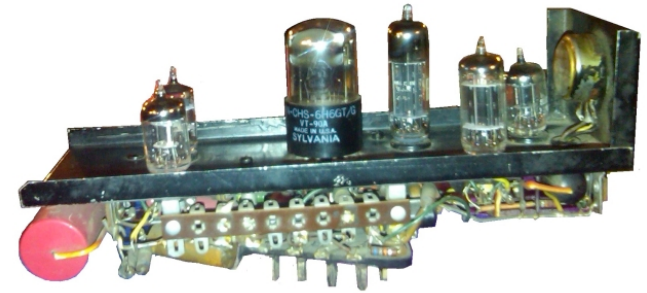
McCulloch-Pitts Neuron (cont)

- McCulloch and Pitts showed
 - all logical connectives (*and, or, not*, etc.)
 - indeed, any computable functioncould be computed by a network of connected artificial neurons
- Donald Hebb (1949) proposed an updating rule for modifying the connection weights in artificial neurons allowing a network to be trained
 - **Hebbian learning** still an influential model today

McCulloch-Pitts Neuron (cont)

- In 1951 two Harvard undergrads Marvin Minsky and Dean Edmonds built the 1st neural network computer – the SNARC

- 3000 vacuum tubes; simulated 40 neurons
- Used it to model the behaviour of a rat in a maze searching for food



One Neuron from the Snarc
<http://cyberneticzoo.com/?p=1053>

- Neural network research remains a core part of AI today
 - Minsky has played a central role in this sub-field since 1950

Turing's “Computing Machinery and Intelligence” paper (1950)

- Last week saw how Turing proposed to replace the question “can machines think?” with a question framed in terms of the **imitation game**
- Paper was immensely influential: not only introduced operational test for thinking but introduced other ideas that continue to influence AI
 - Machine learning
 - Genetic algorithms
 - Reinforcement learning

Logic Theorist (1955-56)

- Written by Herb Simon, Alan Newell and J.C. Shaw
- “first program deliberately engineered to mimic the problem solving skills of a human being”
(http://en.wikipedia.org/wiki/Logic_Theorist)
- Generally called “the first AI program”
- Proved 38 of the first 52 theorems in Whitehead and Russell's *Principia Mathematica* and found a shorter proof for one.

Logic Theorist (1955-56)

- Introduced several key concepts to AI:
 - **Reasoning as search**: proof is viewed as a search starting from a hypothesis root node, expanding it along different branches according to deductive rules and stopping when the proposition to be proved is obtained.
 - **Heuristics**: proof tree grows exponentially and hence some branches need to be pruned using “rules of thumb” or “heuristics” to constrain the search space while hopefully not losing the path to a solution.
 - **List processing**: to implement the Logic Theorist the authors developed a list processing programming language, IPL, that served as the basis for the Lisp programming language introduced slightly later by John McCarthy – an important AI programming language still used today.

Dartmouth Conference (1956)



- Proposed by John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon:

“We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.”

- Also attended by Ray Solomonoff, Oliver Selfridge, Trenchard More, Arthur Samuel, Herbert A. Simon, and Allen Newell
 - Went on to be AI leaders over the following decades.
- Generally taken as the birth point of AI

References

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