

History of Artificial Intelligence

COMP3411 / 9814
<http://www.cse.unsw.edu.au/~cs3411>

What is AI?

"... to investigate the fundamental laws of those operations of the mind by which reasoning is performed; to give expression to them in the symbolical language of a Calculus, and upon this foundation to establish the science of Logic and construct its method; to make that method itself the basis of a general method for the application of the mathematical doctrine of Probabilities; and, finally, to collect from the various elements of truth brought to view in the course of these inquiries some probable intimations concerning the nature and constitution of the human mind.

George Boole (1854)
An Investigation of the Laws of Thought

Artificial Intelligence: The First 2,400 years

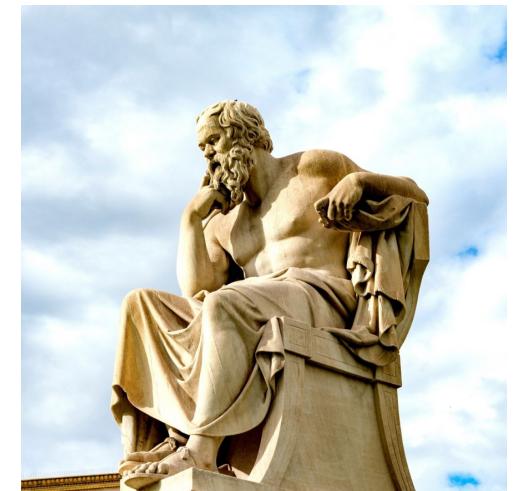
- Logic (Aristotle c. 350BC, Boole 1848, Frege 1879, Tarski 1935)
- Formal algorithms (Euclid c. 300BC)
- Probability (Pascal 17th C, Bayes 18th C)
- Utility theory (Mill 1863)
- Dynamical systems (Poincare 1892)
- Structural linguistics (Saussure 1916, Bloomfield 1933)
- Formal systems (Gödel 1929, Turing 1936)
- Neural networks (McCulloch & Pitts 1943)
- Cybernetics/Control theory (Wiener 1948)
- Game theory (von Neumann & Morgernstern 1947)
- Decision theory (Bellman 1957)
- Formal linguistics (Chomsky 1957)

Foundations of AI

- Philosophy (428 B.C – present)
- Mathematics (c. 800 – present)
- Psychology (1879 – present)
- Linguistics (1957 – present)
- Computing (1940 – present)
- Biocybernetics (1940's – present)
- Neurology (1950's – present)

Foundations of AI - Philosophy

- What is mind? → Mind is like a machine
- Operates on knowledge encoded in an “internal language”
- Thought and reasoning can be used to arrive at the right actions
- What is consciousness?



Foundations of AI - Mathematics

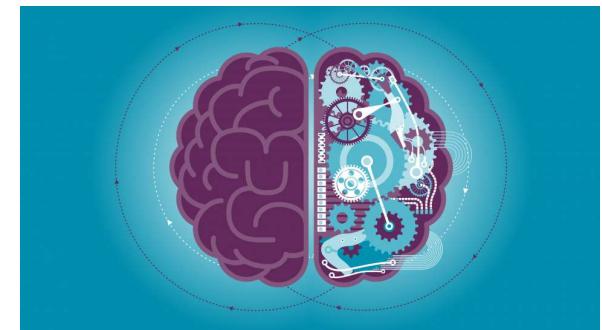
- Tools to manipulate logical statements
- Tools to manipulate probabilistic statements
- Algorithms and their analysis
- Complexity analysis
- Dynamical systems / Recurrent Neural Networks
- Statistical Physics / Hopfield nets
- Methods for pattern recognition
- Models using differential equations, statistics, etc.

The blackboard contains the following mathematical content:

- Trigonometric identities:
 - $\sin \alpha = BC = \frac{a}{c}$
 - $\cos \alpha = OB = \frac{b}{c}$
 - $\operatorname{tg} \alpha = OB = \frac{b}{a}$
 - $\operatorname{ctg} \alpha = OD = \frac{a}{b}$
 - $\alpha^\circ = \frac{\pi}{180} \alpha$
 - $\alpha = \frac{\pi}{180} \alpha^\circ$
 - $\sin^2 \alpha + \cos^2 \alpha = 1$
 - $\sin \alpha \cdot \csc \alpha = 1$
 - $\sin 2\alpha = 2 \sin \alpha \cos \alpha$
 - $\cos 2\alpha = \cos^2 \alpha - \sin^2 \alpha$
 - $\operatorname{tg} 2\alpha = \frac{2 \operatorname{tg} \alpha}{1 - \operatorname{tg}^2 \alpha}$
- Diagrams:
 - A circle divided into four quadrants I, II, III, IV with points A, B, C, D marked.
 - A right-angled triangle with hypotenuse c, horizontal leg b, and vertical leg a.
 - A coordinate system showing a curve u(t) and a point P on it.
 - A graph of a function u versus t.
 - A Cartesian coordinate system with x and y axes.
- Differential equations:
 - $\frac{du}{dt} = A \sin(\omega t + \varphi)$
 - $u = A \sin \omega t + B \cos \omega t$
 - $x = -\frac{b}{\omega}$
 - $\Delta = 4ac - b^2$
 - $\operatorname{tg} \varphi = \pm \sqrt{a^2 - (\frac{b}{\omega})^2}$

Foundations of AI - Psychology

- Humans and other animals are information processing machines
- Introspection
- Experiments
- What is intelligence?
<http://www.iqtest.com/>
- What is learning, memory, problem solving?



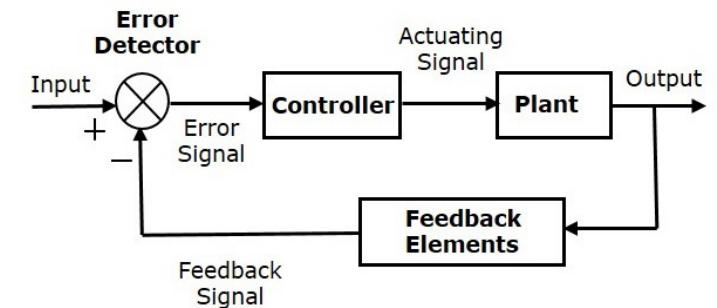
Foundations of AI - Linguistics

- Language use fits into the ‘information processing machine’ model
- Chomsky hierarchy
- Natural language processing



Foundations of AI - Cybernetics

- Intelligent behaviour as a control system
- Feedback mechanisms
- Predictive models
- Links to electrical and mechanical engineering
 - Mechatronics

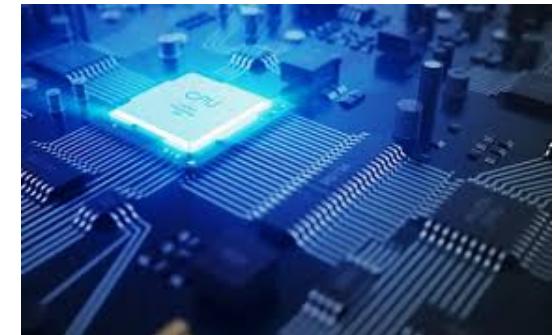


Foundations of AI - Neuroscience

- Neural networks
- Architecture of the brain
- Brain models



Foundations of AI - Computing



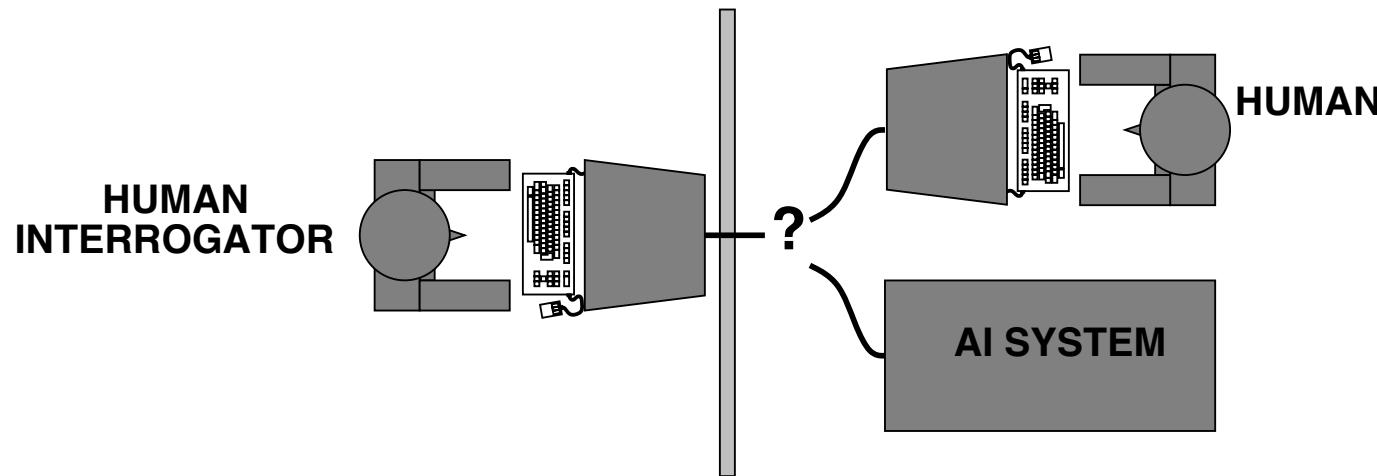
- Thought as computation
- Implementation of algorithms on a computer make theories operational
- Computers and robots fast enough to make AI applications

Thought as Calculation

The only way to rectify our reasonings is to make them as tangible as those of the Mathematicians, so that we can find our error at a glance, and when there are disputes among persons, we can simply say: “Let us calculate”, without further ado, to see who is right.

Liebnitz (1685)
The Art of Discovery

Turing's Imitation Game



I believe that in about fifty years time [2000] it will be possible to programme computers with a storage capacity of about 10^9 to make them play the imitation game so well that an average interrogator will not have more than 70 per cent chance of making the right identification after five minutes of questioning.

Extract from Turing paper

Interrogator: In the first line of your sonnet which reads ‘Shall I compare thee to a summer’s day’, would not ‘a spring day’ do as well or better?

Witness: It wouldn’t scan.

Interrogator: How about ‘A winter’s day’ – That would scan all right.

Witness: Yes, but nobody wants to be compared to a winter’s day.

Interrogator: Would you say Mr. Pickwick reminded you of Christmas?

Witness: In a way.

Interrogator: Yet Christmas is a winter’s day, and I do not think Mr. Pickwick would mind the comparison.

Witness: I don’t think you’re serious. By a winter’s day one means a typical winter’s day, rather than a special one like Christmas.

Eliza Session

Doctor: What brought you here to see me today?

Visitor: Oh, nothing much. I'm feeling a bit tired, that's all.

Doctor: Why do you think you're feeling a bit tired?

Visitor: Well, I've been traveling a lot, and away from home.

Doctor: Tell me more about your family.

Eliza Session

Visitor: The trouble is, my mother's ill.

Doctor: How long has she been ill?

...

Visitor: The trouble is, my mother's Irish.

Doctor: How long has she been Irish?

...

Visitor: The trouble is, my mother's poodle.

Doctor: How long has she been poodle?

Conversational Agents



The Child Machine

“Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child's? If this were then subjected to an appropriate course of education one would obtain the adult brain. Presumably the child-brain is something like a notebook as one buys from the stationers. Rather little mechanism, and lots of blank sheets... Our hope is that there is so little mechanism in the child-brain that something like it can be easily programmed. The amount of work in the education we can assume, as a first approximation, to be much the same as for the human child.”

Alan Turing (1950)
Computing Machinery and Intelligence

The World Brain

- "...a sort of mental clearing house for the mind, a depot where knowledge and ideas are received, sorted, summarized, digested, clarified and compared."
- "any student, in any part of the world, will be able to sit with his projector in his own study at his or her convenience to examine any book, any document, in an exact replica."

H.G. Wells (1937)
World brain: the idea of a permanent world encyclopaedia

Where has AI gone?

- A lot of focus on the world brain
 - Masses of data enable solving problems in ways we couldn't anticipate
 - E.g. Crowd-sourcing
 - Data centres have enormous computing power
 - Child machine becoming more important with rise of the robots

Agents and Autonomous Systems

- Complex behaviours in dynamic environments
- Have to integrate almost all aspects AI
- Combines computing with many other disciplines

Autonomous Systems



Recent History

- Read Nils Nilsson's "The Quest for Artificial Intelligence"
- <https://ai.stanford.edu/~nilsson/QAI/qai.pdf>

Shakey - The First Integrated AI System



Freddy and the Lighthill Report



Some Applications of AI in CSE

- Autonomous maritime vessels
(Ocius)
- Steel manufacture (BlueScope)
- Infrastructure maintenance
(ARC Research Hub)
- Museum knowledge base
(Powerhouse)
- eLearning (Stronger Brains)
- Mine Automation
- Medical imaging
- Satellite image recognition
(SmartSat CRC)
- Lunar analogue simulator
(new ACSER LIEF grant)
- Network security and management
- IOT
- Transport planning

Questions?