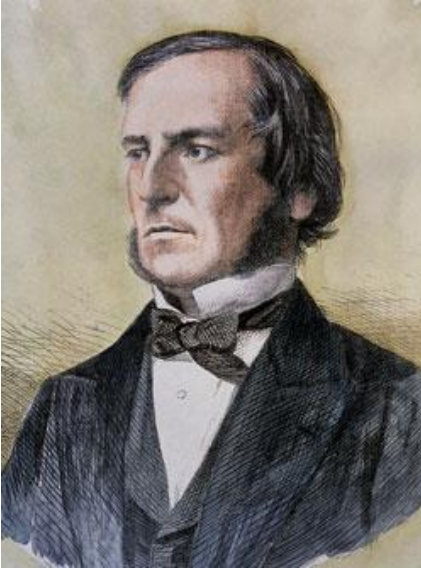


ARTIFICIAL INTELLIGENCE

ECS170 Spring 2018
Josh McCoy, @deftjams

1850s - Boole



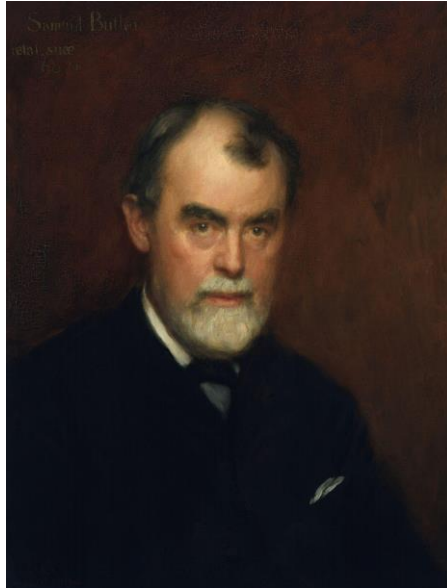
x	y	$x \wedge y$	$x \vee y$	x	$\neg x$
0	0	0	0	0	1
1	0	0	1	1	0
0	1	0	1		
1	1	1	1		

George Boole: philosopher, mathematician, logician
Queens College, Ireland

The Laws of Thought 1854 Boolean Algebra

https://en.wikipedia.org/wiki/George_Boole

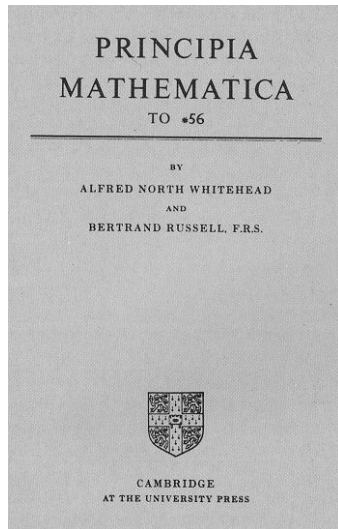
1860s - Butler



Posited the idea that evolution can apply to machines.

[https://en.wikipedia.org/wiki/Samuel_Butler_\(novelist\)](https://en.wikipedia.org/wiki/Samuel_Butler_(novelist))

1910s – Formal Logic



*1.01. $p \supset q . \equiv . \sim p \vee q$. **Df.**

*1.1. Anything implied by a true elementary proposition is true.

(*1.11 was abandoned in the second edition.)

*1.2. $\vdash p \vee p . \supset . p$. **Pp** principle of tautology

*1.3. $\vdash q . \supset . p \vee q$. **Pp** principle of addition

*1.4. $\vdash p \vee q . \supset . q \vee p$. **Pp** principle of permutation

*1.5. $\vdash p \vee (q \vee r) . \supset . q \vee (p \vee r)$. **Pp** associative principle

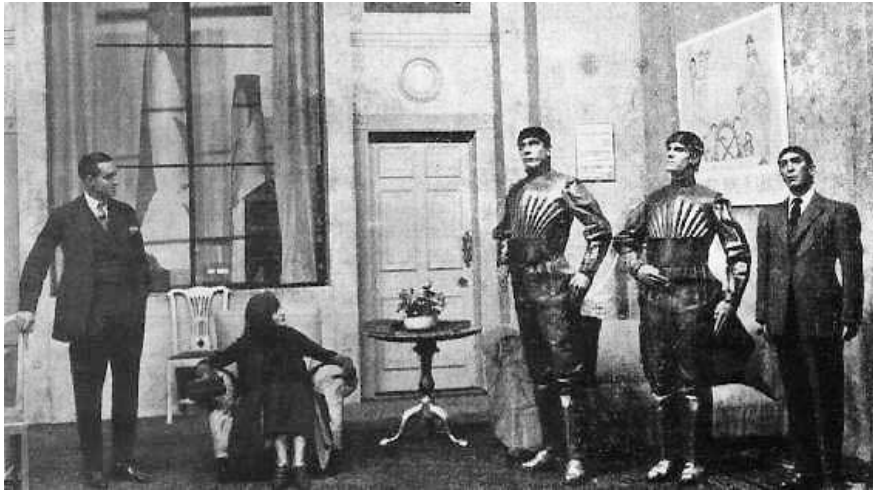
*1.6. $\vdash . q \supset r . \supset : p \vee q . \supset . p \vee r$. **Pp** principle of summation

Whitehead and Russell

The first formal notation for logic. It looks different than modern notation.

https://en.wikipedia.org/wiki/Principia_Mathematica

1923 – Rossum's Universal Robots

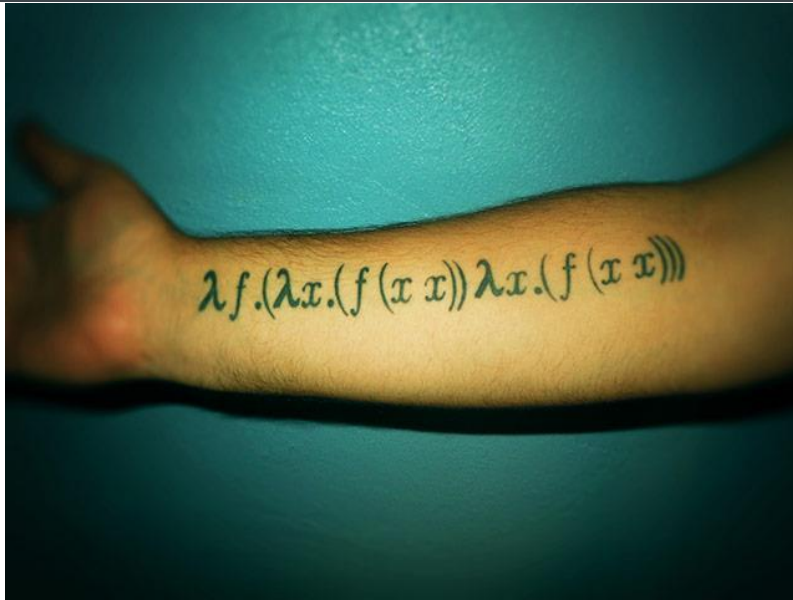


Karel Čapek Cha-peck 's play featuring automoton called "robots".
Influenced by pragmatic liberalism.
Robot translates as "slave".

https://en.wikipedia.org/wiki/Karel_%C4%8Capek

<https://en.wikipedia.org/wiki/R.U.R.>

1930s Lambda Calculus



Alfonzo Church developed Lambda Calculus.

A universal model of computation equivalent to the Turing Machine in capability.

This is the theoretical basis for recursion.

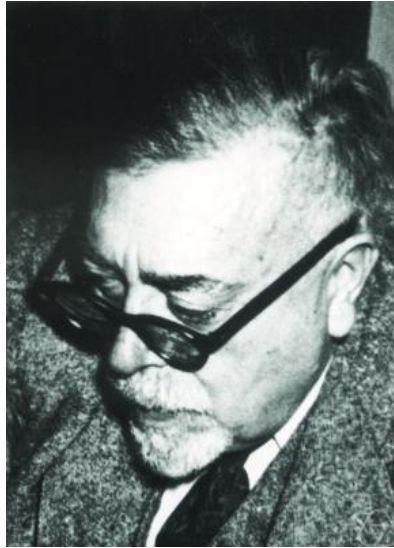
Check out the y-combinator.

Basis for recursive

Image:

<https://sophimania.lamula.pe/2011/11/27/formulas-y-codigos-los-extravagantes-tatuajes-de-los-cientificos-fotos/sophimania/#lg=1&slide=1>

1940s – Cybernetics and ANNs



Norbert Wiener: cybernetics is ""the scientific study of control and communication in the animal and the machine.""

This led to the foundations of artificial neural networks.

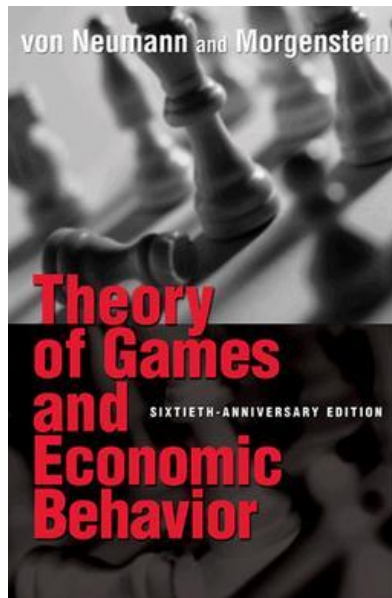
<https://en.wikipedia.org/wiki/Cybernetics>

https://en.wikipedia.org/wiki/Arturo_Rosenblueth

https://en.wikipedia.org/wiki/Warren_Sturgis_McCulloch

https://en.wikipedia.org/wiki/Norbert_Wiener

1945 – Game Theory



Game theory was established by John von Neumann

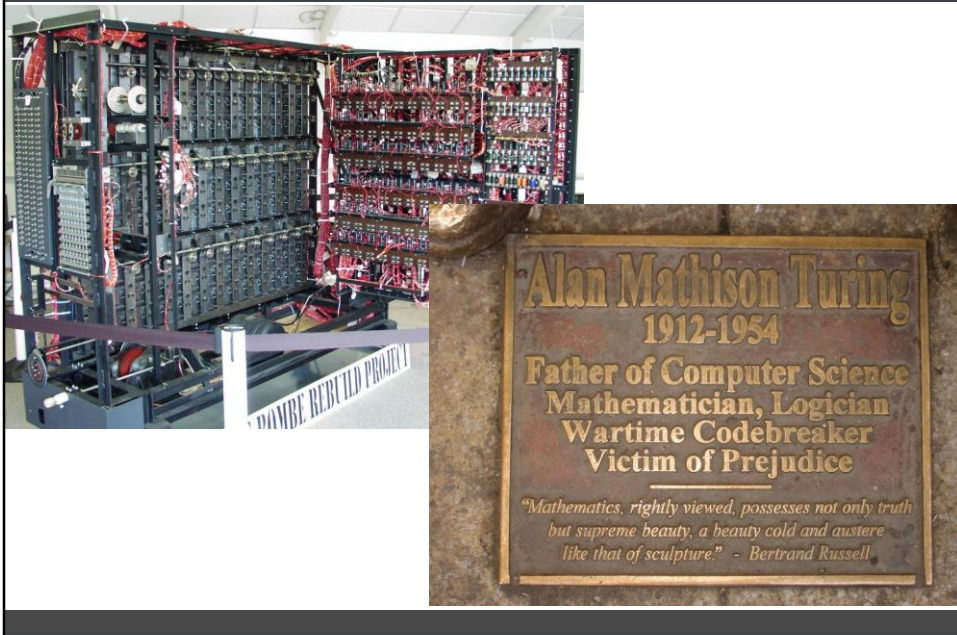
"You insist that there is something a machine cannot do. If you will tell me precisely what it is that a machine cannot do, then I can always make a machine which will do just that!". Von Neumann was presumably alluding to the Church-Turing thesis which states that any effective procedure can be simulated by a (generalized) computer.

https://en.wikipedia.org/wiki/Theory_of_Games_and_Economic_Behavior

The Birth of Modern AI

1950-196x

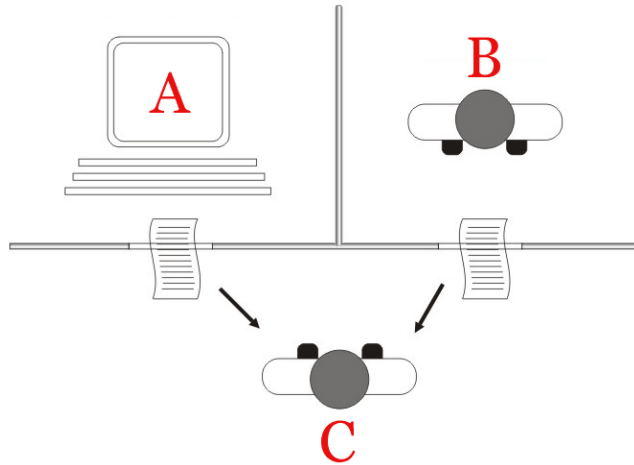
1950 – Computing Machinery and Intelligence



Turing, A.M. (1950). Computing machinery and intelligence. *Mind*, 59, 433-460.
<http://loebner.net/Prizef/TuringArticle.html>

Photograph taken by [Lmno](#)

1950 – The Turing Test

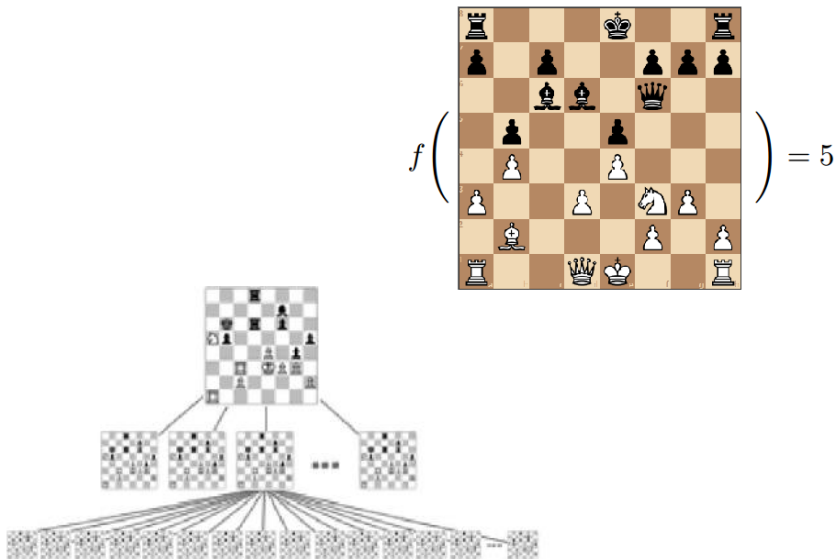


The Turing Test was proposed as a measure of machine intelligence.

Can a neutral human judge (C) determine if A and B are human or machine? Text-only communication.

https://en.wikipedia.org/wiki/Turing_test

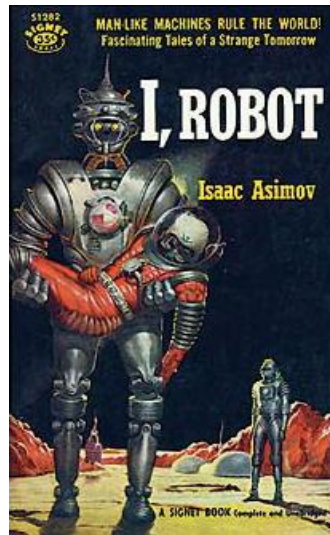
1950 – Chess as Search



Shannon implements chess as a search problem using the minimax algorithm.
Evaluation function used.

<http://stanford.edu/~cpiech/cs221/apps/deepBlue.html>

1950 – Three Laws of Robotics



Isaac Asimov

A robot may not injure a human being or, through inaction, allow a human being to come to harm.

A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

https://en.wikipedia.org/wiki/Three_Laws_of_Robotics

1956 – "Artificial Intelligence"



The term “Artificial Intelligence” coined at a workshop in 1956 at Dartmouth College by John McCarthy.

1958 - Lisp

```
(defun sqrt-iter (guess x)
  (if (good-enough-p guess x)
      guess
      (sqrt-iter (improve guess x) x)))

(defun improve (guess x)
  (mean (list guess (/ x guess))))

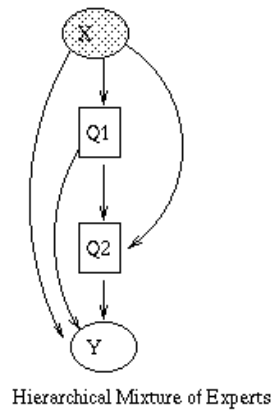
;see format page 121-122

(defun good-enough-p (guess x)
  (format t "~% Guess =~7,4f      Guess^2 = ~7,4f      Error= ~7,4f" guess
          (* guess guess) (abs (- (* guess guess) x))
          (< (abs (- (* guess guess) x)) .001)))

(defun factorial (n)
```

Lisp was invented by John McCarthy at MIT.

1960s – Math and AI



Universal Bayesian methods developed by Ray Solomonoff.

<https://www.cs.ubc.ca/~murphyk/Bayes/bnintro.html>

1957 – General Problem Solver

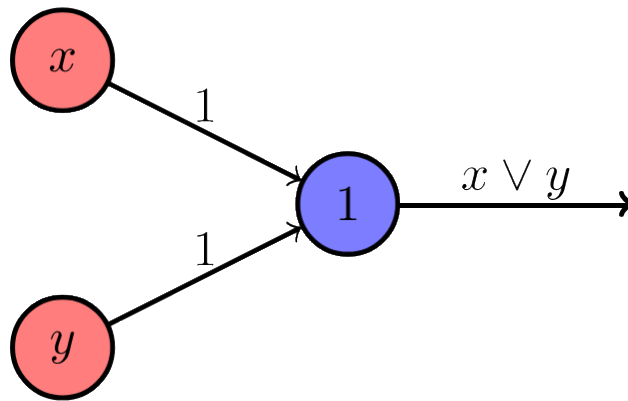


[Herbert A. Simon](#), [J. C. Shaw](#), and [Allen Newell](#) creates a general problem solver (GPS program) out of directed graphs, axioms/sources, and sinks/conclusions.

Specializes in proofs: predicate logic, Euclidean geometry were example spaces.

https://en.wikipedia.org/wiki/General_Problem_Solver

1963 Perceptrons



Marvin Minsky & Seymour Papert publish about perceptrons, the basic building block of ANNs.

This example is or. If $X+Y \geq 1$, 1 is output. Otherwise, 0 is output.

X and Y come in as input values. Simple math on input values (addition, multiplication), value is thresholded. If above threshold, return 1, if below return false.

1965 – Eliza

<http://www.masswerk.at/eliza/>

Joseph Weizenbaum (MIT)

Interactive therapist.

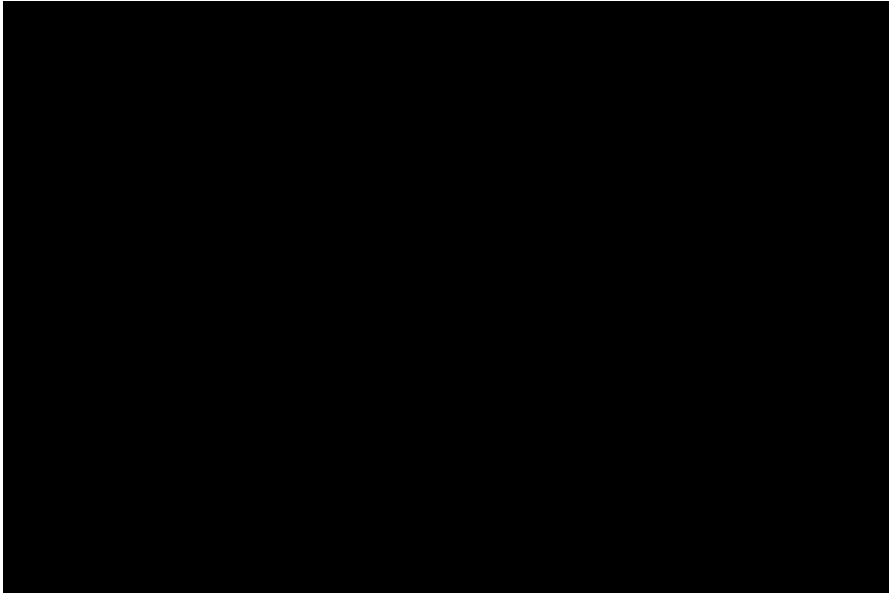
Simple string transformation.

The "Eliza Effect"

1966

- Machine Intelligence
 - Term and conference.
- Dendral
 - Joshua Lederberg
 - Bruce Buchanan
 - Georgia Sutherland
 - First successful knowledge-based program for a difficult task (scientific reasoning).

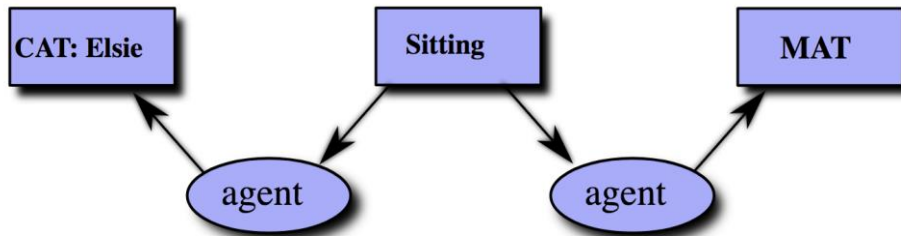
1969 – Shakey the Robot



Stanford Research Institute(SRI): Shakey the Robot, demonstrated combining animal locomotion, perception and problem solving.

https://en.wikipedia.org/wiki/Shakey_the_robot

1969 – Conceptual Graphs



Robert Schank, John F. Sowa

Merging of logical representations with graph representations. Use the tools of both fields!

https://en.wikipedia.org/wiki/Conceptual_graph

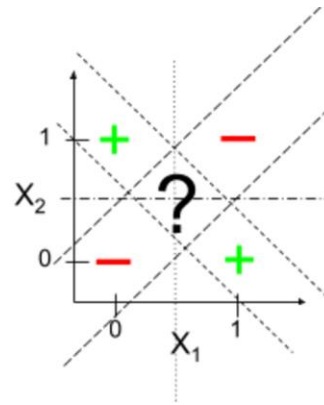
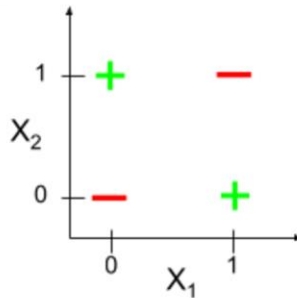
Next time: AI winter!



AI Winter
1969 - 1990

1969 - Perceptrons

x_1	x_2	$x_1 \text{ XOR } x_2$
0	0	0
0	1	1
1	0	1
1	1	0



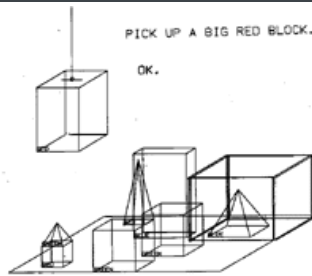
Marvin Minsky proved that three-layered feed-forward perceptrons (a.k.a. hidden layer) could not calculate XOR. (Without the hack of at least one weighted communication channel that buypasses the hidden layer.)

This caused a crisis in the AI community and resulted in funding sources pulling back resources from the field.

[https://en.wikipedia.org/wiki/Perceptrons_\(book\)](https://en.wikipedia.org/wiki/Perceptrons_(book))

<https://medium.com/@claude.coulombe/the-revenge-of-perceptron-learning-xor-with-tensorflow-eb52cbdf6c60>

1971 - SHRDLU



Person: PICK UP A BIG RED BLOCK.
Computer: OK. (does it)
Person: GRASP THE PYRAMID.
Computer: I DON'T UNDERSTAND WHICH PYRAMID YOU MEAN.
Person: FIND A BLOCK WHICH IS TALLER THAN THE ONE YOU ARE HOLDING AND PUT IT INTO THE BOX.
Computer: BY "IT", I ASSUME YOU MEAN THE BLOCK WHICH IS TALLER THAN THE ONE I AM HOLDING.
Computer: OK. (does it)
Person: WHAT DOES THE BOX CONTAIN?
Computer: THE BLUE PYRAMID AND THE BLUE BLOCK.
Person: WHAT IS THE PYRAMID SUPPORTED BY?
Computer: THE BOX.
Person: HOW MANY BLOCKS ARE NOT IN THE BOX?
Computer: FOUR OF THEM.
Person: IS AT LEAST ONE OF THEM NARROWER THAN THE ONE WHICH I TOLD YOU TO PICK UP?
Computer: YES, THE RED CUBE.
Person: IS IT SUPPORTED?
Computer: YES, BY THE TABLE.
Person: CAN THE TABLE PICK UP BLOCKS?
Computer: NO.

Terry Winograd created SHRDLU: a robotic arm that would arrange blocks based on typed English instructions.

Procedures as a Representation for Data in a Computer Program for Understanding Natural Language It was published as a full issue of the journal *Cognitive Psychology* Vol. 3 No 1, 1972, and as a book, *Understanding Natural Language* (Academic Press, 1972).

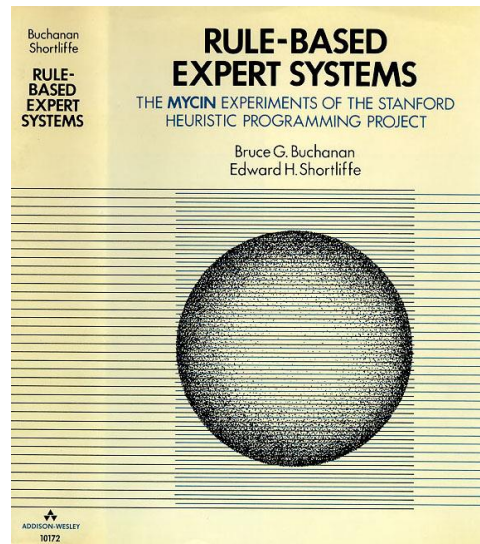
<https://hci.stanford.edu/winograd/shrdlu/>

1973 – Lighthill Report

The winter is now colder.

The Lighthill report gives the British government the recommendation to discontinue most support for AI research.

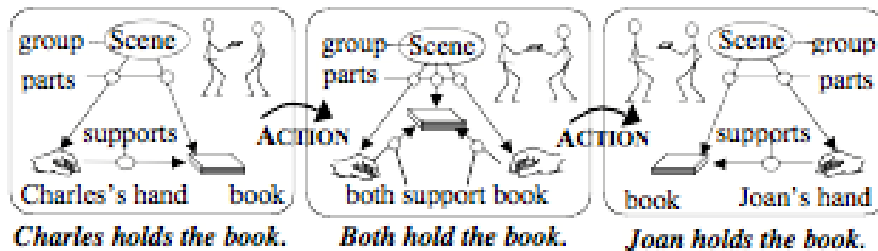
1974 - MYCIN



Ted Shortliffe's dissertation work covered MYCIN: a knowledge/rules-based system for medical diagnosis. Inspiration came from DENDRAL. Strongly influenced expert systems.

<https://en.wikipedia.org/wiki/Mycin>

1975 –Plans and Frames



Earl Sacerdoti designed and implemented techniques for partial-order planning in the NOAH system. Used to diagnose and repair electromechanical systems.

Austen Tate developed Nonlin planning system that created plans and alternates given the structure of the goal.

Marvin Minsky published frames as a knowledge representation mode that integrated a few of the leading KR concepts into a whole.

https://en.wikipedia.org/wiki/Partial-order_planning

https://en.wikipedia.org/wiki/Austin_Tate

https://en.wikipedia.org/wiki/Frame_problem

1980s – Lisp Machines



Computers with hardware designed to run Lisp efficiently were developed. As most AI programs (and expert systems) were developed with Lisp, this was a large step forward in their applicability. (Think GPU acceleration and ML.)

The Knight Machine is shown above.

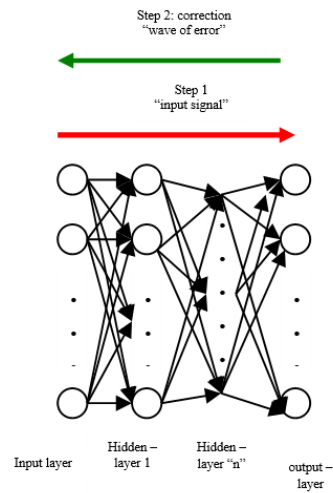
https://en.wikipedia.org/wiki/Lisp_machine

1980 – AAI



The first meeting to of the American Association for Artificial Intelligence held at Stanford. Still the top tier conference. Now known as the Associated for the Advancement of Artificial Intelligence.

1980s – Neural Networks Useful



https://commons.wikimedia.org/wiki/File:Backproagation_neural_networks.png

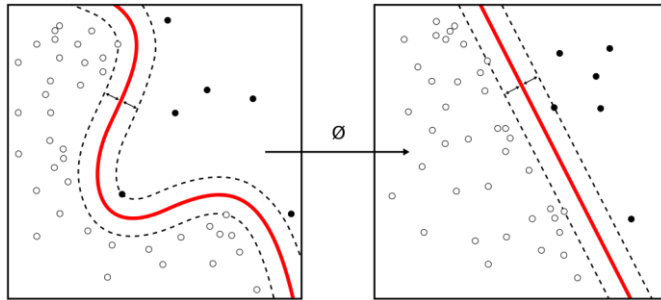
Mid 1980s-1992ish - AI Winter v2.0



Some argue that spring never arrived.

Some believe that expert systems were the first time AI was commercially successful and set the stage for AI to be broadly applied.

1990s - Support Vector Machines



Vladimir Vapnik and Alexey Chervonekis in 1963.

Lost in the cold war.

Rediscovered and resurrected in early 1990s by Vapnik.

Astoundingly successful compared to ML techniques at the time.

https://en.wikipedia.org/wiki/Support_vector_machine#History

1990s – The Conquest of the Neats

Provable
grounded
incremental

VS

Inherently intractable
solve with homogenous systems
too complex to prove

Neats and Scruffies

■ Neats:

- McCarthy
- Newell
- Simon
- Feigenbaum

■ Scruffies:

- Brooks
- Winograd
- Schank
- Minsky

https://en.wikipedia.org/wiki/Neats_and_scruffies#Well-known_examples