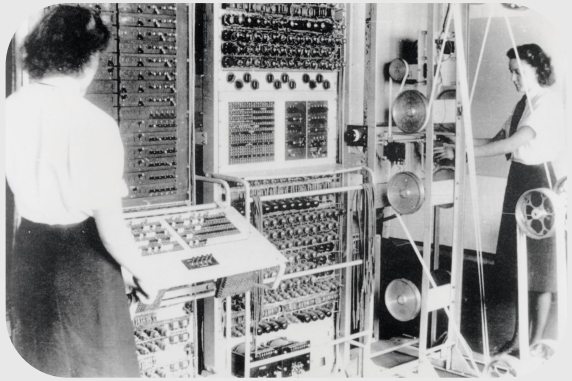
# A Brief History of AI

*"I propose to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'"*
- ALAN M TURING (1950)



This lecture traces the remarkable journey of Artificial Intelligence, from its conceptual roots in the 19th century to its transformative impact and future potential in the 21st century.

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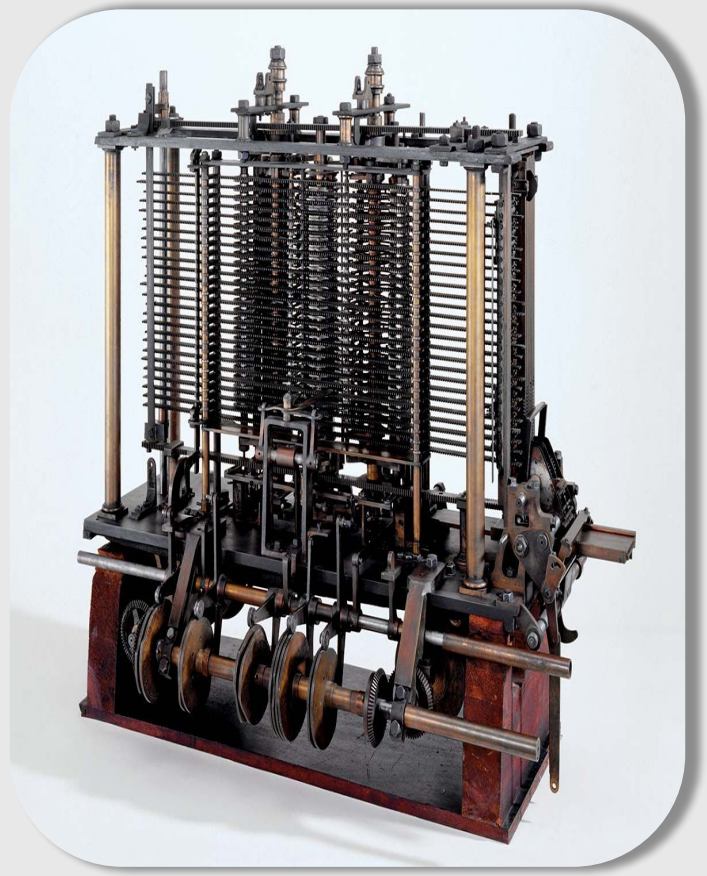
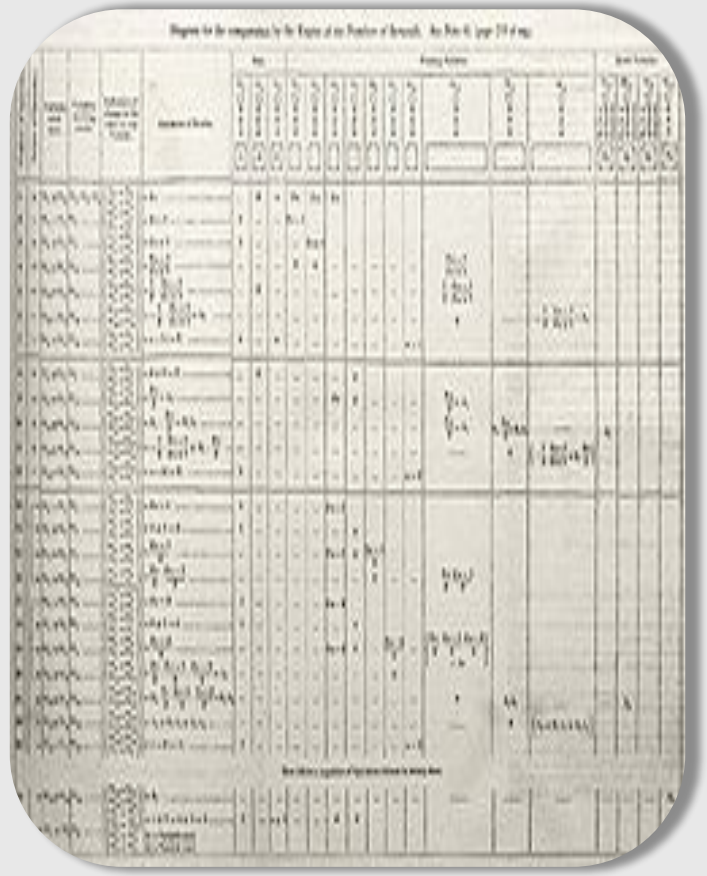
# Charles Babbage and The Analytical Engine – 1830's

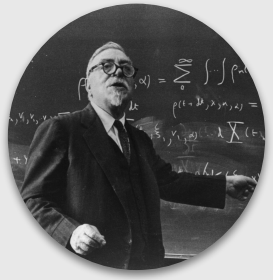
- English Mathematician and Inventor
- Credited for the first Mechanical Computer called the Difference Engine
- Proposed the Analytical Engine
  - Punch Cards for taking input (Computer Program)
  - Store for storing data (RAM)
  - Mill for performing computations (CPU)
  - Output used a printer, curve plotter, and a bell (I/O Devices)



# Ada Lovelace the first Computer Programmer– 1840's

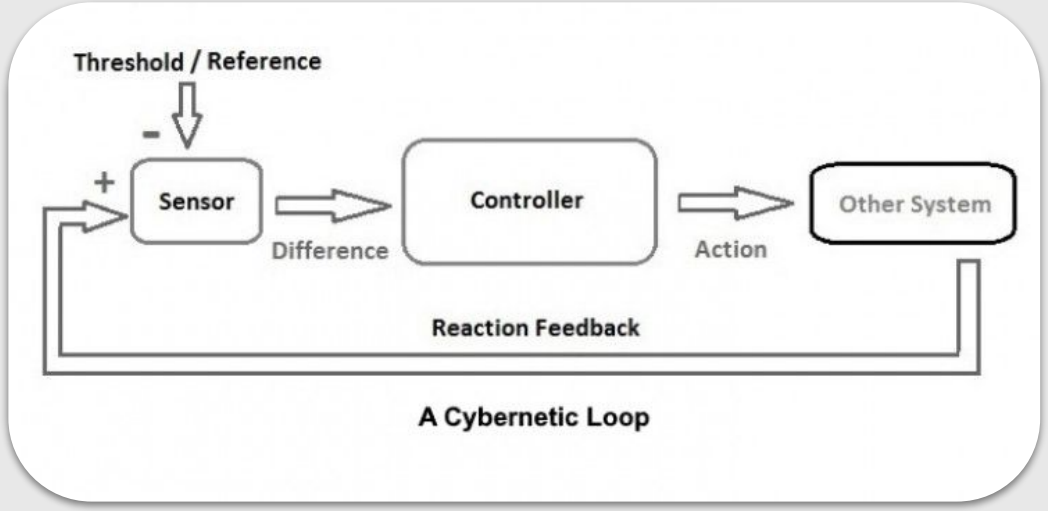
- English Mathematician and Writer
- First meet Babbage when she was 17
- She translated a French article on the Analytical Engine and added extensive notes
  - Wrote a Program to calculate a sequence of Bernoulli Numbers for the Analytical Engine
- "[The Analytical Engine] might act upon other things besides number... the Engine might compose elaborate and scientific pieces of music of any degree of complexity or extent"
- "The Analytical Engine has no pretensions whatever to *originate* anything. It can do whatever we *know how to order it* to perform. It can *follow* analysis; but it has no power of *anticipating* any analytical relations or truths."





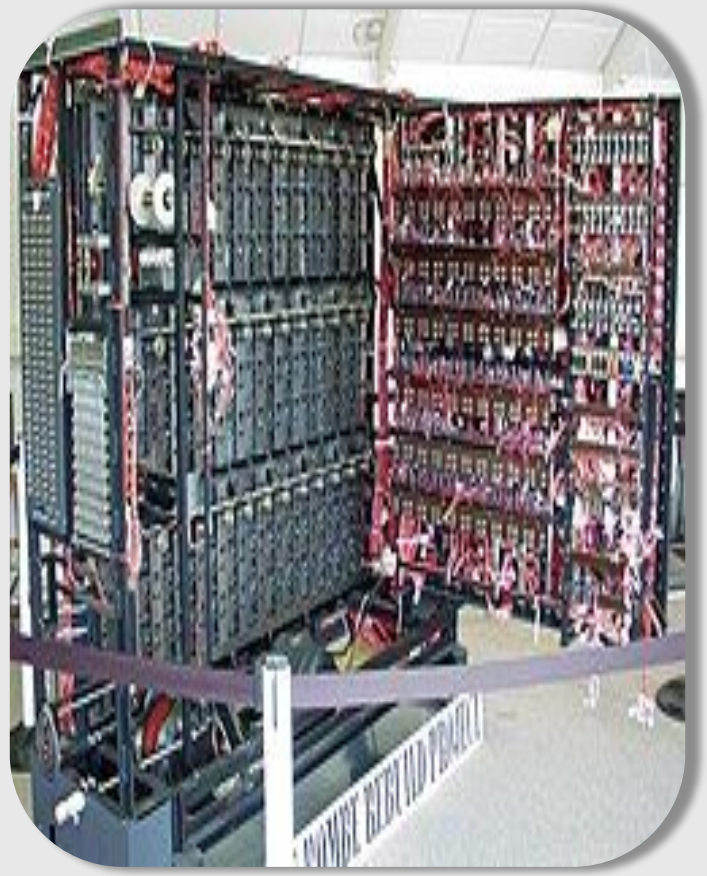
# Norbert Wiener and Cybernetics - 1940's

- Mathematician & engineer at MIT
- Coined the term Cybernetics in 1948 with his book *Cybernetics: Or Control and Communication in the Animal and the Machine*
  - The scientific study of control and communication in animals, humans, and machines.
- He presents the idea of a feedback system where a machine can adjust based on the output



# Alan Turing and the Imitation Game – 1950's

- English Mathematician and Computer Scientist
- Created a machine to break the German Enigma code during WWII
- "A variant of Lady Lovelace's objection states that a machine can 'never do anything really new.' … A better variant of the objection says that a machine can never 'take us by surprise.' This statement is a more direct challenge and can be met directly. Machines take me by surprise with great frequency."



# Alan Turing and the Imitation Game – 1950's

- "The new form of the problem can be described in terms of a game which we call the 'imitation game.' It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart front the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either "X is A and Y is B" or "X is B and Y is A. … We now ask the question, 'What will happen when a machine takes the part of A in this game?'"

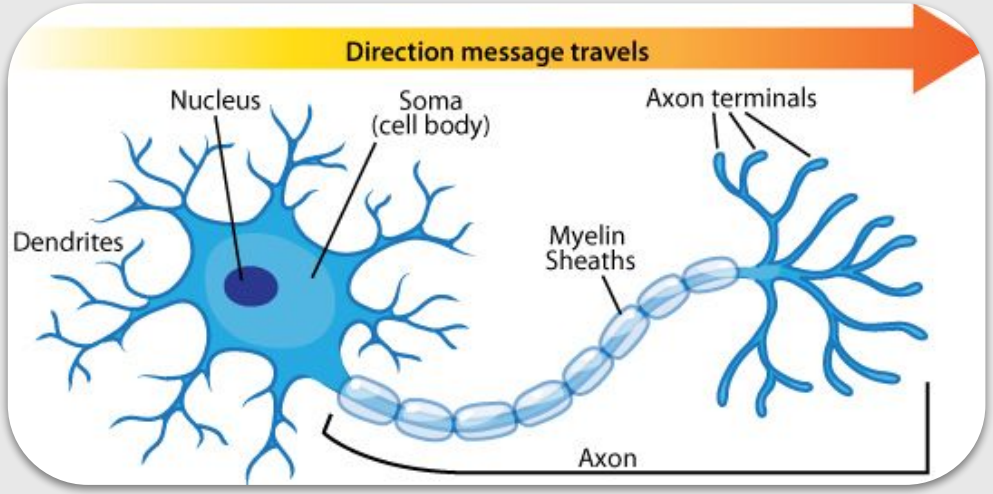
# The Birth of Machine Translation - 1950's

- 1955 Georgetown-IBM Experiment: First major MT demo translating 60 Russian sentences into English using a small vocabulary and hand-crafted rule

- Noam Chomsky (1957): Introduced generative grammar, focusing on deep structure and universal rules of language.
  - Concern: Chomsky argued that language cannot be learned purely from statistical patterns; rules and structure were essential.
  - This influenced early MT to favor rule-based approaches over data-driven methods.

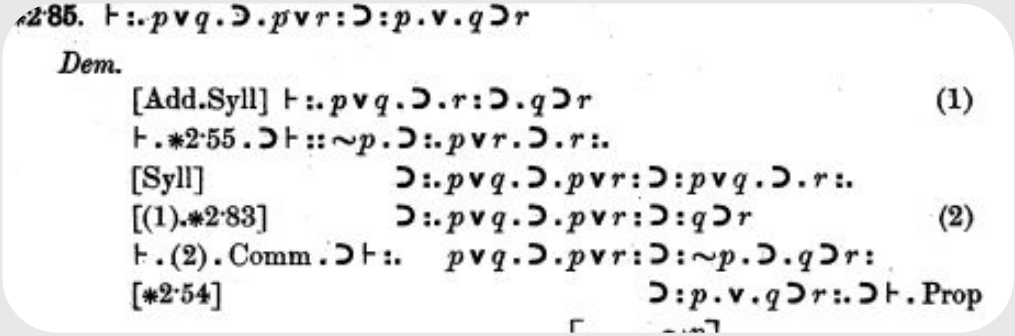
# Human Neuron - Hodgkin & Huxley - 1952

- Alan Hodgkin – British physiologist.
- Andrew Huxley – British physiologist and biophysicist
- Awarded the 1963 Nobel Prize in Physiology or Medicine (with John Eccles)
- Provided the first quantitative model of how neurons work.
- Inspired early artificial neural networks by showing:
  - Neurons can be modeled mathematically.
  - Information is transmitted via signals that follow predictable rules.



# Symbolic AI & Logic Theorist - 1955

- Symbolic AI- Approach to AI where knowledge is represented as symbols and manipulated by logical rules.
- Logic Theorist
  - Considered the first AI program.
  - Designed to prove mathematical theorems from Principia Mathematica (Whitehead & Russell).
- Used heuristic search to mimic human problem-solving:
  - Applied general rules.
  - Tried promising approaches first (rather than brute force).
- Successfully proved 38 of the first 52 theorems, sometimes with more elegant proofs than humans.



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*Dem.*

[Add.Syll] $\vdash :. p \vee q . \supset . r : \supset . q \supset r$ (1)

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[(1).*2·83] $\supset :. p \vee q . \supset . p \vee r : \supset : q \supset r$ (2)

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[*2·54] $\supset : p . \vee . q \supset r :. \supset \vdash .$ Prop

# The Dartmouth Workshop– 1956

- A 2 month 10 man study on Artificial Intelligence carried out in the summer of 1956 at Dartmouth
- "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" - McCarthy et al.
- How Can a Computer be Programmed to Use Language
  - Neuron Nets
  - Self Improvement
  - Randomness and Creativity


# Minsky vs Rosenblatt and The Perceptron – 1960's

- In 1957 Frank Rosenblatt proposes the Perceptron based off a human neuron. It was to be made of 3 parts:
  - A set of sensory units which receive optical input
  - A set of association units, each of which fire based on input from multiple sensory units
  - A set of response units, which fire based on input from multiple association units

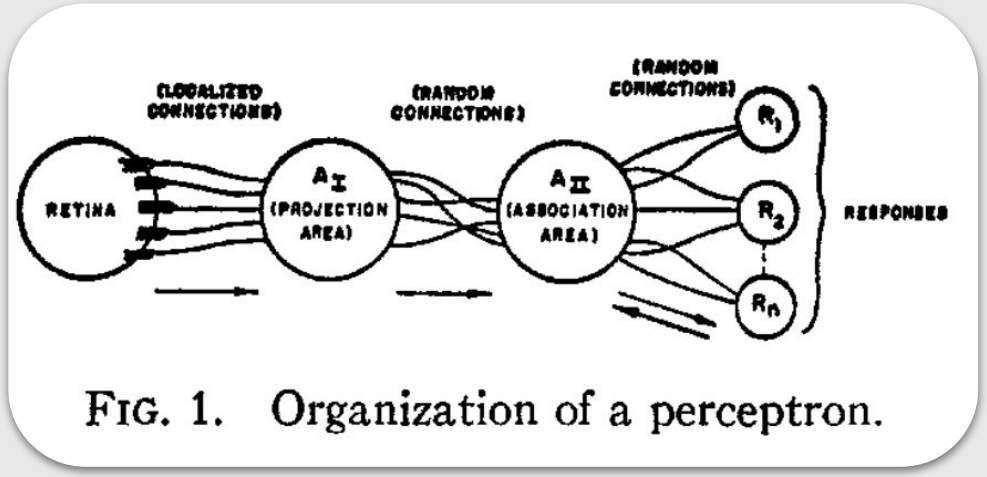
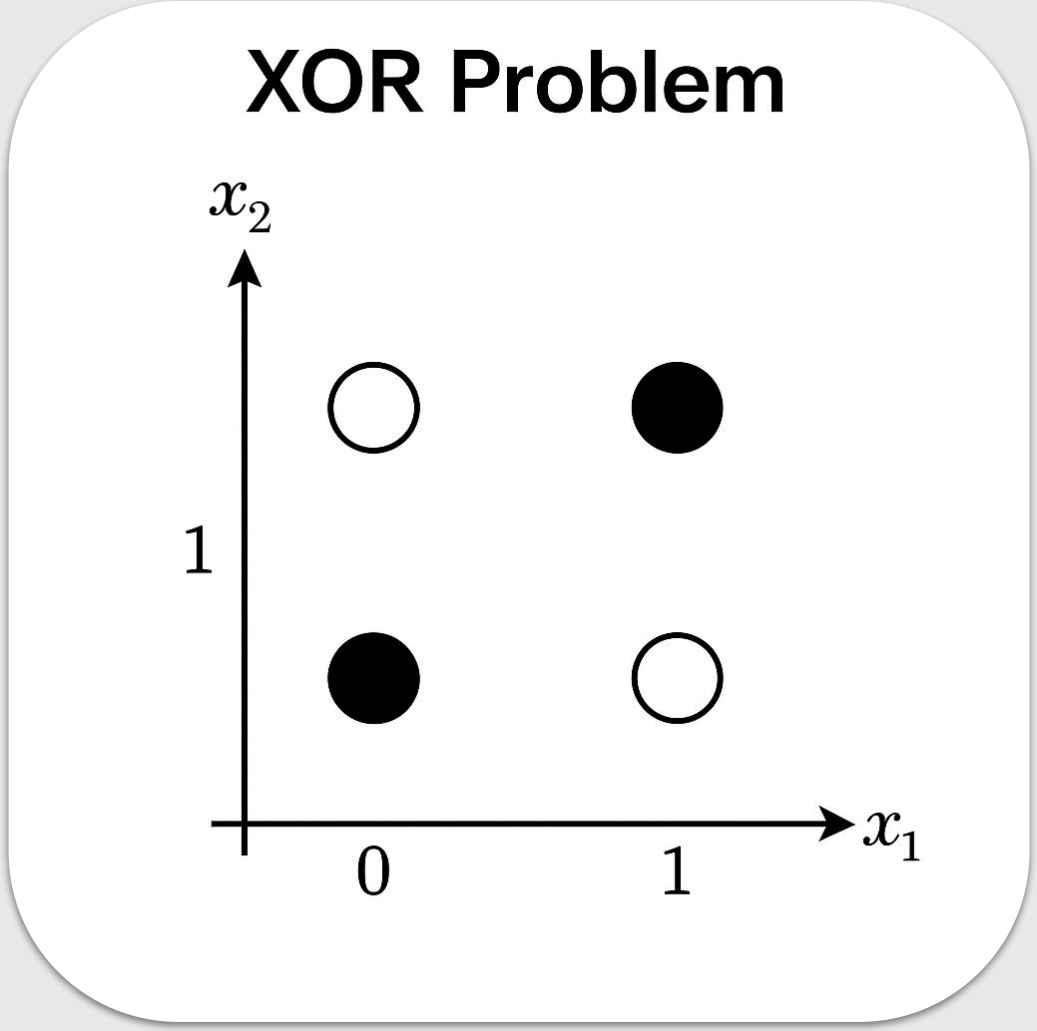



FIG. 1. Organization of a perceptron.


# Minsky vs Rosenblatt and The Perceptron – 1960's

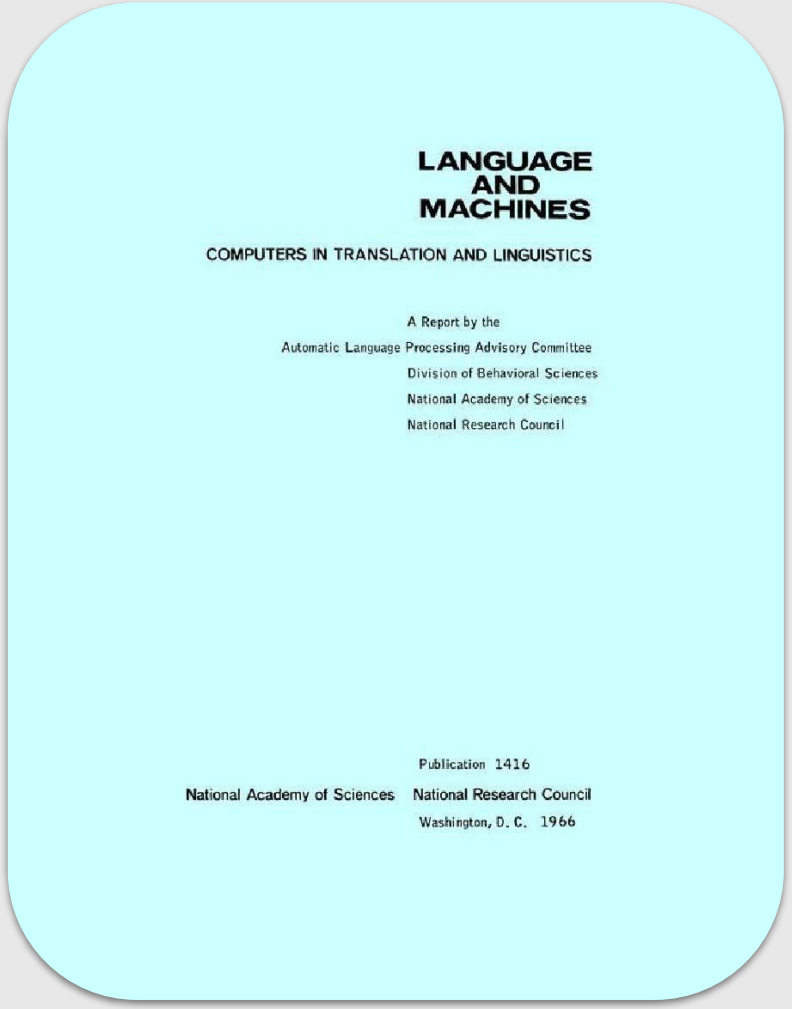
- In 1963 Marvin Minsky and Seymour Papert began working on a counter argument to Rosenblatt's perceptron publishing their book Perceptron in 1969
  - They showed that the Perpetron could not solve the XOR problem

- The XOR Problem
  - Given a set of four points on the x-y plane classified in two classes (A and B). If the points at (0,1) and (1,0) are in class A and points (0,0) and (1,1) are in class B the question is Can you draw a straight line to seperate the points?



# The ALPAC Report - 1960's

- ALPAC (Automatic Language Processing Advisory Committee) Report (1966): U.S. government evaluation of MT progress concluded:
  - Output was expensive, slow, and inaccurate.
  - Recommended cutting funding, halting most MT projects.
- Impact: Research shifted from fully automatic MT to more linguistics-driven, semi-automatic tools (e.g., computer-assisted translation).
- AI language research cooled during the late 1960s due to the report and general disillusionment



LANGUAGE AND MACHINES

COMPUTERS IN TRANSLATION AND LINGUISTICS

A Report by the
Automatic Language Processing Advisory Committee
Division of Behavioral Sciences
National Academy of Sciences
National Research Council

Publication 1416

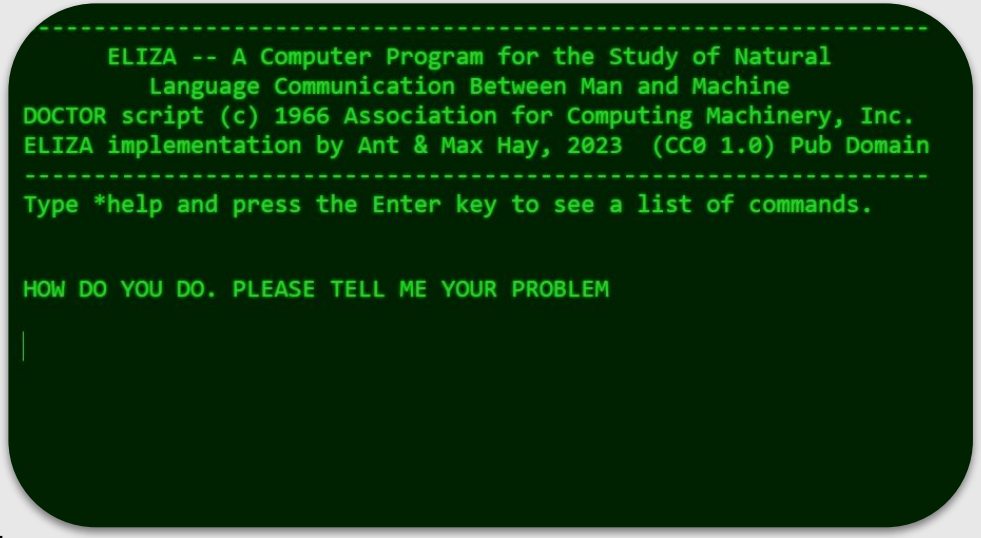
National Academy of Sciences National Research Council
Washington, D. C. 1966

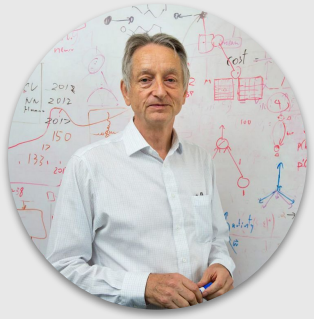
# Early AI Applications Checkers – 1962

- Arthur Lee Samuel (1901–1990) was an American computer scientist who worked at IBM.
- He is often credited with coining the term “machine learning” and was among the first to explore how computers could “learn” from experience rather than being explicitly programmed.
- Why Checkers:
  - The activity must not be deterministic in the practical sense.
  - A definite goal must exist
  - The rules of the activity must be definite and they should be known.
  - There should be a background of knowledge concerning the activity
  - The activity should be one that is familiar to a substantial body of people so that the behavior of the program can be made understandable to them

# Early AI Applications Chatbots– 1967

- “ELIZA is a program which makes certain kinds of natural language conversation between man and computer possible.”
- Input sentences are analyzed on the basis of decomposition rules which are triggered by key words appearing in the input text.
- Responses are generated by reassembly rules associated with selected decomposition rules.
- Why Psychiatry
  - If, for example, one were to tell a psychiatrist, “I went for a long boat ride,” and he responded, “Tell me about boats,” one would not assume that he knew nothing about boats, but that he had some purpose in so directing the subsequent conversation.

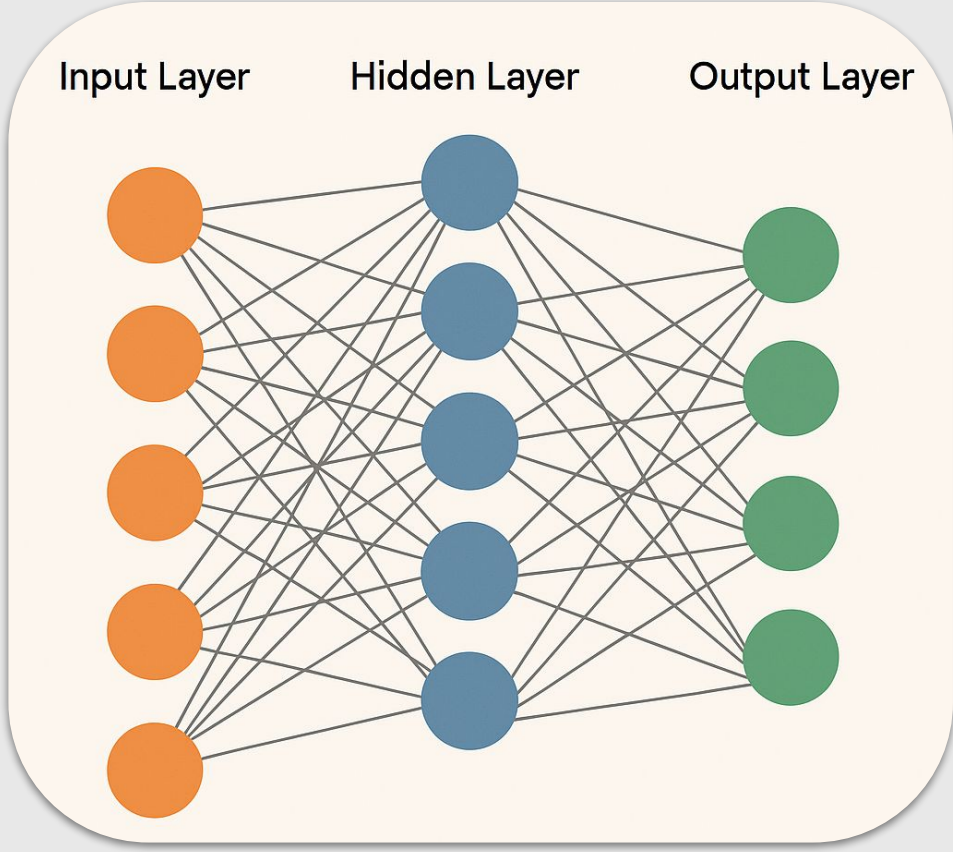




# The Rebirth of the Perceptron and Backpropagation– 1980's

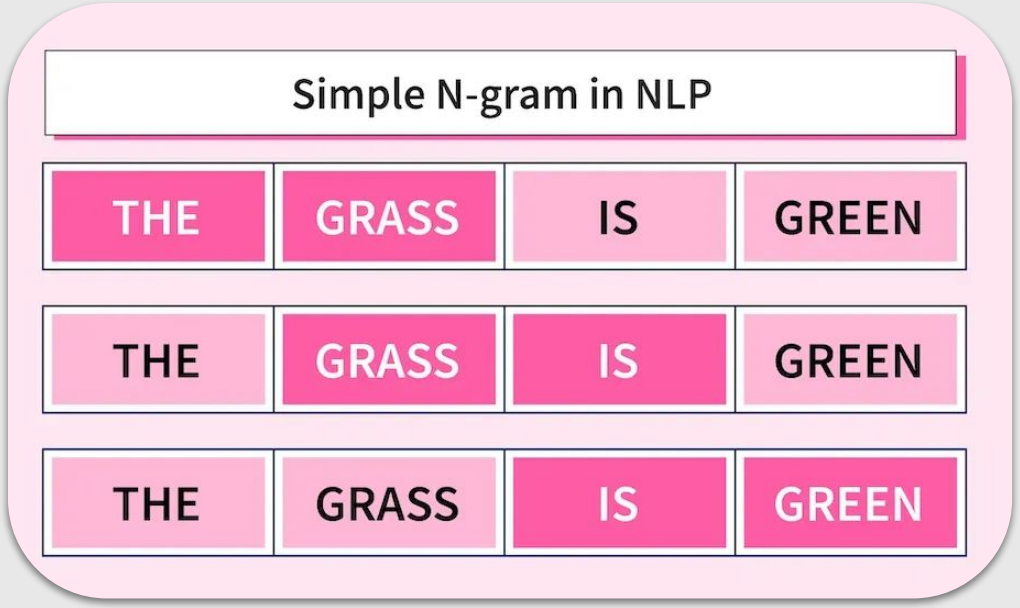
- John Hopfield - "Neural networks and physical systems with emergent collective computational abilities"
- Rumelhart, Hinton, and Williams - "Learning Representations By-Back Propagating Errors"
  - "…the procedure discovers weights that turn units in intermediate layers into an "ecology" of useful feature detectors…"

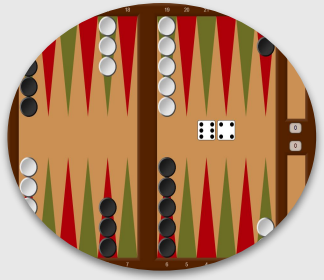
- LeNet 1989 - Digit Recognition
- Limitations:
  - Required large datasets
  - Required large compute power
  - Hard to train more than 3 hidden layers



# The Rise of Statistical Models – 1990's

- Shift from Rules to Data
  - Hand-crafted linguistic rules gave way to probabilistic models.
- Statistical Machine Translation (SMT)
  - IBM alignment models (1990–1993) pioneered word/phrase mapping.
- N-gram Language Models:
  - Looks at the previous n words to determine the next word
  - Computer Science is _____





# Man vs Machine AI in Games– Backgammon 1992

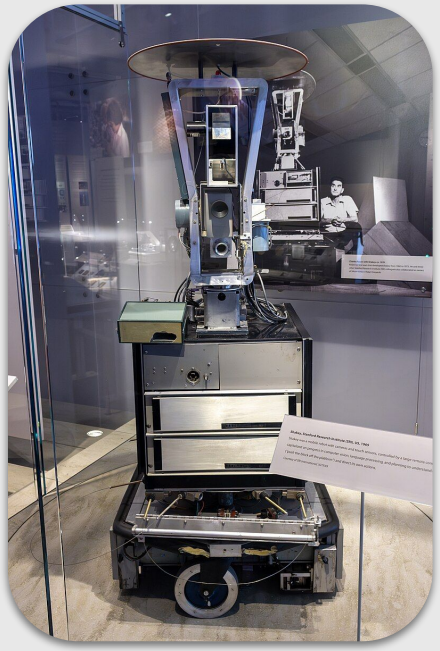
- Created by Gerald Tesauro in 1992
- A neural network–based AI designed to play backgammon, a board game with both strategy and chance (due to dice rolls).
- Did not start with expert knowledge; it learned entirely from scratch
- Used an MLP with one hidden layer
- Played millions of games against itself to refine its strategies
- It discovered positional play and tactics that rival the best human players and were previously thought to require human intuition

# Man vs Machine AI in Games– Chess 1997

- “I could feel—I could smell—a new kind of intelligence across the table.” - Garry Kasparov
- A chess-playing supercomputer built by IBM.
- First computer to defeat a world champion in a full match under tournament conditions
- Evaluated 200 million chess positions per second using custom hardware.
- Combined brute-force search with human-crafted chess knowledge.

# Autonomous Robots and Vehicles

- **Shakey The Robot -** The first general-purpose mobile robot able to reason about its own actions. (1966)



- **Stanley** - Autonomous car which won the 2005 DARPA Grand Challenge (2005)

- “A Miami jury decided that Elon Musk's car company Tesla was partly responsible for a deadly crash in Florida involving its Autopilot driver assist technology and must pay the victims more than $240 million in damages” -NPR (August 2 2025)

# Natural Language Processing in the Age of the Internet - 2000's

- Statistical Machine Translation Goes Global
  - 2006: Google Translate launched using web-scale Statistical MT.

- Data-Driven NLP Expands
  - Internet-scale text fueled probabilistic language models.
  - Enabled better information retrieval, search, and question answering.

- Voice Assistants Enter the Mainstream
  - 2011: Apple Siri combined speech recognition + NLP.
  - Marked the shift from text-based MT to interactive, conversational AI.

# Man vs Machine AI in Games– Jeopardy 2011

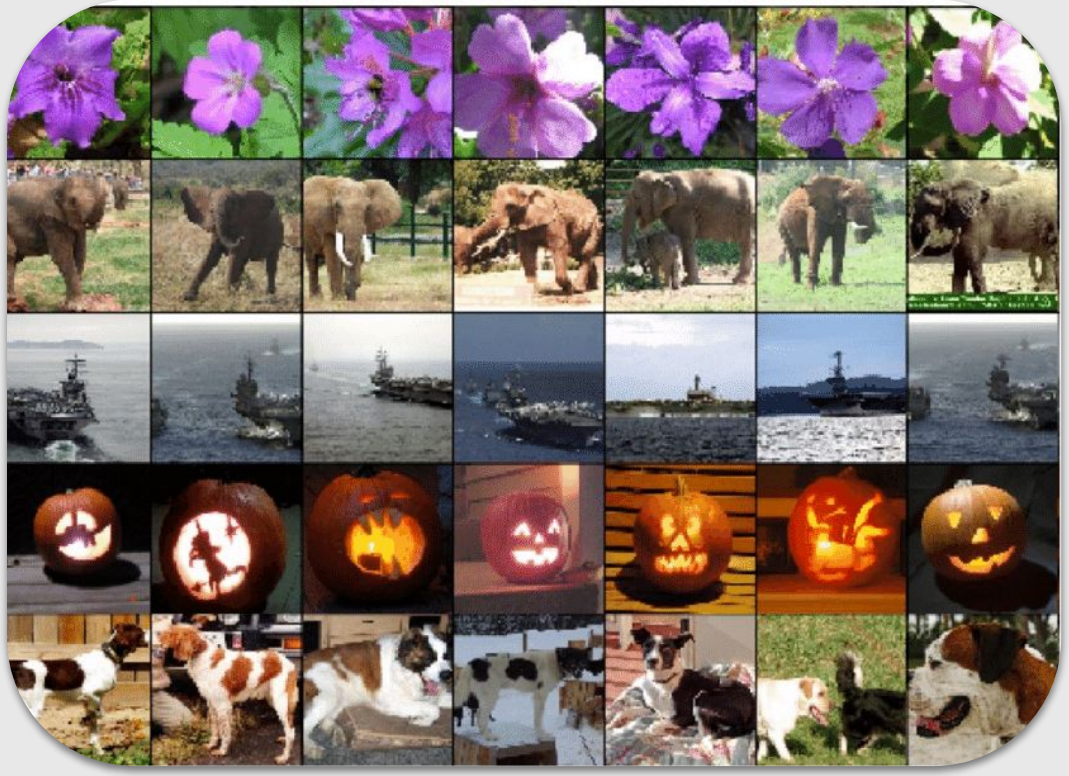
- “Quiz show contestant’ may be the first job made redundant by Watson, but I’m sure it won’t be the last.” - Ken Jennings Jeopardy Contestant
- Named after IBM’s first CEO, Thomas J. Watson Sr., Watson is a question-answering computer system developed by an IBM research team
- Unlike search engines, which can parse basic keywords and return a list of related documents that may or may not be relevant, Watson can understand questions posed in natural language and return answers that directly answer the question.

# Man vs Machine AI in Games– Go 2016

- “I feel like his moves were from an alien intelligence.” - Lee Sedol
- Go is an ancient Chinese board game with simple rules but immense complexity.
- The board is 19x19 (vs. chess’s 8x8), and the number of possible positions is estimated at $10^{170}$, vastly more than chess (~$10^{47}$).
- In 2016, Google DeepMind’s AlphaGo became the first AI to defeat a professional Go player, Lee Sedol, 4-1
- Neural networks trained on millions of human games to predict moves.

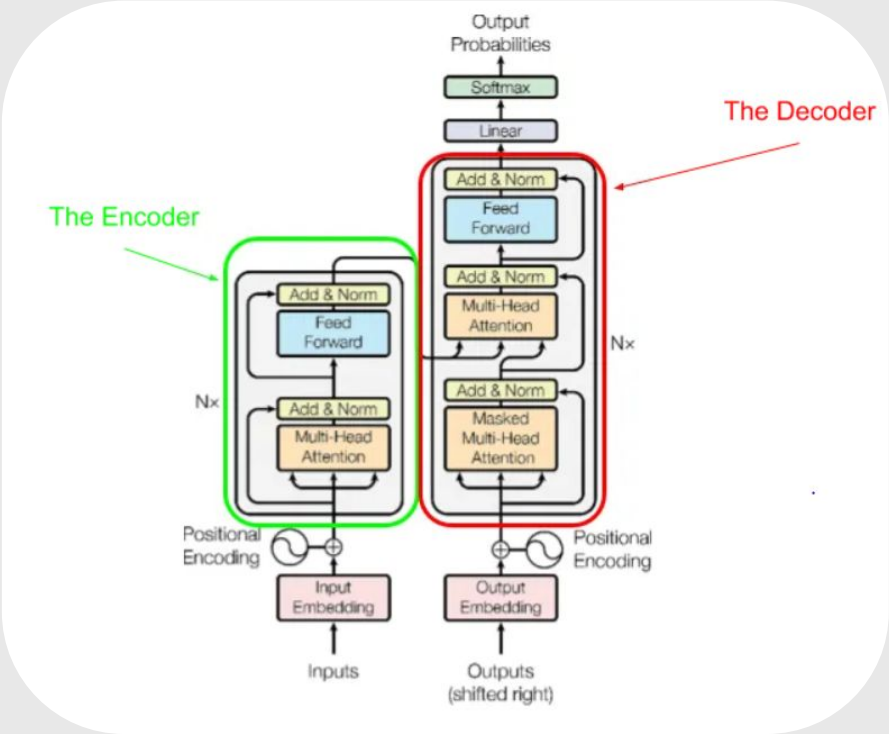
# Deep Learning – 2010's

- In 2012 Alex Krizhevsky, Ilya Sutskever, and Geoffrey E. Hinton release AlexNet which was trained to classify images
- In 2011 the Top-5 Error rate for the dataset was ~26% AlexNet cut the Top-5 Error Rate to ~18%
- Deep, multi-layered CNNs outperformed shallow networks—hierarchical pattern learning at scale
- Utilize several new ideas in AI:
  - GPU Training to speed up training time
  - ReLu Activation function
  - Model Normalization (Dropout Layers and Pooling)



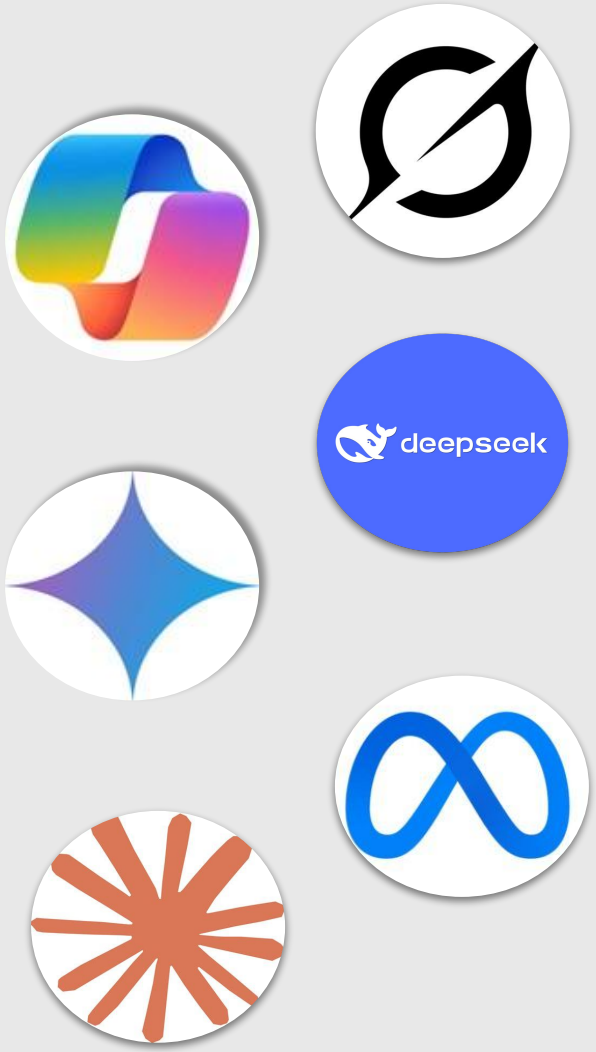
# The Transformer – Late 2010's

- A transformer type of AI model that reads and understands language (or images) by focusing on important parts of the input.
- It uses something called "attention" to decide what to pay attention to—just like how we focus on key words when reading.
- First proposed by a team at Google in a paper called Attention is All You Need
- This team was trying to figure out how to make language translation models faster, more accurate, and better at handling long sentences?



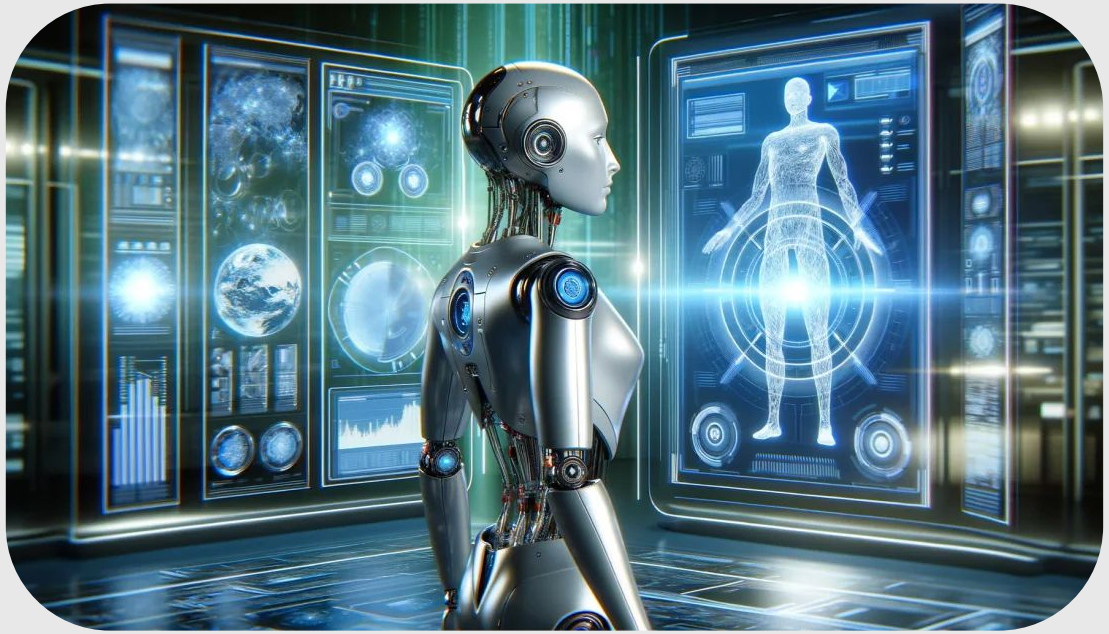
# The Large Language Model – 2020's

- A Large Language Model (LLM) is a type of AI trained on huge amounts of text to generate and understand human-like language.
- It learns to predict the next word in a sentence, enabling it to answer questions, write stories, translate, and more
- GPT-1 (2018)
- GPT-2 (2019)
- GPT-3 (2020)
- GPT-3.5 (2022)
- ChatGPT, Copilot, Gemini, Grok, Claude, Llama, Deepseek



# The Future of AI - Road Map

- Domain Specific AI
- Chain of Thought Reasoning
- AI Agents
- Cyber Physical AI
- Artificial General Intelligence



# The Future of AI - Pros and Cons

## An Optimistic Outlook

- Productivity Gains
- Transforms Science and Medicine
  - Faster Drug Development
  - Cross Field Expertise
  - Better Medical Care

## A Pessimistic Outlook

- P (doom) - AI Take Over
- “Bad Actors Using AI for Bad Things”
  - Cyberattacks
  - Create new weapons
  - Manipulate Elections

# Race for AI Dominance - 2025++

- “The United States must not only lead in developing general-purpose and frontier AI capabilities, but also ensure that American AI technologies, standards, and governance models are adopted worldwide to strengthen relationships with our allies and secure our continued technological dominance.” - PROMOTING THE EXPORT OF THE AMERICAN AI TECHNOLOGY STACK (2025)

- “By 2030, China’s AI theories, technologies, and applications should achieve world-leading levels, making China the world’s primary AI innovation center, achieving visible results in intelligent economy and intelligent society applications, and laying an important foundation for becoming a leading innovation-style nation and an economic power.” - New Generation Artificial Intelligence Development Plan’ (2017)

# References (in notes)

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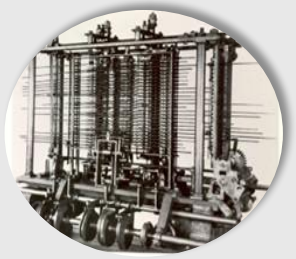
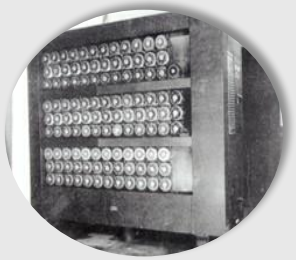
"Genetics researchers have fruit flies. Oncologists have white mice. For pioneering computer scientists studying artificial intelligence, it was games" – IBM The Games that Helped AI Evolve

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This lecture traces the remarkable journey of Artificial Intelligence, from its conceptual roots in the 19th century to its transformative impact and future potential in the 21st century.

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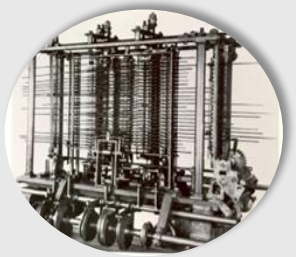


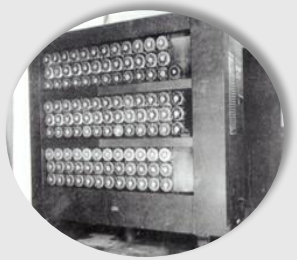


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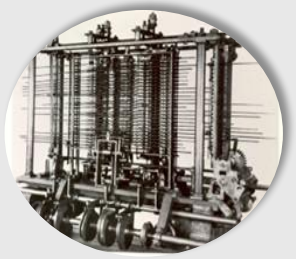


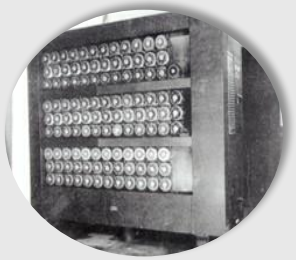

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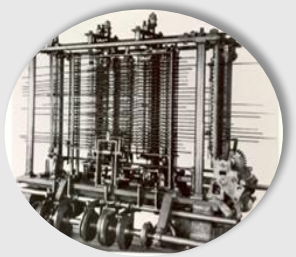


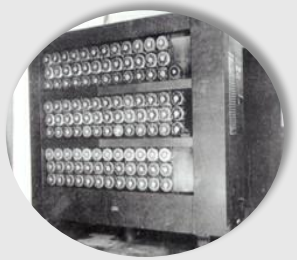


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