# AI in Culture and Arts – Tech Crash Course

## A Brief History of Artificial Intelligence

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9th of April 2025

MUC.DAI
Munich Center for
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Hochschule
für Musik und Theater
München

*"The question of whether a computer can think is no more interesting than the question of whether a submarine can swim." – Edsger Dijkstra (1930 – 2002)*

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1. Introduction
2. Symbolism I
3. Connectionism I
4. Symbolism II
5. Connectionism II

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# Key Terms

### Symbolism

Exploits explicit, rule-based symbolic manipulation, logic, and structured reasoning to represent knowledge and solve problems.

- **Assumption:** Intelligence uses high-level, human-readable symbols to represent problems and logic to solve them.
- **Motivation:** Model the **mind**!

### Connectionism

Exploits artificial neural networks & statistics, emphasizing learning from patterns, distributed representations, and emergent behaviors.

- **Assumption:** Intelligence emerges from the interaction of simple and low-level units, i. e. biological neurons.
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## Symbolism I: Logos Shall Rule!

- **Aristotle's Logic (circa 4th century BCE)**
  - Origin of formal logic and structured reasoning.
  - Introduction of syllogisms as symbolic structures for inference.

Euclid, Eratosthenes, Hypatia

- **Symbolic Logic and Mathematics (19th–20th century)**
  - Formalization of logic (George Boole, Gottlob Frege, Bertrand Russell, David Hilbert).
  - Provided a mathematical basis for symbolic reasoning.

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## Symbolism I: Proofs as Symbolic Manipulations

**Idea:** Logical inference is mechanical and rule-based. Thus, a computer can do it.

### Example: Symbolic Proof (Modus Ponens)

Given the rules:

1. If it rains, the grass is wet. $(Rain \rightarrow Wet)$
2. It rains. $(Rain)$

**Conclusion (by applying rules):** The grass is wet. $(Wet)$

**Machine "Reasoning" Steps:**

1. Represent statements symbolically.
2. Apply inference rules systematically.
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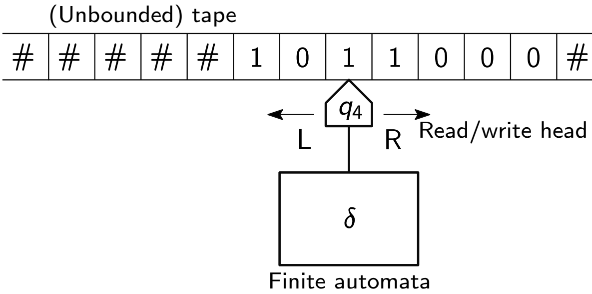
Gödel, Church, Turing

In 1937 Alan Turing presents a general model of computation called the *Turing machine* as a byproduct (?, ?).

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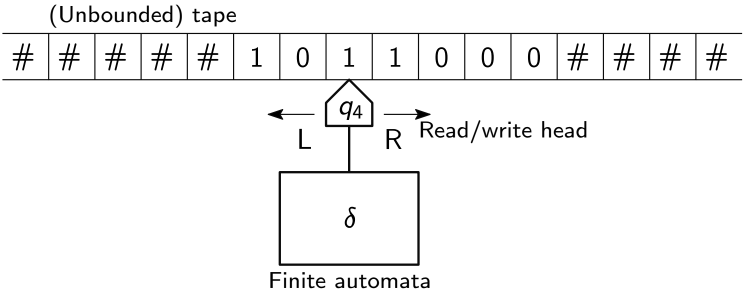


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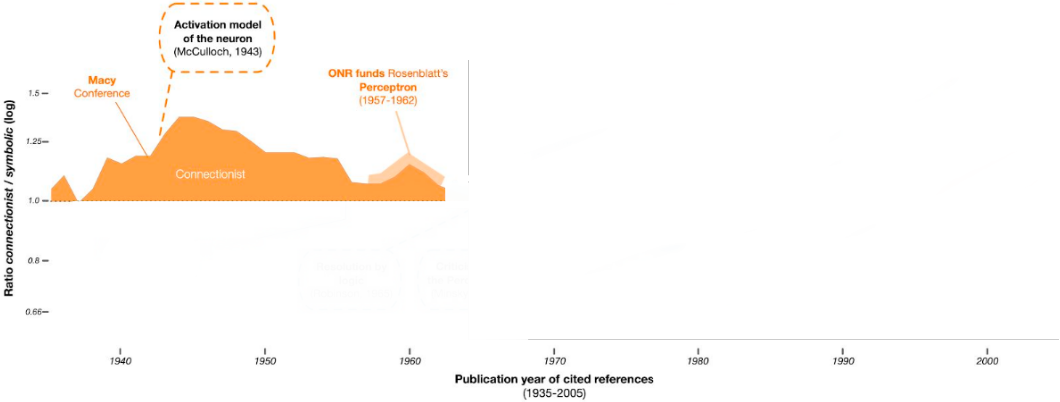
Activation model
of the neuron
(McCulloch, 1943)
Macy
Conference
ONR funds Rosenblatt's
Perceptron
(1957-1962)
Connectionist
Ratio connectionist / symbolic (log)
1.5
1.25
1.0
0.8
0.66
1940
1950
1960
1970
1980
1990
2000
Publication year of cited references
(1935-2005)

Source: (?, ?)

# Connectionism I: Historical Foundations

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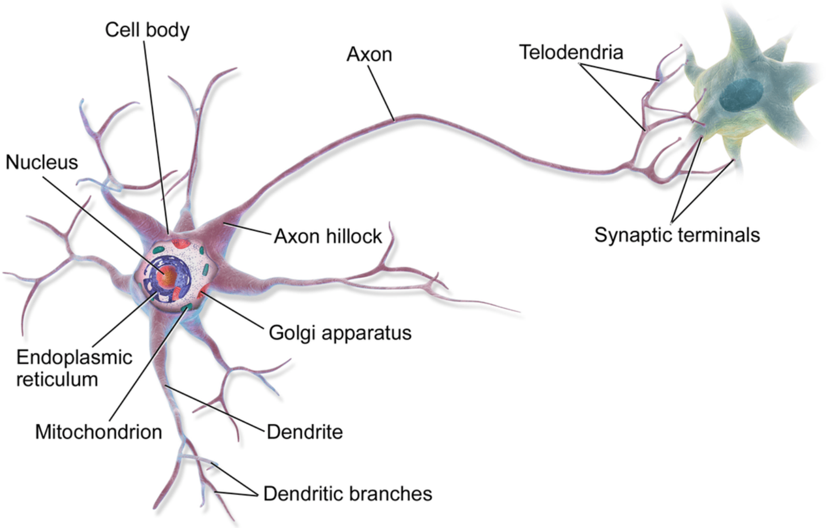
# Connectionism I: The Neuron



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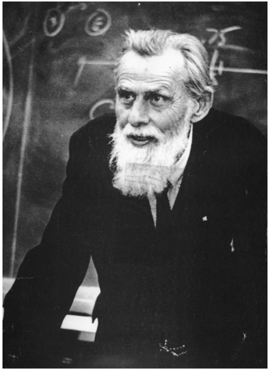
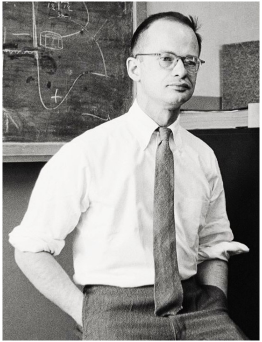


Warren S. McCulloch

- Communication takes place when an electro-chemical signal gets transferred from one neuron to another.
- All the processing then happens in the cell body.
- The processed information then travels to the synaptic terminal which "decides" whether the information should be passed to the next neuron or not.
- The same information passes to millions of neurons.



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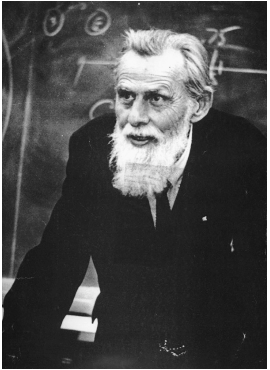

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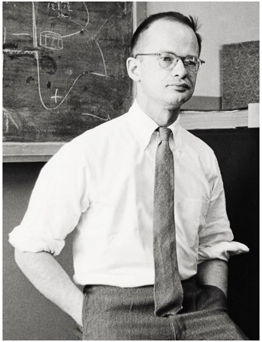

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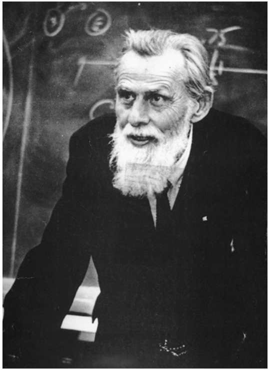

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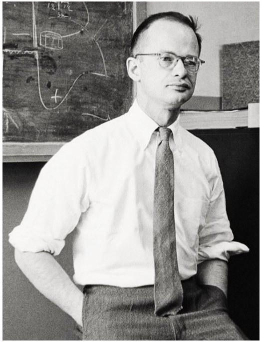

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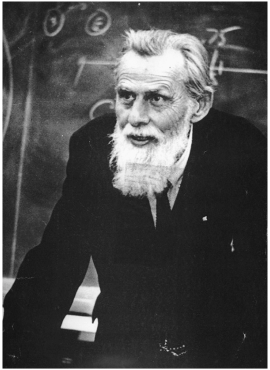

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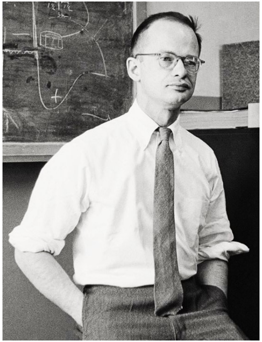

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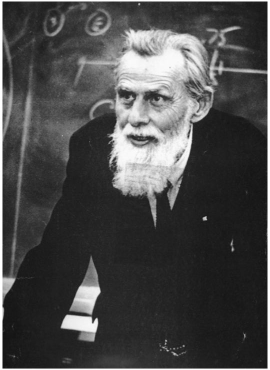
# Connectionism I: The Mathematical Neuron



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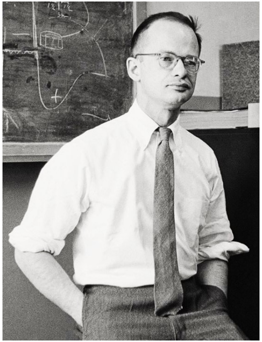

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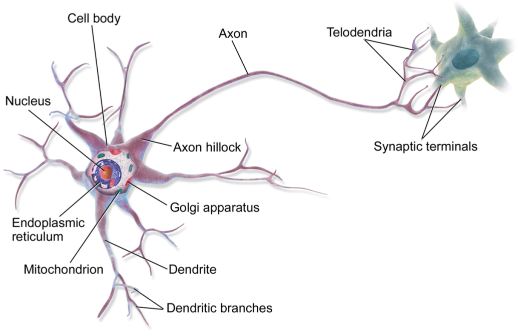


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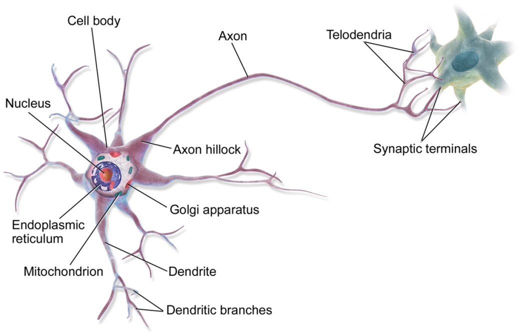


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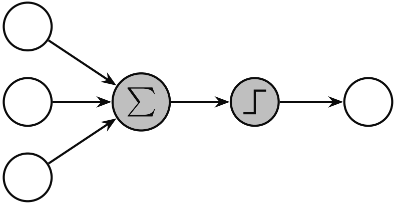

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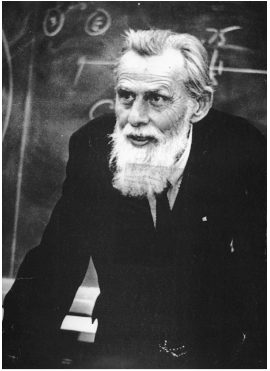

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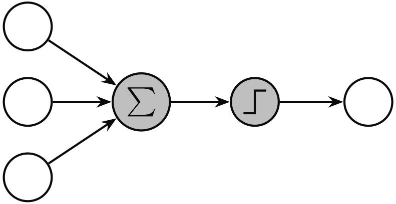


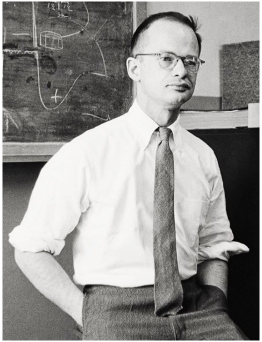

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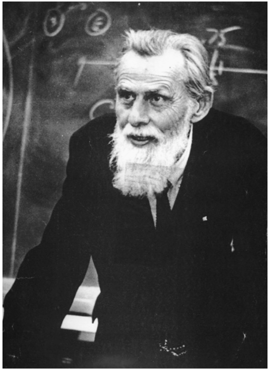

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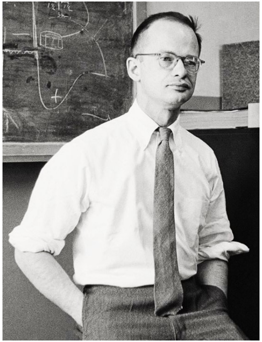
$$f(x_1, \ldots, x_n) = \begin{cases} 1 & \text{if } \sum_{k=1}^{n} x_k > 1 \\ 0 & \text{otherwise.} \end{cases}$$



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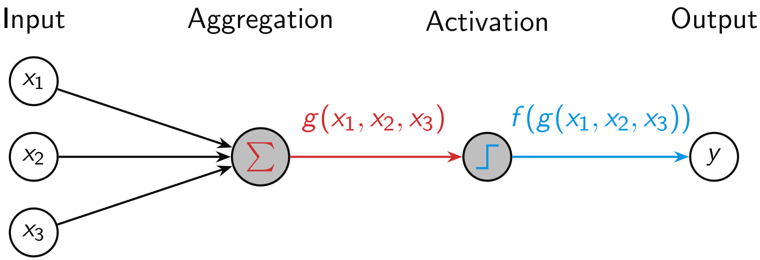


$$g(x_1, x_2, x_3) = x_1 + x_2 + x_3 \qquad f(z) = \begin{cases} 1 & \text{if } z \geq 1 \\ 0 & \text{otherwise.} \end{cases} \qquad y = \begin{cases} 1 & \text{if } x_1 + x_2 + x_3 \geq 1 \\ 0 & \text{otherwise.} \end{cases}$$

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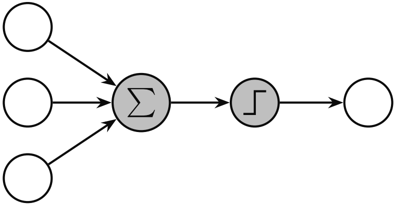

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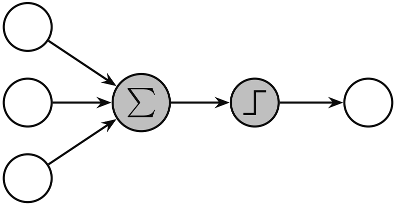
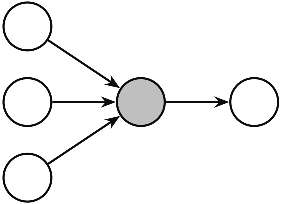
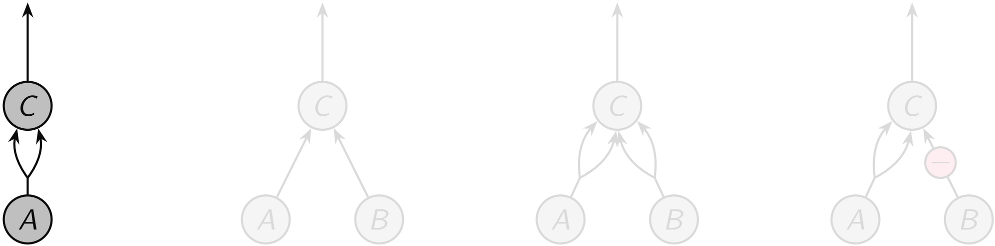




Complex logical operations can be performed using networks of binary neurons.




Identity: $C = A$

And: $C = A \wedge B$

Or: $C = A \vee B$

Negation: $C = A \vee \neg B$

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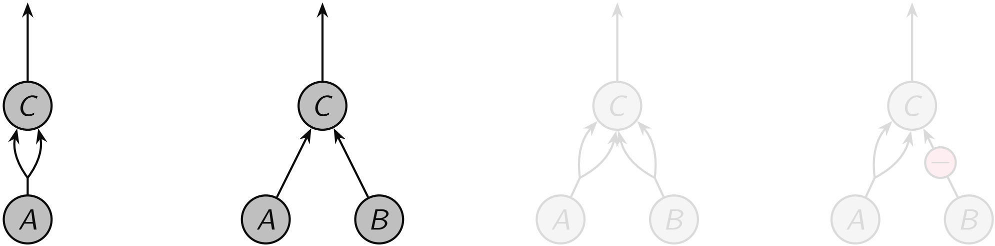


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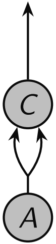


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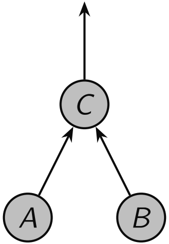


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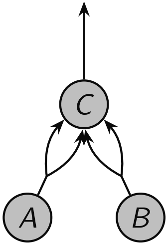


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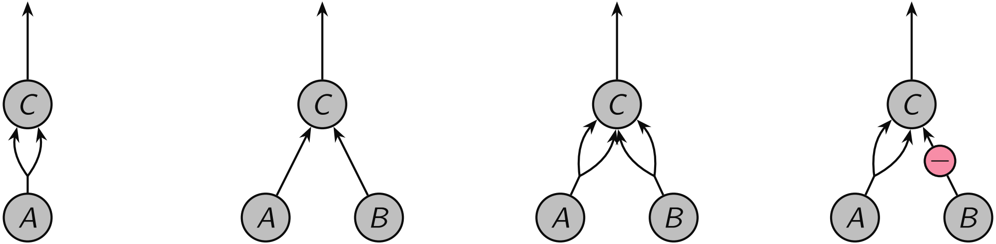


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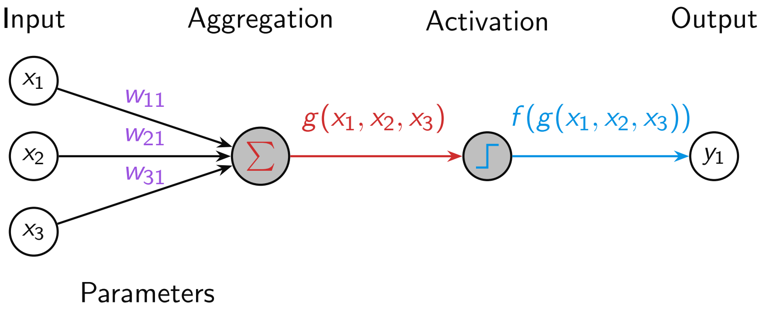
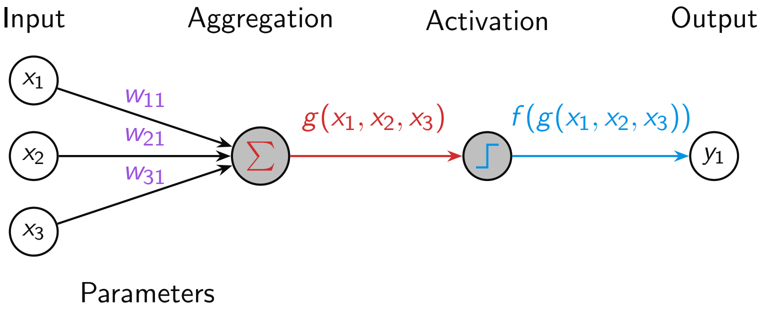



Parameters determine how strong neurons are wired together:

$$g(x_1, x_2, x_3) = x_1 \cdot w_{11} + x_2 \cdot w_{21} + x_3 \cdot w_{31}$$




*"Neurons that fire together, wire together."*

$$w_{ij} = w_{ij} - \eta \cdot x_i \cdot y_j$$

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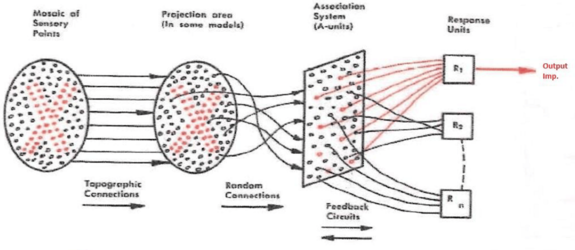
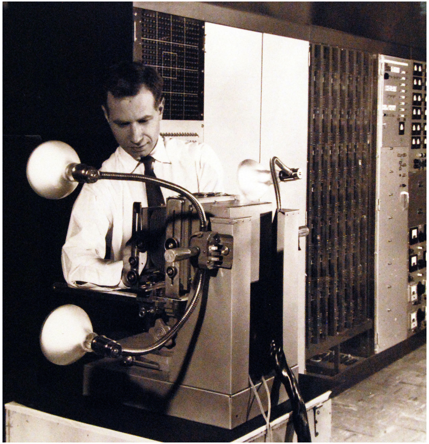



FIG. 2 — Organization of a perceptron.



Charles Wightman

# Connectionism I: Mark I Perceptron

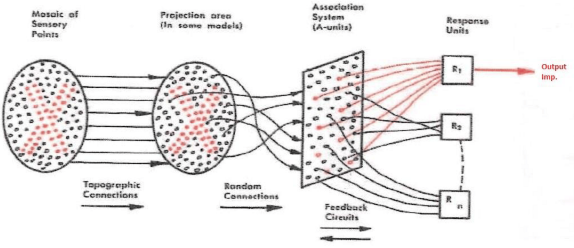
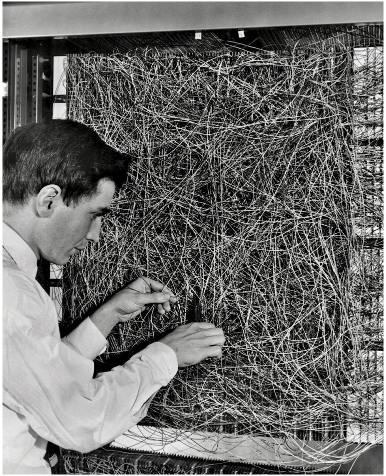



FIG. 2 — Organization of a perceptron.



Frank Rosenblatt

**Video**

1. Introduction
2. Symbolism I
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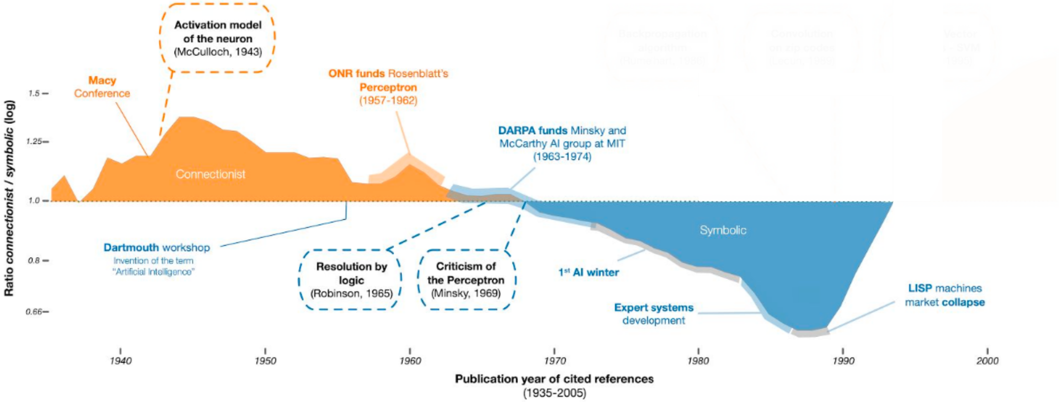
5. Connectionism II


Activation model of the neuron (McCulloch, 1943)
Macy Conference
ONR funds Rosenblatt's Perceptron (1957-1962)
DARPA funds Minsky and McCarthy AI group at MIT (1963-1974)
1.5
1.25
1.0
0.8
0.66
Ratio connectionist / symbolic (log)
Connectionist
Symbolic
Dartmouth workshop
Invention of the term "Artificial Intelligence"
Resolution by logic (Robinson, 1965)
Criticism of the Perceptron (Minsky, 1969)
1st AI winter
Expert systems development
LISP machines market collapse
1940
1950
1960
1970
1980
1990
2000
Publication year of cited references (1935-2005)

Source: (?, ?)

# Symbolism II: The Dartmouth Workshop

John McCarthy, Marvin Minsky, Claude Shannon, Tranchard More, Ray Solomonoff, Olivier Selfridge, Nathaniel Rchester

# Symbolism II: Logos Meets Computation

- **Origins of Symbolic AI (1950-1960s)**
  - Logic Theorist (1956, Newell & Simon)
  - LISP, logic-based reasoning (McCarthy, 1958)
  - General Problem Solver (1959)
  - Early focus on explicit rule-based reasoning
- **Expert systems (1970s–1980s)**
  - DENDRAL (chemistry)
  - MYCIN (medical diagnosis)
  - Creation of the Prolog programming language (France, 1972)
- **AI Winter (Late 1970s–1980s)**
  - Unrealistic expectations unmet by symbolic methods
  - Funding cuts, skepticism
  - Critiques, e. g., Hubert Dreyfus *What Computers Can't Do*

# Symbolism II: Toy Problems

Christopher Strachey developed AI program in 1951.

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## What are Expert Systems?

Expert systems are rule-based programs designed to emulate the decision-making abilities of human experts in specialized fields.

**Key Examples:**

- **DENDRAL** (1965–1983)
  - Identified molecular structures from mass spectra data.
  - First practical expert system in chemistry.
- **MYCIN** (1972–1980)
  - Diagnosed infectious blood diseases.
  - Provided explanations for its reasoning.

A Symbolics 3640 Lisp machine: an early (1984) platform for expert systems

### What are Expert Systems?

Expert systems are rule-based programs designed to emulate the decision-making abilities of human experts in specialized fields.

**Strengths:**

- Explicit representation of knowledge.
- Transparent reasoning (explainability).

**Limitations:**

- Lack of flexibility (brittle under unexpected scenarios).
- Difficulty handling uncertain or ambiguous situations.

A Symbolics 3640 Lisp machine: an early (1984) platform for expert systems

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## Assumptions of AI Research of the Time

- **The biological assumption:** The brain processes information in discrete operations by way of some biological equivalent of on/off switches.
- **The psychological assumption:** The mind can be viewed as a device operating on bits of information according to formal rules.
- **The epistemological assumption:** All knowledge can be formalized.
- **The ontological assumption:** The world consists of independent facts that can be represented by independent symbols.

Dreyfus attacks all of these assumptions in (?, ?, ?) using the (European) tradition of phenomenology (Husserl, Heidegger, Merleau-Ponty).

*"What does [Dreyfus] offer us? Phenomenology! That ball of fluff. That cotton candy!" – Edward Feigenbaum*

**Dreyfus was right (and sucessfully ignored):**

- Neurons are not essentially digital, rather the action of analog neurons can be simulated by digital machines to a reasonable level of accuracy.
- Human reasoning does not consist primarily of high-level symbol manipulation.
- Humans also solve problems by a fast, intuitive and unconscious System (?, ?).
- Common knowledge is difficult to model logically
- Economic collapse of LISP machines.

## Symbolism II: Dreyfus Critique

*"[Dreyfus'] derisiveness has been so provoking that he has estranged anyone he might have enlightened. And that's a pity." – Pamela McCorduck*

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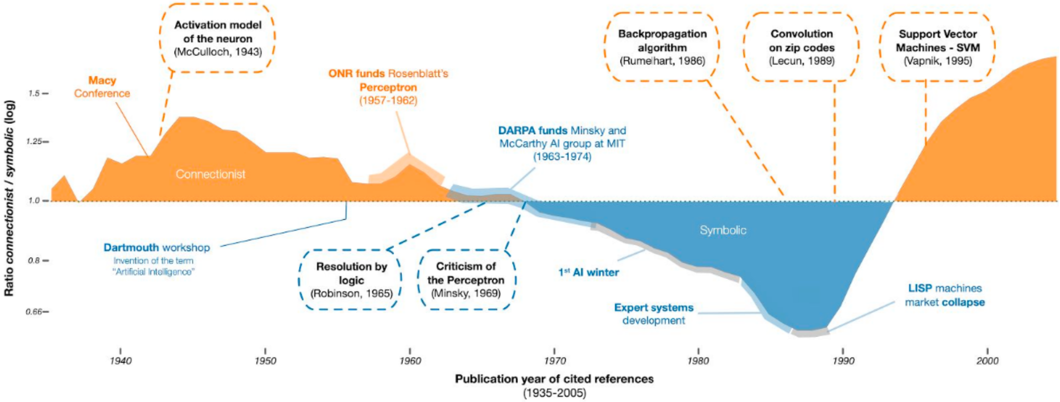
# Connectionism II: Revenge of the Neuron

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**Video**

## Connectionism II: AI Renaissance (2000–Present)

- **2006–2012: Early Breakthroughs**
  - Revival of deep neural networks
  - Major success: ImageNet competition (AlexNet, 2012)
- **2013–2017: Rapid Expansion of Deep Learning**
  - CNN dominance in image recognition
  - Reinforcement Learning breakthroughs (AlphaGo, 2016)
- **2018–Present: Transformers and Large Language Models**
  - Natural Language Processing revolution (BERT, GPT)
  - Generative AI models (GPT-3, ChatGPT, Stable Diffusion)
- **Modern Symbolic Revival and Hybrid AI (Ongoing)**
  - Neurosymbolic AI: Combining deep learning and symbolic reasoning
  - Explainable AI (XAI): Interpretable, trustworthy systems
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# Connectionism II: Causes

1. **Computational Power**
   - Massive increase in GPU computing capacity.
   - Parallelization of neural network training.
2. **Big Data**
   - Availability of huge, labeled datasets.
   - Online data collection (ImageNet, web scraping).
3. **Algorithmic Advances**
   - Improved training algorithms (e. g., backpropagation, Adam optimizer).
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**Any questions?**

# References I


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