

Intelligenza Artificiale

Introduzione

O. Incani, 2 novembre 2023

Cogliere l'ironia

Singolarità tecnologica (Ray Kurzweil)

Intelligenza, coscienza, autoconsapevolezza

Scaturite da un substrato non intelligente (cellule biologiche)

Come realizzarle in un computer

Anni '70: prospettiva entusiasmante, così lontana, senza pericoli all'orizzonte, a cento premi Nobel di distanza

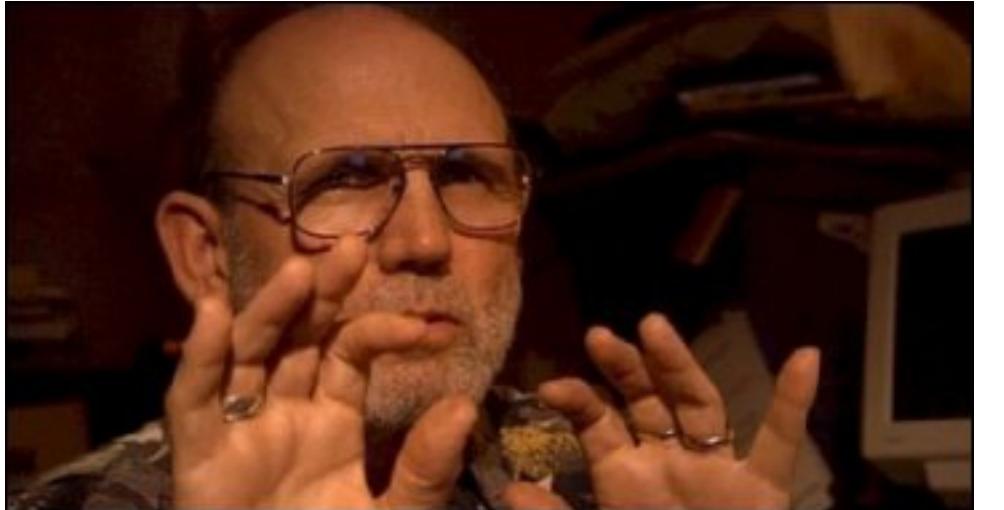
1957: Herbert Simon (pioniere dell'AI): entro dieci anni un programma di scacchi sarebbe stato campione del mondo

1997: Deep Blue di IBM batte Garry Kasparov

1979 Douglas Hofstadter: Gödel, Escher, Bach: An Eternal Golden Braid

Musica

David Cope —



David Cope

Professor Emeritus of Music

Algorithmic Composition, Musical Intelligence

music.ucsc.edu/people/david-cope

Experiments in Musical Intelligence (Emi, 1981)

Inizialmente sviluppato come supporto nella fase di composizione

Creazione di brani nello stile dell'autore

EMI divenne famosa per aver creato brani nello stile di Bach o Chopin

Genera turbamento

L'idea che la manipolazione di schemi algoritmici possa generare qualcosa come se provenisse dal cuore di un essere umano è molto inquietante

Esperimento alla Eastman School of Music: mazurka poco nota di Chopin vs musica composta da Emi



verso la singolarità

- Automobili a guida autonoma
- Riconoscimento vocale
- Comprensione del linguaggio naturale
- Traduzione simultanea da una lingua all'altra
- Arte generata al computer
- Composizione musicale

La paura dei profani

Per gli addetti ai lavori: nulla di tutto questo è minimamente preoccupante

Per alcuni pensatori: sembra che l'intelligenza e la creatività (ma forse anche le emozioni o addirittura la coscienza) possano essere troppo facili da creare; scuote l'idea che la cosa più preziosa per il genere umano possa originarsi da un insieme di stupidi algoritmi (forza bruta).

Minaccia?

Stephen Hawking warns artificial intelligence could end mankind

Humans, who are limited by slow biological evolution, couldn't compete and would be superseded

Elon Musk:

With artificial intelligence we are summoning the demon

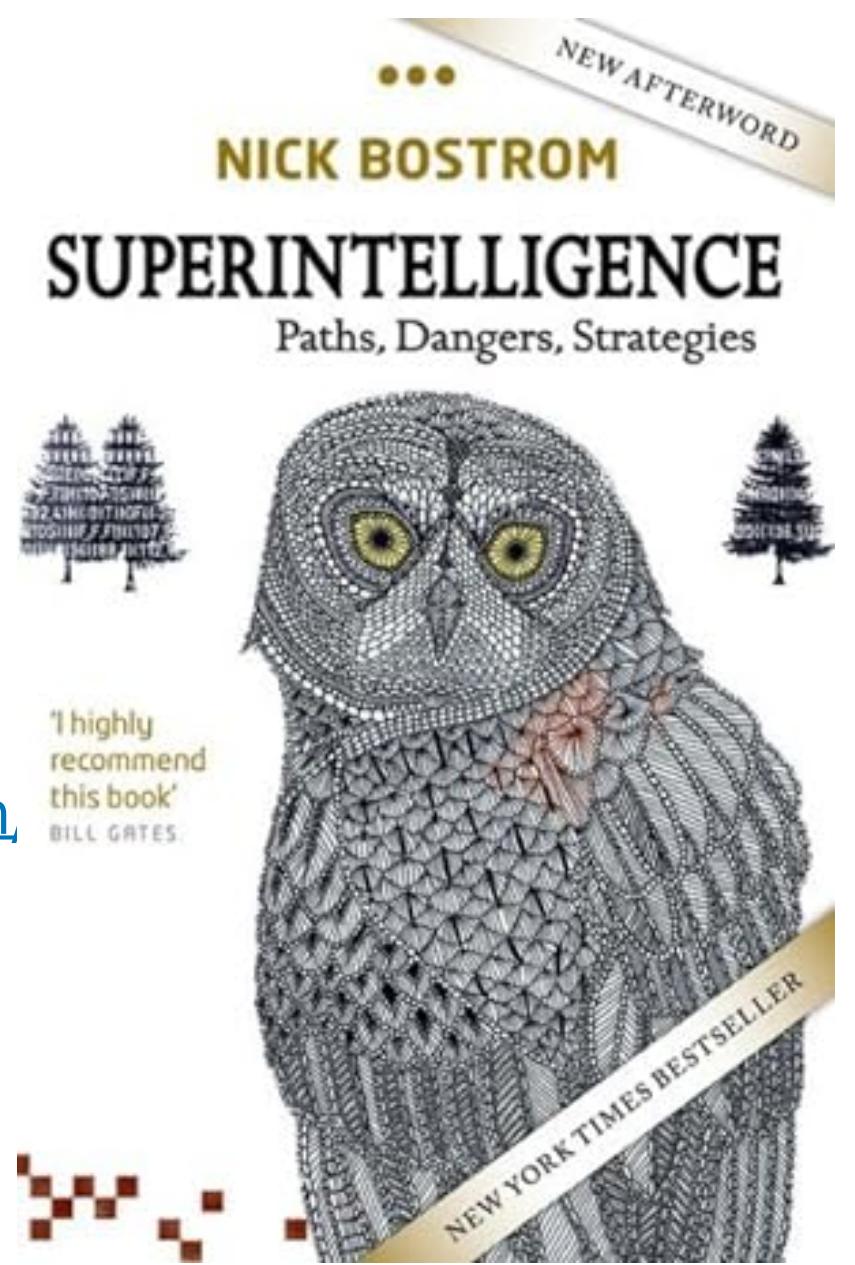
www.washingtonpost.com/news/innovations/wp/2014/10/24/elon-musk-with-artificial-intelligence-we-are-summoning-the-demon/

Nick Bostrom:

Superintelligence: Paths, Dangers, Strategies, 2016



www.bbc.com/news/technology-30290540



Minaccia o opportunità



Enthusiasts and Skeptics Debate Artificial Intelligence

www.vanityfair.com/news/tech/2014/11/artificial-intelligence-singularity-theory

12 Observations About Artificial Intelligence From The O'Reilly AI Conference

www.forbes.com/sites/gilpress/2016/10/31/12-observations-about-artificial-intelligence-from-the-oreilly-ai-conference/

- AI is a black box—just like humans
 - AI is difficult—“we wanted Rosie the robot, instead we got the Roomba”
 - The AI driving driverless cars is going to make driving a hobby. Or maybe not.
 - AI must consider culture and context—“training shapes learning”
 - AI is not going to take all our jobs—“we are not going to run out of problems”
 - AI is not going to kill us—“AI is going to empower us”
 - AI isn’t magic and deep learning is a useful but limited tool—“a better ladder does not necessarily get you to the moon”
 - AI is Augmented Intelligence—“using the strengths of both humans and machines”
 - AI changes how we interact with computers—and it needs a dose of empathy
 - AI should graduate from the Turing Test to smarter tests
 - AI According to Winston Churchill
 - AI continues to be possibly hampered by a futile search for human-level intelligence while locked into a materialist paradigm

Peter Norvig: “You can say about machine learning what Winston Churchill said about democracy—it is the worst possible system except all the others that have been tried.”

Oren Etzioni: “To paraphrase Winston Churchill —deep learning is not the end, it’s not the beginning of the end, it’s not even the end of the beginning.”

Intelligenza Artificiale

John McCarthy: 1956

«L'obiettivo era l'*intelligenza autentica*, ma un nome dovevo pur darglierlo»

Entusiastico ottimismo:

- Stanford Artificial Intelligence Project:
«*entro dieci anni una macchina pienamente intelligente*»
- Herbert Simon (futuro premio Nobel):
«*le macchine saranno capaci entro vent'anni di fare qualsiasi lavoro che l'uomo sa fare*»
- Marvin Minsky (MIT AI Lab):
«*entro una generazione...*»

Definizione del campo di studio

Reverse engineering del cervello umano?

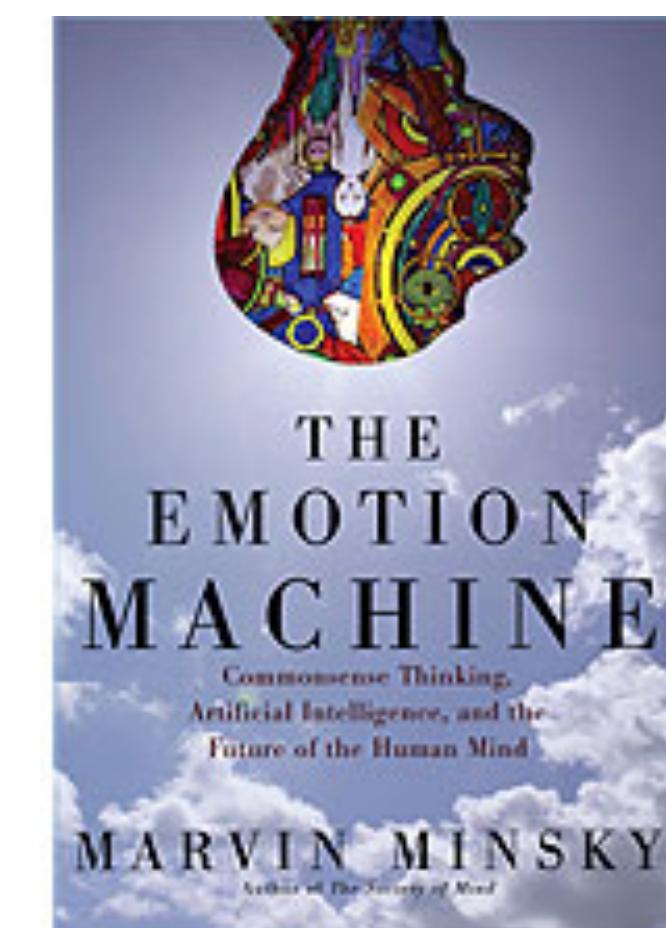
— oppure —

Esistono algoritmi che non ancora conosciamo capaci
di produrre quella che noi riconosciamo essere la piena intelligenza?

Marvin Minsky

*The Emotion Machine:
Commonsense Thinking, Artificial Intelligence,
and the Future of the Human Mind*, 2006

Parola valigia: intelligenza, pensiero,
processo cognitivo, coscienza, emozione...



*Definite i vostri termini o non
riusciremo mai a capirci l'un l'altro*
— Voltaire

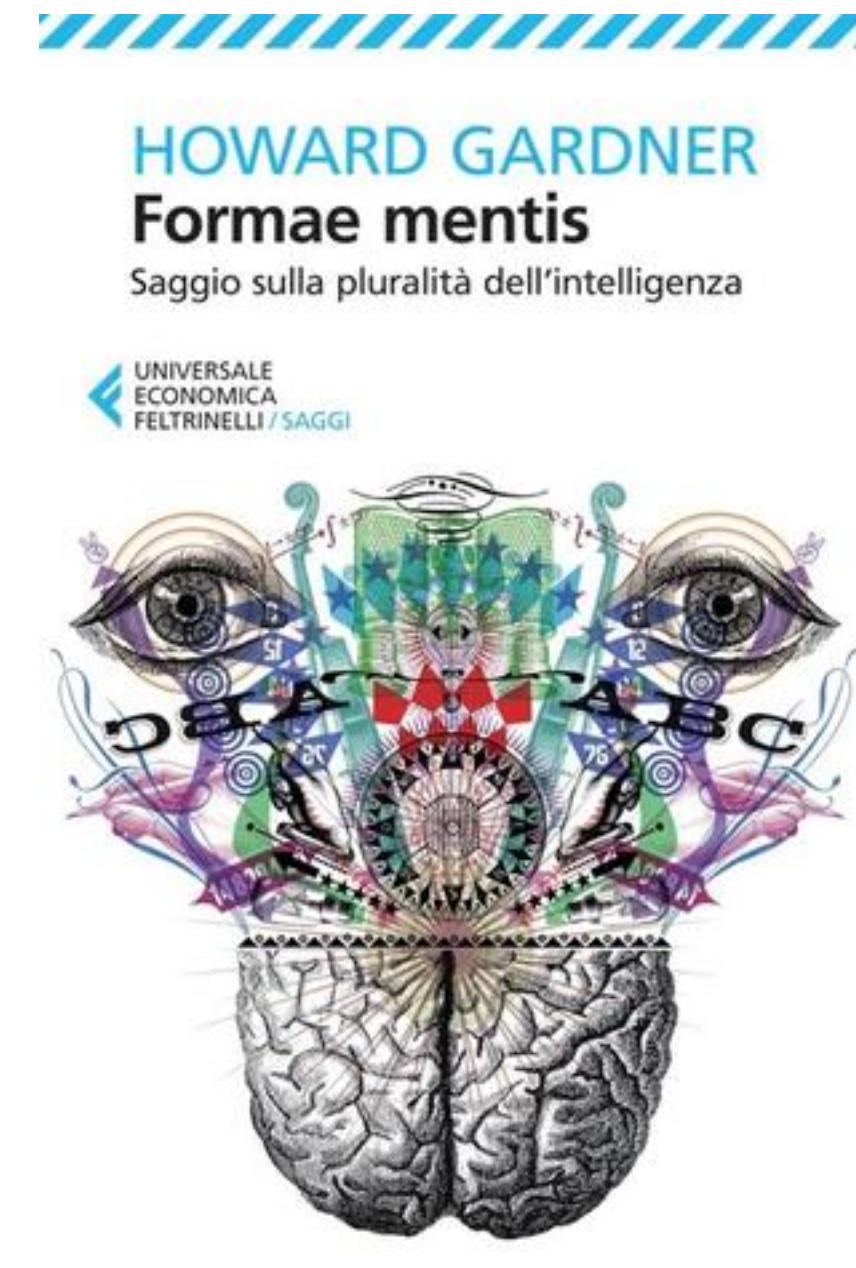
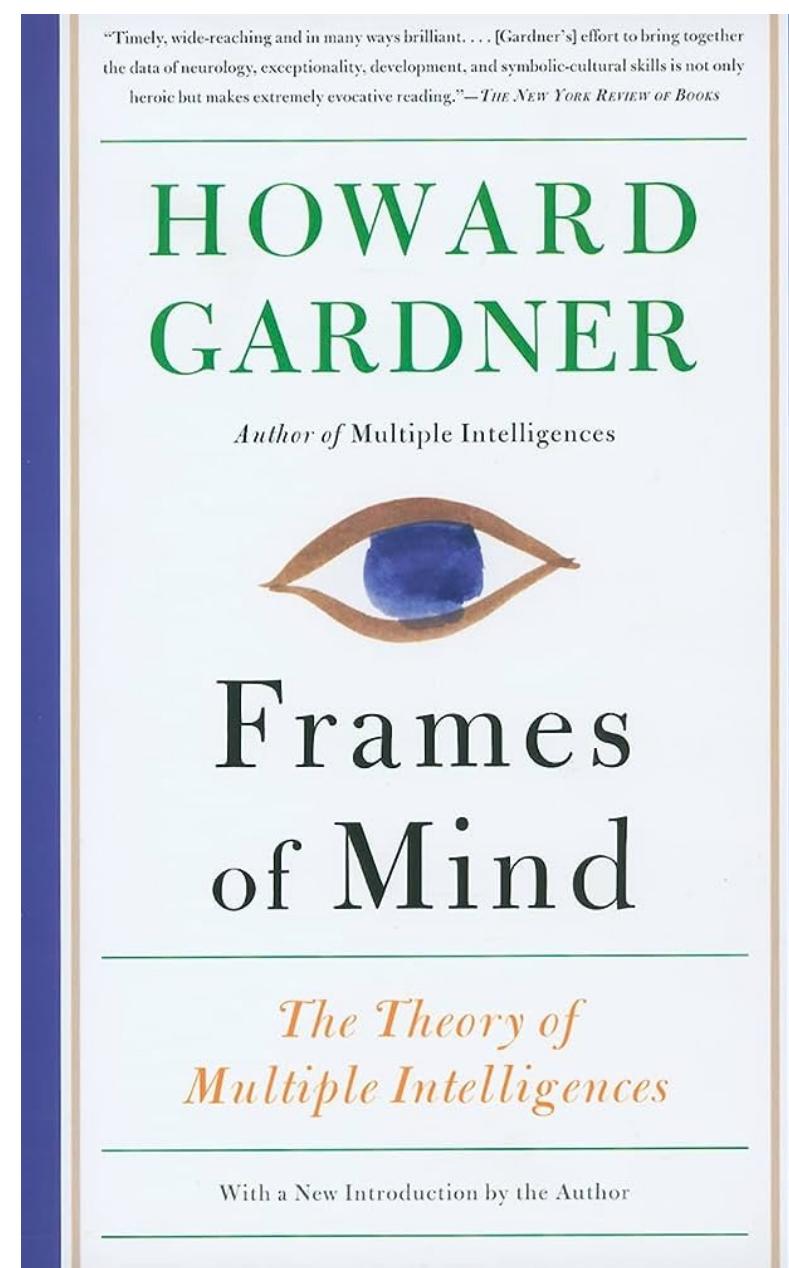
- We are born with many mental resources
- We learn from interacting with others
- Emotions are different Ways to Think
- We learn to think about our recent thoughts
- We learn to think on multiple levels
- We accumulate huge stores of commonsense knowledge
- We switch among different Ways to Think
- We find multiple ways to represent things
- We build multiple models of ourselves

www.technologyreview.com/2007/03/12/226270/minsky-on-ais-future/

Intelligenze multiple

Howard Gardner, 2011

Frames of Mind: The Theory of Multiple Intelligences



Hailed by educators throughout the world, Howard Gardner's theory of multiple intelligences has been applied in hundreds of classrooms and school districts since *Frames of Mind* was first published in 1983. Gardner challenges the widely held notion that intelligence is a single general capacity possessed by every individual to a greater or lesser extent. Amassing a wealth of evidence, Gardner posits the existence of a number of intelligences that ultimately yield a unique cognitive profile for each person. This tenth anniversary edition, published in conjunction with a reader on multiple intelligences, features a new introduction that explores the theory's development over the last decade.

pz.harvard.edu/resources/frames-of-mind-the-theory-of-multiple-intelligences

Metodologie

- Logica matematica, ragionamento deduttivo
- Metodi induttivi: estrarre conoscenza dai dati, metodi probabilistici per trattare l'incertezza
- Ispirarsi alla biologia e alla psicologia: creare programmi/computer simili al cervello umano
- Esistono tuttora...
- Ma dai primi anni duemila: deep learning
- IA simbolica vs IA subsimbolica

Metodologie

Tutti i paradigmi per capire l’Intelligenza artificiale (non solo deep learning)

www.agendadigitale.eu/cultura-digitale/tutti-i-paradigmi-per-capire-lintelligenza-artificiale-non-solo-deep-learning/

- *General Artificial Intelligence* (AI in senso lato, coscienza, emozioni, quella dei film)
- *Narrow Artificial Intelligence* (AI ristretta a campi specifici: scacchi, traduzione, una sola cosa, ma fatta bene)
- Sistemi simbolici e subsimbolici ←
- *Logic Programming*
- *Fuzzy Logic*
- Algoritmi Genetici
- Intelligenza di sciame (sistemi robotici auto-organizzati)

AI simbolica

emulazione ad alto livello delle funzioni del cervello umano

Ispirata dalla logica matematica

Usa simboli (parole, frasi) comprensibili dagli umani

Insieme di regole per combinare i simboli

H. Simon and A. Newell, *General Problem Solver* (GPS), 1957

en.wikipedia.org/wiki/General_Problem_Solver

Esempio: enigma dei missionari e dei cannibali. Chat-GPT non è capace di risolverlo!

AI simbolica ha dominato la scena nei primi 30 anni (sistemi esperti)

Strategia: esperti umani compilano le regole per la diagnosi di una malattia o per prendere decisioni in campo giuridico e poi queste regole (algoritmi) vengono implementati nei computer (sistemi esperti)

AI subsimbolica

emulazione delle funzioni del cervello a livello elementare

Ispirata dalle neuroscienze

Processi mentali, spesso inconsapevoli

Percezione rapida (riconoscere volti o interpretare la voce umana)

Non usa un linguaggio comprensibile dagli umani

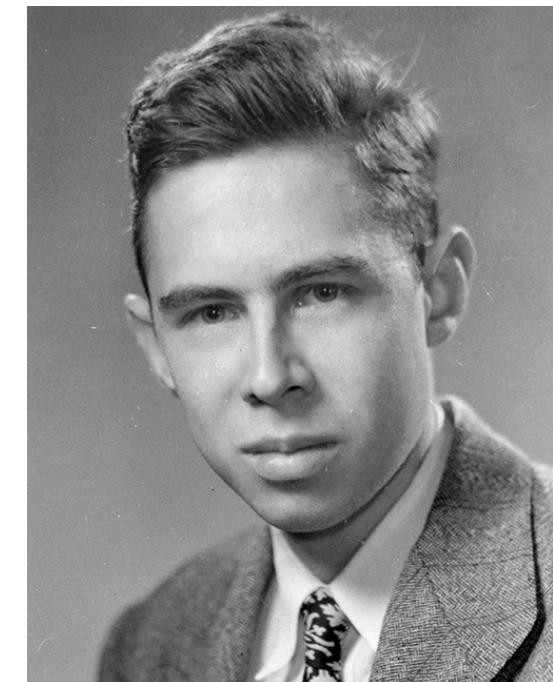
Guazzabuglio di equazioni, operazioni algebriche

Impara dai dati



Perceptron

Frank Rosenblatt 1928–1971



Frank Rosenblatt

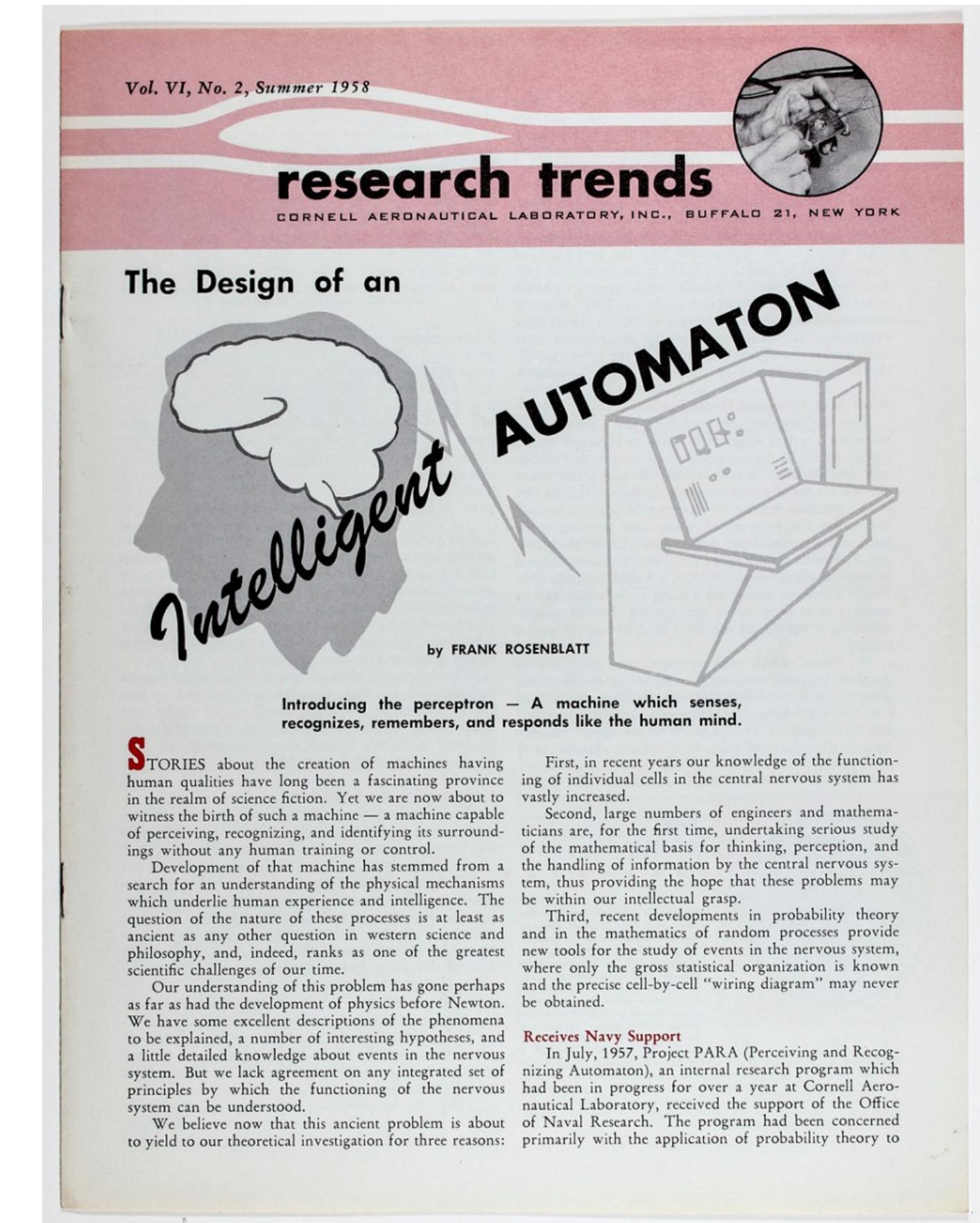
The Perceptron: A Probabilistic Model for Information Storage and Organization in the Brain

Psychol. Rev., 65, 6, 386–408, 1958

Pietra miliare, antesignano dell'AI attuale:
il deep learning (reti neurali profonde)

Professor's perceptron paved the way for AI – 60 years too soon

news.cornell.edu/stories/2019/09/professors-perceptron-paved-way-ai-60-years-too-soon



Vol. VI, No. 2, Summer 1958

research trends
CORNELL AERONAUTICAL LABORATORY, INC., BUFFALO 21, NEW YORK

The Design of an *Intelligent AUTOMATON*

by FRANK ROSENBLATT

Introducing the perceptron — A machine which senses, recognizes, remembers, and responds like the human mind.

STORIES about the creation of machines having human qualities have long been a fascinating province in the realm of science fiction. Yet we are now about to witness the birth of such a machine — a machine capable of perceiving, recognizing, and identifying its surroundings without any human training or control.

Development of that machine has stemmed from a search for an understanding of the physical mechanisms which underlie human experience and intelligence. The question of the nature of these processes is at least as ancient as any other question in western science and philosophy, and, indeed, ranks as one of the greatest scientific challenges of our time.

Our understanding of this problem has gone perhaps as far as had the development of physics before Newton. We have some excellent descriptions of the phenomena to be explained, a number of interesting hypotheses, and a little detailed knowledge about events in the nervous system. But we lack agreement on any integrated set of principles by which the functioning of the nervous system can be understood.

We believe now that this ancient problem is about to yield to our theoretical investigation for three reasons:

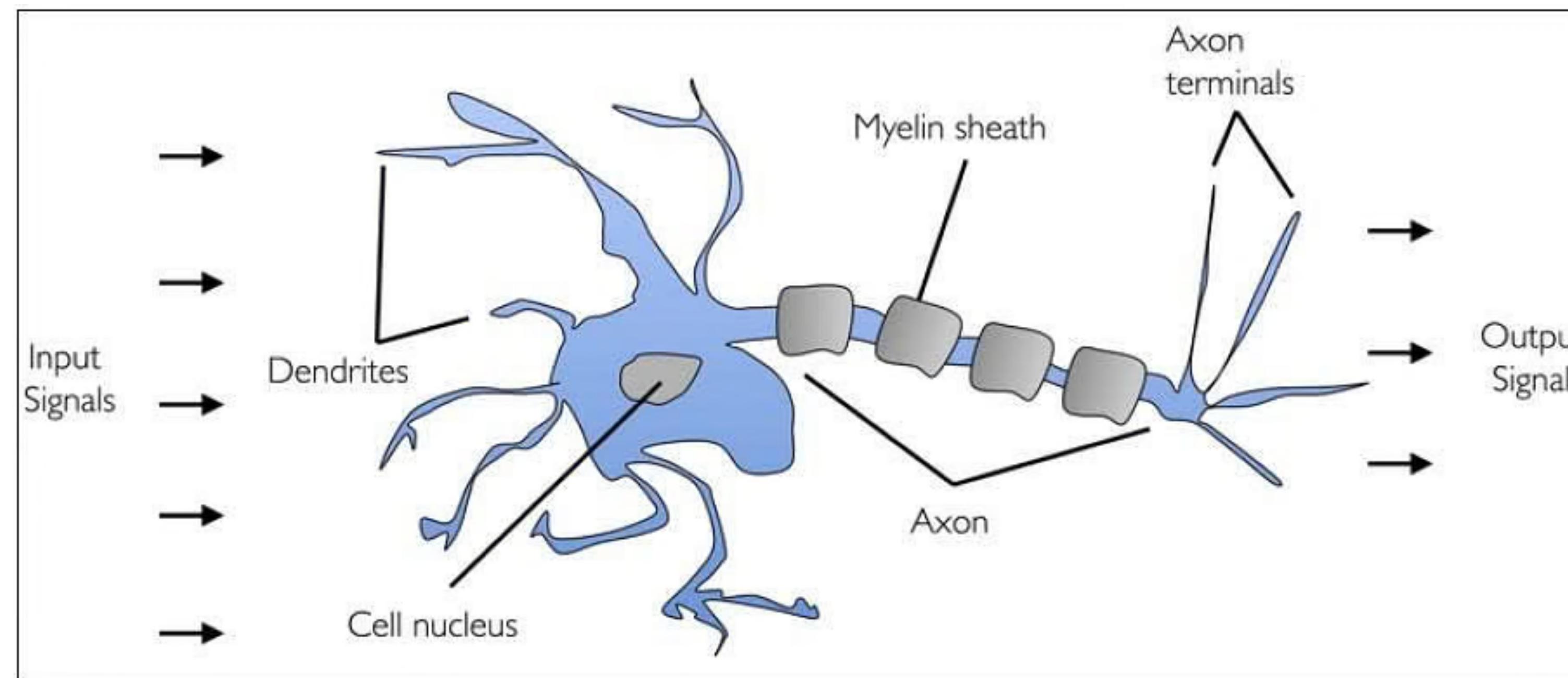
Receives Navy Support

In July, 1957, Project PARA (Perceiving and Recognizing Automaton), an internal research program which had been in progress for over a year at Cornell Aeronautical Laboratory, received the support of the Office of Naval Research. The program had been concerned primarily with the application of probability theory to

What is Perceptron

What is Perceptron: A Beginners Guide for Perceptron

www.simplilearn.com/tutorials/deep-learning-tutorial/perceptron



Biological Neuron

A human brain has billions of neurons.

Neurons are interconnected nerve cells in the human brain that are involved in processing and transmitting chemical and electrical signals.

Dendrites are branches that receive information from other neurons.

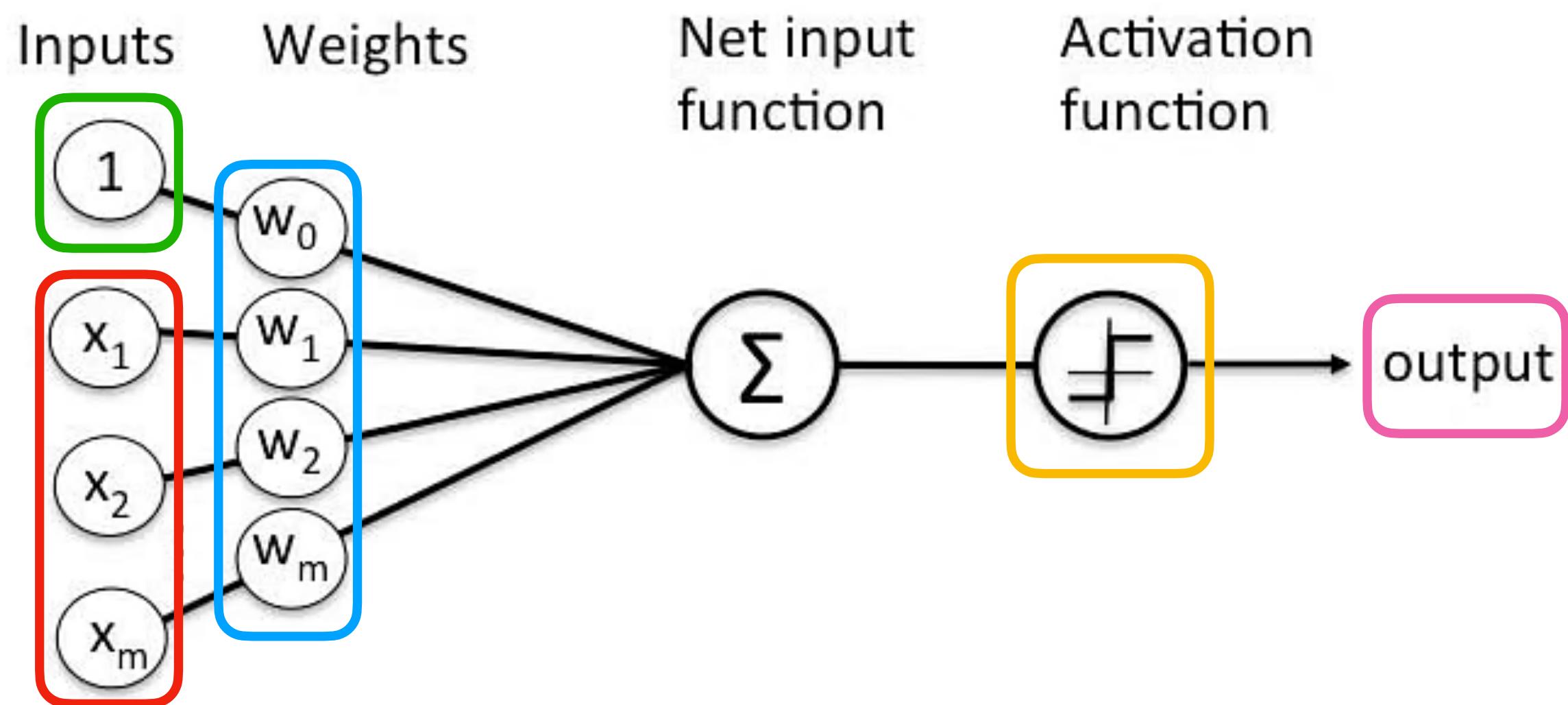
Cell nucleus or Soma processes the information received from dendrites.

Axon is a cable that is used by neurons to send information.

Synapse is the connection between an axon and other neuron dendrites.

Perceptron

A type of artificial neural network



Input Layer: neurons which receive input signals from the external world

Weights represent the strength of the connection between the input neuron and the output neuron.

Bias provides the perceptron with additional flexibility in modeling complex patterns in the input data.

The **activation function** determines the output of the perceptron based on the weighted sum of the inputs and the bias term (the step function, sigmoid function, and ReLU function).

The **output** of the perceptron is a single binary value, either 0 or 1, which indicates the class or category to which the input data belongs.

Training Algorithm: The perceptron is typically trained using a supervised learning algorithm. During training, the **weights** and **biases** of the perceptron are adjusted to minimize the error between the predicted **output** and the true output for a given set of training examples.

Overall, the perceptron is a simple yet powerful algorithm that can be used to perform binary classification tasks and has paved the way for more complex neural networks used in deep learning today.

Perceptron

- Esempio: riconoscimento delle dieci cifre

Perceptron

- Come imparare?
- Psicologia comportamentista: condizionamento
- Addestramento di topi con rinforzo (positivo o negativo)
- *Supervised learning*
- *Training set* (addestramento)
- *Test set* (verifica del grado di predittività)
- New York Times 1958: la marina militare [...] il prototipo sarà capace di camminare, parlare, vedere, scrivere, riprodursi, essere cosciente della propria esistenza...
- Numeri e procedure non simboliche impediscono di tradurre i risultati in regole comprensibili dagli umani
- Situazione analoga con l'osservazione del nostro cervello

Primavere ed inverni

Dalla metà degli anni '70

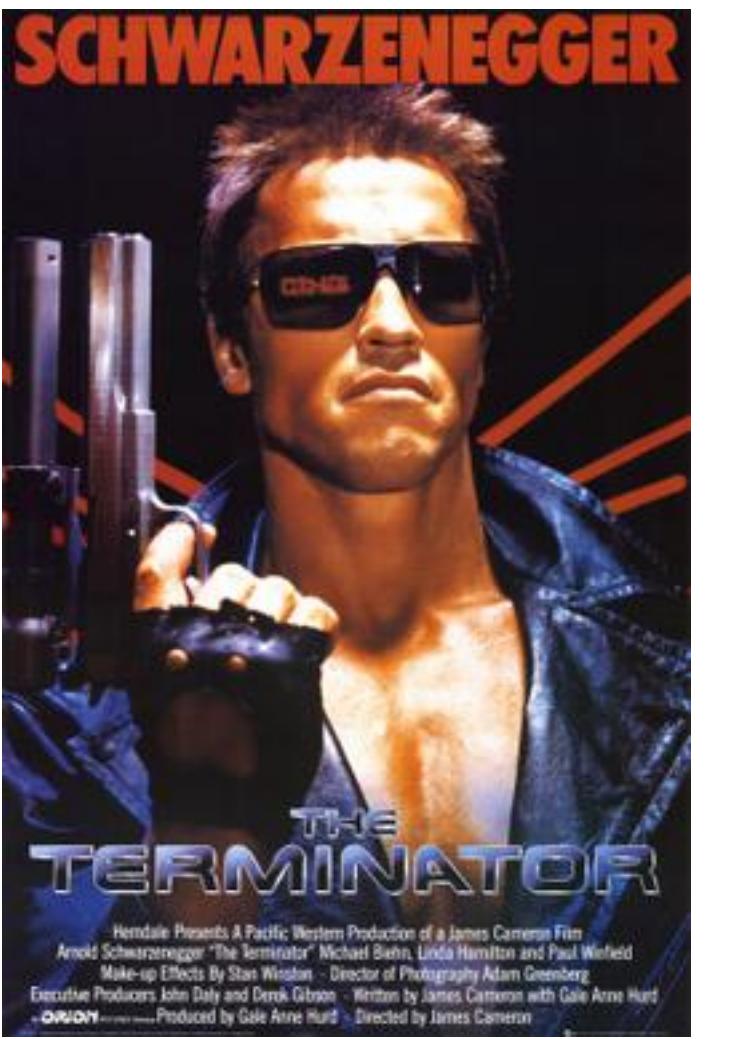
- AI nonsimbolica: solo problemi semplici
- AI simbolica: promesse roboanti (sistemi esperti)
- Risultati modesti e scoraggianti
- AI generale: il suo arrivo sembra sempre più remoto
- Schema ricorrente:
 - Fase I: nuove idee, ottimismo
 - Fase II: risultati modesti, delusione
- Cicli di 5-10 anni
- IA: obiettivo più difficile di quanto pensavamo (John McCarthy 50 anni dopo)
- Le cose facili sono difficili (Marvin Minsky: paradosso, scarsa consapevolezza di ciò che la mente umana sa fare meglio)

Neural Networks

- Reti neurali multistrato (deep networks)
- Retropropagation
- Machine Learning
- Branca dell'AI completamente separata dall'AI simbolica
- “*Good Old-Fashioned AI*” — J Haugeland, *Artificial Intelligence: The Very Idea* (1985)

Primavera

- 1997: Deep Blue vs Garry Kasparov
- Google Translate
- Guida autonoma (ADAS)
- Siri e Alexa: richieste vocali
- YouTube: sottotitoli
- Skype: traduzione simultanea
- Facebook: riconoscimento volti
- Flickr: etichettatura automatica delle foto
- 2016: AlphaGo



- Tutti esempi di AI ristretta o debole
- — in antitesi a —
- AI generale o forte
- Un cumulo di intelligenze ristrette non varrà mai un'intelligenza generale
- — M. L. Minsky, Computation: Finite and Infinite Machines, 1967
- <https://ai100.stanford.edu>

- One Hundred Year Study on Artificial Intelligence (AI100)
- <https://ai100.stanford.edu>

- Limiti dei percettroni: solo problemi semplici
- 1971, Frank Rosenblatt muore a 42 anni in un incidente
-