

# A classification for kinds of Artificial Intelligence

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# Kommer Kleijn SBC

- VFX Cinematographer - Stereographer
- Research and Education, Inventor, consultant
- Chair of IMAGO Technical Committee 2005 - 2015
- Served as board member of SBC, EDCF, UP3D, Fellow of SMPTE
- Participating member SMPTE 27C TC, Chaired DCP Frame Rate Groups
- Following AI developments since 1978

## 3 main Kinds of (Classes of) AI

When working with AI, it can be worthwhile to keep in mind which kind you are working with. That can help to anticipate what kind of results to expect.

- 1 – GOFAI – Traditional Deterministic Algorithms, written by humans
- 2 – Artificial Neural Networks – ANN - SNN - Pattern recognition
- 3 – Generative AI – Creative output – May be perceived as self-thinking

When a product you are using says “with AI”, it may be using any combination of 1, 2, and 3. Most practical systems today are hybrid

Appendix: Upcoming or future forms of AI under development:

- 4 – Artificial Agentic Intelligence - AAI - Artificial Autonomous Intelligence
- 5 – Artificial General Intelligence - AGI
- 6 – Artificial Super Intelligence – ASI

# 1 - AI of the first kind: GOF AI

- All forms of cognitive assistance can be considered AI. Strictly spoken, a cash register or a pocket calculator can be seen as a form of AI
- Traditional computer systems are a form of AI as they already relieve our brain from cognitive tasks. (Like remembering, sorting, calculating, ...)
- Traditional computer systems are deterministic. Deterministic means that a specific question/task will always result in the same answer or result. We often associate this behavior with “machines” or “automation”
- Traditional computer systems use algorithms and rules, usually written in human readable program lines
- GOF AI – Good Old Fashioned Artificial Intelligence

# Computer program code

```
17 string sInput;  
18 int iLength, iN;  
19 double dblTemp;  
20 bool again = true;  
21  
22 while (again) {  
23     iN = -1;  
24     again = false;  
25     getline(cin, sInput);  
26     system("cls");  
27     stringstream(sInput) >> dblTemp;  
28     iLength = sInput.length();  
29     if (iLength < 4) {  
30         again = true;  
31         continue;  
32     } else if (sInput[iLength - 3] != '.') {  
33         again = true;  
34         continue;  
35     } while (++iN < iLength) {  
36         if (isdigit(sInput[iN])) {  
37             continue;  
38         } else if (iN == (iLength - 3)) {  
39             continue;  
40         }
```

# Takeaways for AI of the first kind

- Based on Central processing (Central Processing Units, CPU)
- Applications are made of code readable by humans – (in principle)
- Deterministic – Predictable – (in principle)
- Controllable – (in principle) - “Machine” behavior, automatic behavior
- GOFAI – Spite the “Good” in the title, GOFAI is not always innocent
- Controlled by humans, but humans sometimes can make poor decisions
- Boeing 737 Max MCAS was GOFAI and so were the algorithms used by Cambridge Analytic to influence voters during the Brexit referendum

## 2 - AI of the Second kind (and up) “after GOFAI” “New AI”: Artificial Neural Networks 1/4

- Origin = Neuroscience: The science that studies how the human brain works: Many notable AI researchers are neuroscientists, Psychologists
- A neuron is a very basic and a quite digital data processor
- Digital in that it can only either fire, or not fire (Yes or No)
- It has multiple inputs, and multiple outputs (from one up to thousands)
- All outputs carry the same message in parallel: signal or no signal
- Inputs have all the same function but can each have a different sensibility
- The sensibility of an input is called “weight” and changes with learning
- The brain is composed of billions of neurons, organized in layers (cortex)

## 2 - AI of the Second kind

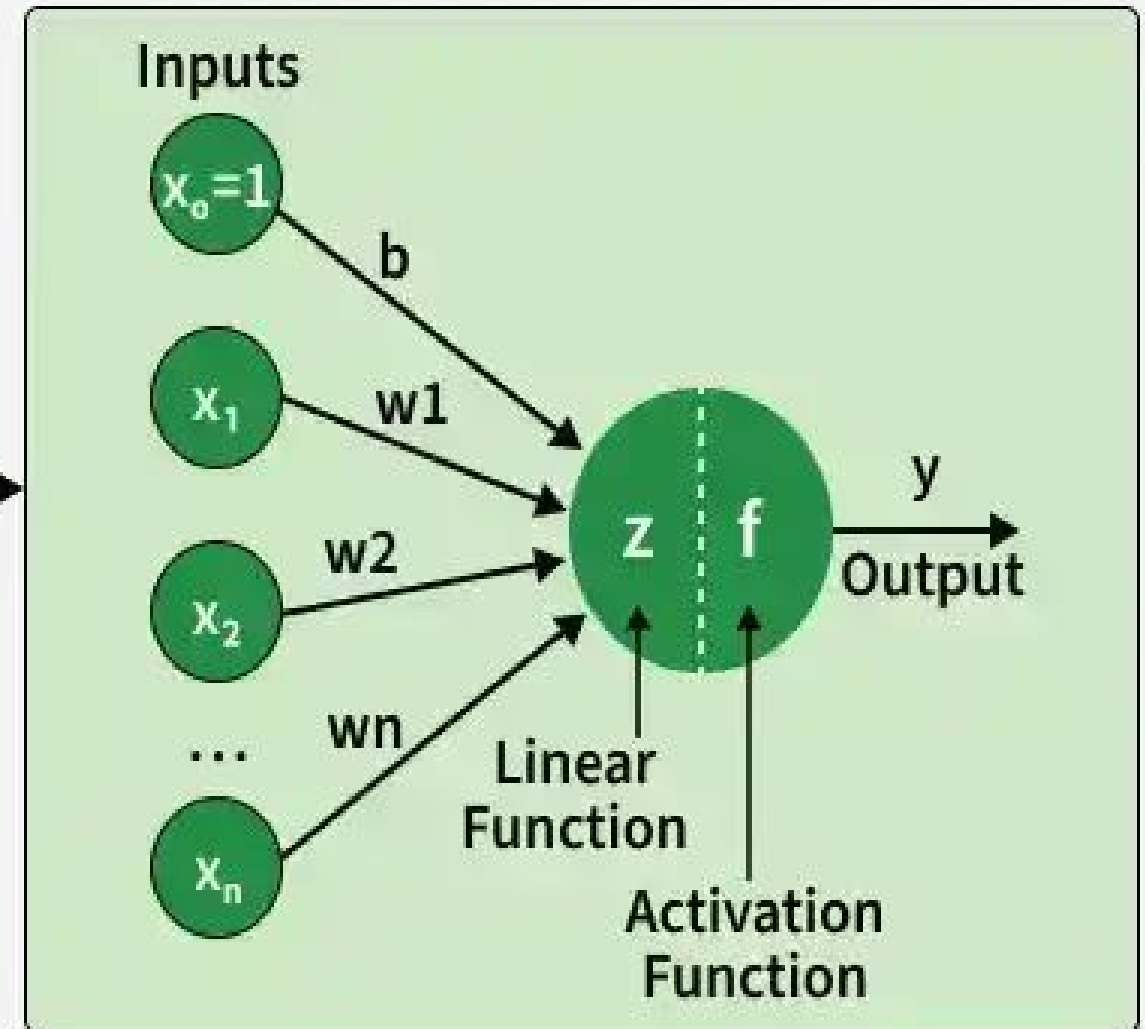
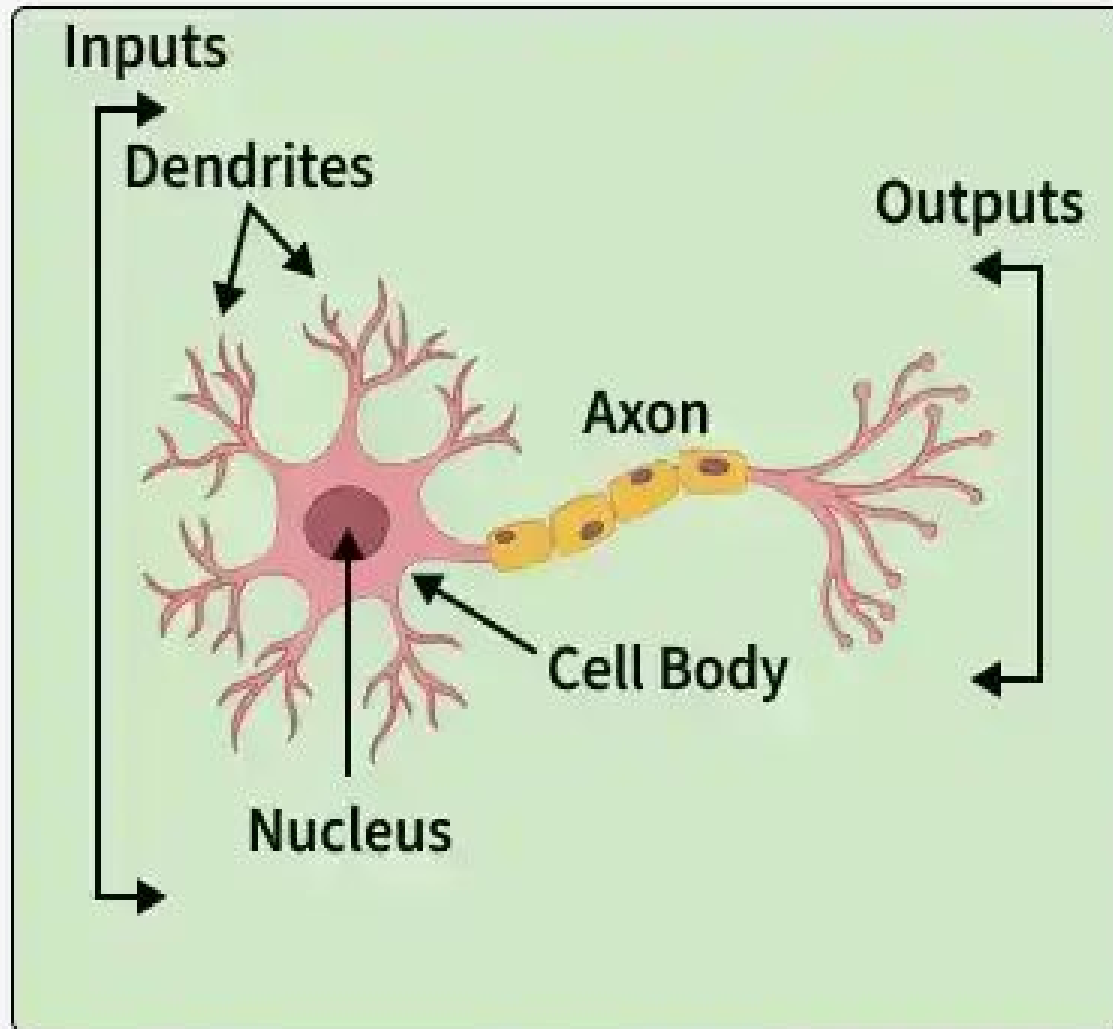
### Artificial Neural Networks 2/4

- Neural Networks are at the end of the spectrum of parallel processing, as opposed to traditional computing based on Central Processing Units (CPU)
- Neuro science described the behavior of a neuron in 1943 in a mathematical formula: The Artificial Neuron
- The first practical ANNs used electronic circuits (valves and relays)
- In 1960 Frank Rosenblatt, a psychologist, demonstrated the first working ANN: The Mark 1 Perceptron. It could recognize the handwritten figures from 0 to 9. Pattern recognition
- Artificial Neural Networks did not originate in Information Technology: Their origins are with Neuroscience

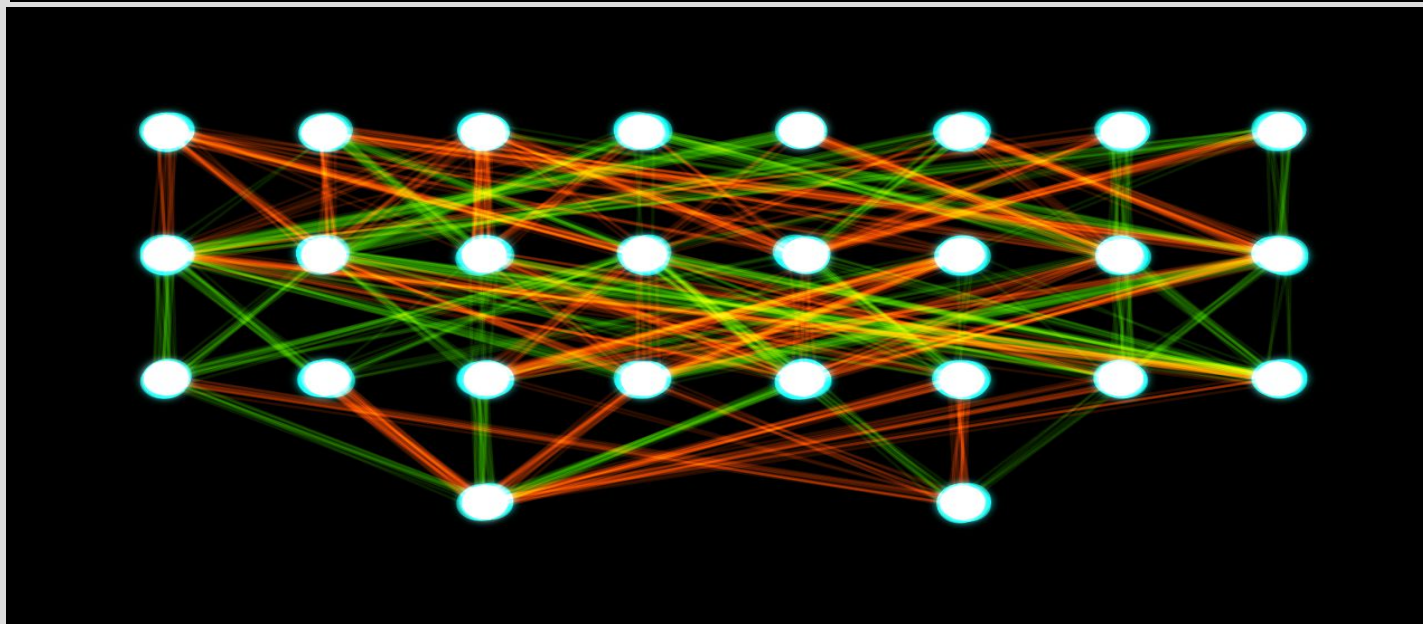
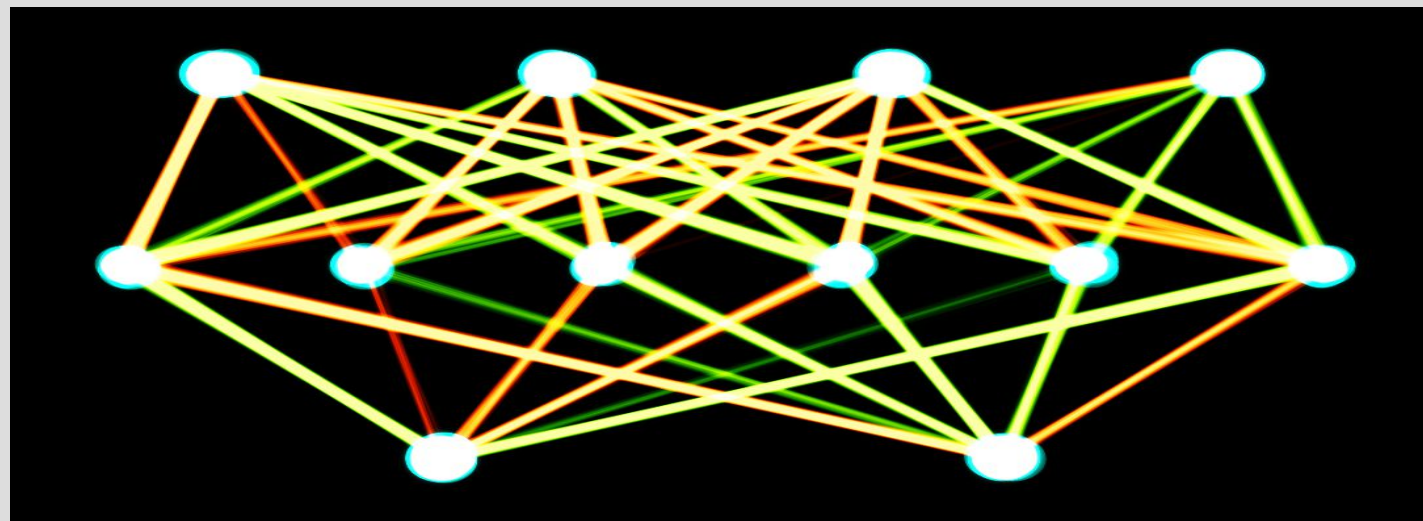
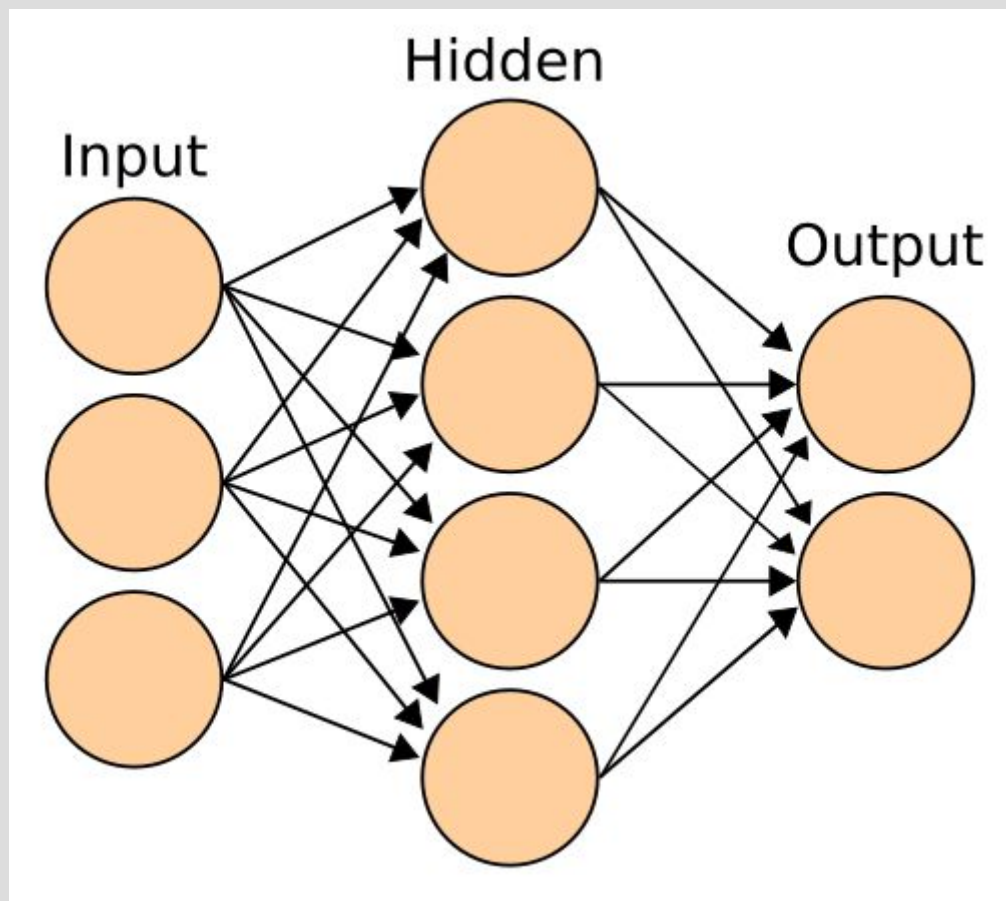
# Biologic Neuron

vs

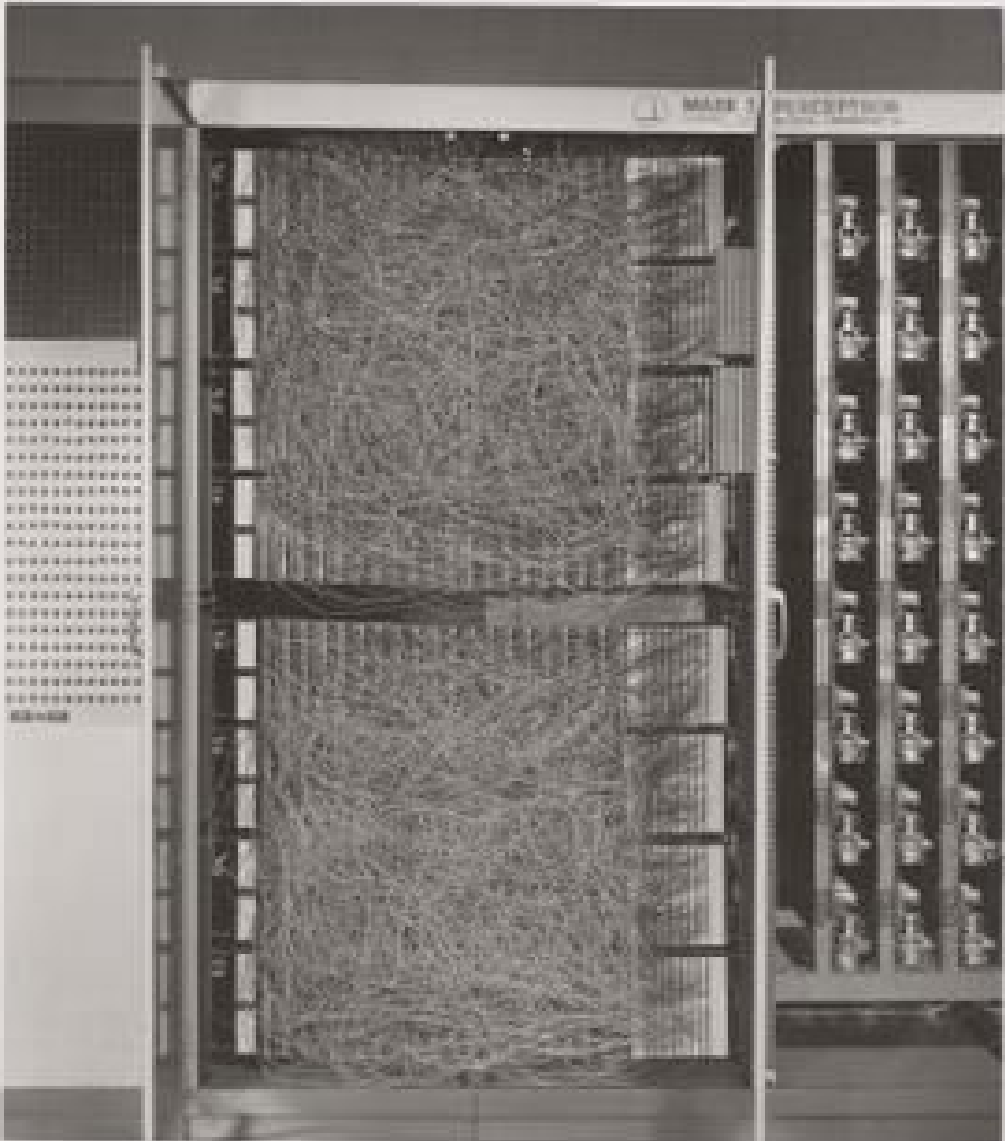
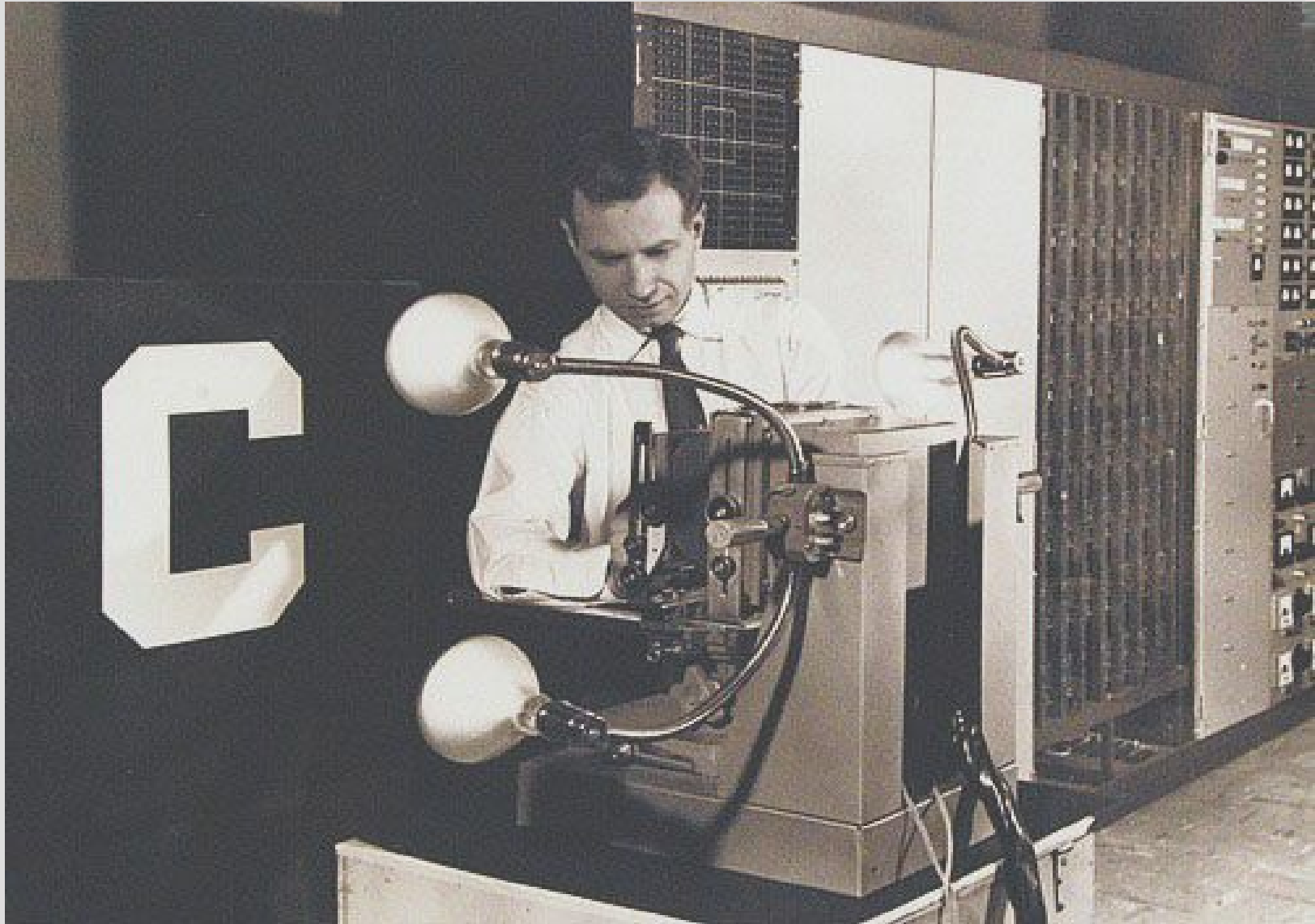
# Art. N or Sim. N



# Neural Networks



# The Mark 1 Perceptron





## 2 - AI of the Second kind

### Artificial Neural Networks 3/4

- Later the formula was programmed into a computer. In computers we can simulate almost any process. This led to Simulated Neural Networks (SNN)
- Now Information Technology becomes involved. As a tool, not as the core
- Computers not powerful enough in the sixties + lack of training data, leading to a pause called “the AI Winter”, from the sixties to the eighties
- ANN development was revived by Geoff Hinton et al, thanks to the availability of more powerful computers and training data from the Internet
- Actual ANN/SNN systems all work by simulating NNs on a computer
- GPU chips are multiprocessors and can be programmed to simulate a parallel processing neural network. Hence the success of the nVidia chips

## 2 - AI of the Second kind

### Artificial Neural Networks 4/4

- Main motivation for Neural Networks is (was) pattern recognition
- Pattern recognition is relatively inefficient with traditional algorithms
- Analogies with the input/output information filters of the biological brain: Most of our brain is doing unconscious information processing
- The neural network is self learning, it is not programmed by code lines but by training (teaching), this is the case for both humans and ANN alike
- Inner workings of Neural Networks of up to three layers (one hidden layer) are understood: We can understand how information progresses in it
- AI of the second kind is not generative. It recognizes patterns and sorts them into classes. This has many useful applications. But is not creative

# Takeaways for AI of the Second kind

- Neural Networks work fundamentally differently from traditional computing
- The results are not based on algorithms, but on training, w trial and error
- Artificial Neural Networks are a simulation of biological brain tissue
- Neural Networks have layers: Input layer, hidden layer(s), output layer
- Neural Networks are not deterministic – Behavior not fully predictable
- While the simulation software is traditional, the SNN results are not
- Hardware, microcode, firmware, drivers, operating system are traditional. The application (which determines the result) is not. It emerged by training

# Computer Systems Recap

- Traditional computer systems execute programs lines sequentially. The computer behavior is determined by the written program it is running
- Computers have a layered programming structure: Hardware, microcode, firmware, operating system, driver software, application
- However in fine, all layers are support layers, except for the application
- The application determines the behavior (the results) for 100%
- The behavior of a computer system is not just “influenced by” the application, its behavior is 100% determined by the application
- Simulated Neural Networks simulate biological tissue using a computer
- After training it becomes an application that is created by emergence

# 3 - Artificial Intelligence of the Third kind 1/2

- Above a certain threshold (number of Neurons in multiple hidden layers) the capabilities of a Neural Network can surpass pattern recognition and can become generative: Producing content it has not been given
- November 2022 launch of ChatGPT: Generative Pre-trained Transformer
- Pre-Trained means learning and use separation: a learning period (training) and then after testing, usage with deep learning disabled
- Pre-trained systems can not access the Internet after training is complete
- Reason is to mitigate misaligned behavior
- Behavior cannot be controlled other than by training, testing, re-training when needed and then disabling learning

## 3 - Artificial Intelligence of the Third kind 2/2

- GOFAI input- output-filters added for behavioral security. Guardrails
- Non-deterministic: the same question can produce different responses
- Responses not fully or reliably predictable
- Generative AI Is not fully understood. As it essentially is simulated brain tissue, which we also do not fully understand the workings of in detail
- Genrative ANNs are considered “Black Boxes”. What is going on inside is unknown and therefore also hard to control, other than by training/teaching
- Chat systems need guardrail filters before and after. Guardrail filters are mostly using AI of the first kind for them to be reliable and controllable

# Takeaways for AI of the Third kind

- Generative. Also generates results that were never input
- This is what differs it from AI of the 2<sup>nd</sup> kind
- Exact internal workings are poorly understood. Lots of expertise on how to make it, but little on how it actually works inside ...
- Like building a breeding machine. Lots of expertise on best temperature but no knowledge on how and egg transforms into a chick.
- Kleijn: Bred Intelligence (BI) - Nate Soares: “Grown, not crafted”
- AI tech builds the simulated tissue. The intelligence emerges in it
- Generative systems may (and do!) hallucinate. Double-check the results!

# Some differences between biological Neural Networks and their simulation

- A human brain has about a 40 times more parameters than commercial LLMs. So ChatGPT could be seen as a simulation of about 25 grams of brain tissue in a laboratory setting ...
- However, simulated neurons are near a million times faster than bio
- Parameters can be saved and copied between SNNs, not so for biological Neural Nets.
- Knowledge, and acquired experience, can be copied without re-teaching
- SNNs do not have the auto-destruct function that biological NNs have. If power is cut from a SNN, it won't die but resume when powered back up
- SNN are big, heavy and energy needy, while bio NNs are more portable

# Takeaways for the Cinematographer

- Know which Kind of AI you are working with: Which kind? Is it AI of the first, second or third kind? Or which combination there of ?
- Is it Traditional or is it an ANN/SNN ? Deterministic (GOFAI) or not?
- If not deterministic you may want to double-check if the results are exact!
- When ANN/SNN, is it pattern recognition only or is it generative?
- If generative, you may want to check if the results please you. And if they are true, correct, and not “hallucinated”

# Upcoming or future kinds of AI

- New forms of AI are under development, either starting to become available or announced as future goals by big tech companies

4 – Artificial Agentic Intelligence - AAI - Artificial Autonomous Intelligence

5 – Artificial General Intelligence - AGI - (under development) (future)

6 – Artificial Super Intelligence – ASI - (under development) (future)

# 4 - AAI: Artificial Intelligence of the 4th kind

- Agentic AI is a new form of artificial intelligence that can autonomously reason, plan, and execute tasks with minimal human intervention
- It often integrates multiple agents to manage complex tasks or workflows to achieve specific goals. AKA Autonomous Artificial Intelligence (AAI)
- Agentic AI tools prioritize decision-making over content creation
- Agentic AI can access the internet to autonomously do research
- Agentic AI can act on the users behalf in the real world (like booking)
- An AAI does not wait for prompts. It consumes significantly more power
- AAI is relatively new and does not (yet) always work very well

# 5 - AGI: Artificial Intelligence of the 5th kind (future)

- Artificial General Intelligence - AGI
- Under development, not available yet
- Not task specific: Can do most or all cognitive tasks that a human can do
- Capable of replacing a human behind a computer at almost any task
- Declared as a development goal by several of Big Tech Companies

# 6 - ASI: Artificial Intelligence of the 6th kind

## Artificial Super Intelligence – (future)

- ASI: AGI not equal but but better than the best humans at the task
- Expected when? : Unknown - some say 3 years, others say 50 years
- ai-2027.org considers that by 2029 the best AI researcher might be an AI
- As SNNs are much faster than humans, the time from an AI generation to the next may become a fraction of what is usual now. We then might see systems that are 10, 100, or 1000 times more performant than human
- We eventually may not be able to understand all output of such systems
- Humanity might loose societal control to ASI
- If that happens, the future might bring important changes ...

# A classification for kinds of Artificial Intelligence

**Thank you for your attention**

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