

Overview of AI: Machine Learning & Deep Learning

Deep Learning with Big Data

Thuan L Nguyen, PhD

Slide 2: Overview of AI – Machine Learning & Deep Learning

1. AI – Machine Learning & Deep Learning: A Bit of History
2. The Start of Modern AI: Artificial Neuron and Perceptron
3. The First Wave of the Modern AI
4. The Second Wave of the Modern AI
5. The Third Wave of the Modern AI: The Breakthrough with Deep Learning
6. Deep Learning & Big Data: The Powerful Combination

Slide 3: Overview of AI – Machine Learning & Deep Learning

- **Learning** is the act of acquiring new or reinforcing existing knowledge, behaviors, skills or values.
- **Humans** have the ability to learn.
- **Learning** does not happen all at once, but it builds upon and is shaped by previous knowledge.
- To that end, learning may be viewed as a **process**, rather than a collection of factual and procedural knowledge.

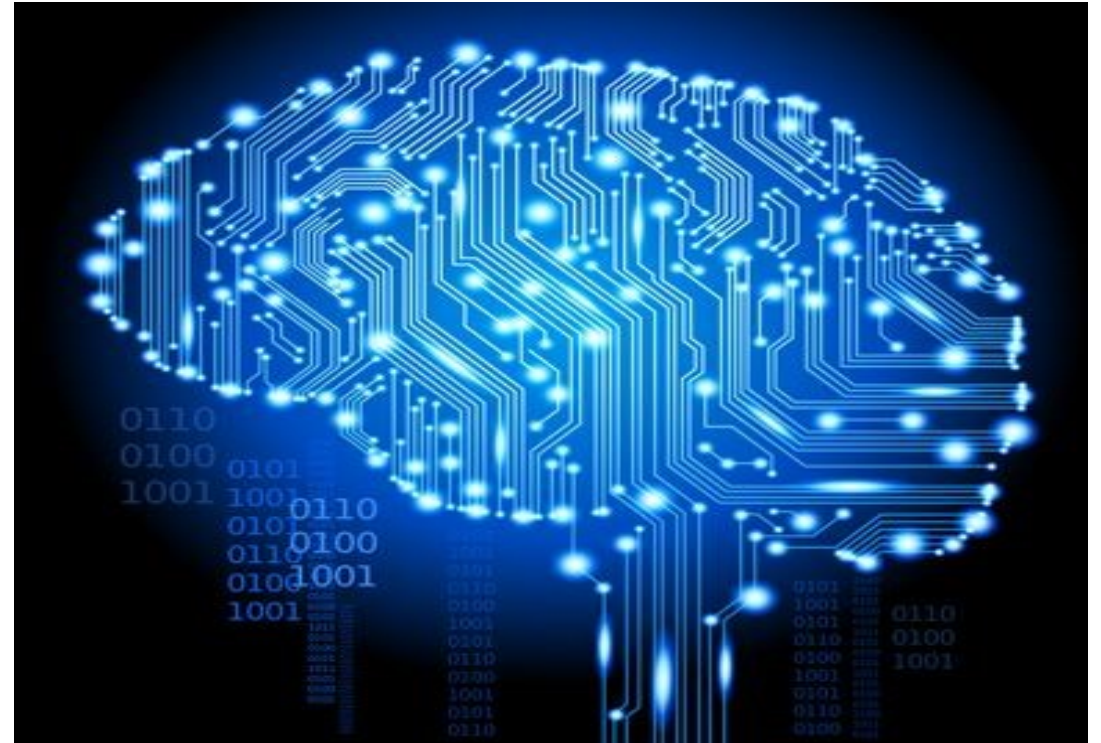


Source: chicagorealtor.com

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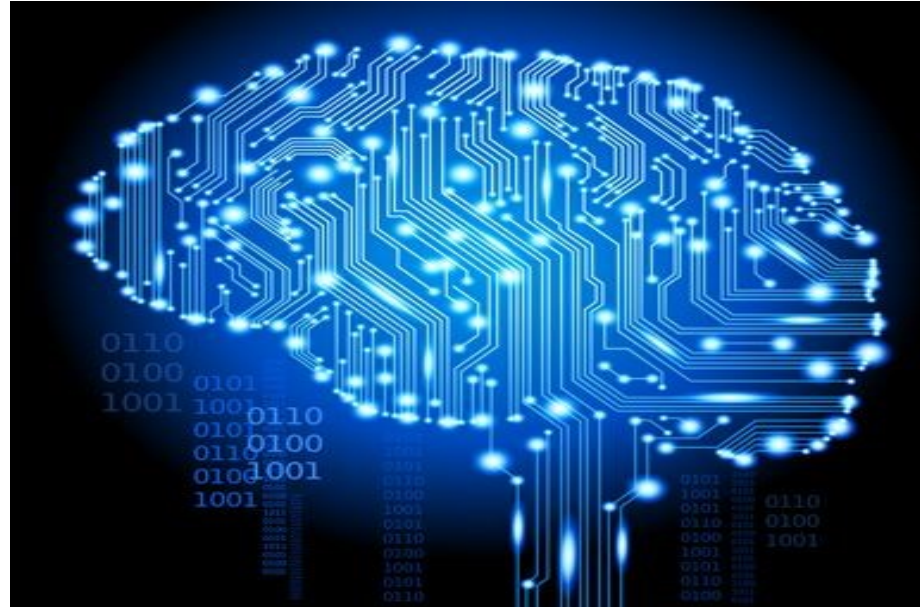


Source: chicagorealtor.com



Source: ranktechnology.blogspot.com

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Source: ranktechnology.blogspot.com

Machine learning is a way to achieve artificial intelligence (AI).

The term was coined by Arthur Samuel in 1959 and defined as the **ability of computing devices to learn without explicitly being programmed**.

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Artificial Intelligence (AI)



What is AI? (Source: Wikipedia)

***AI** is the **theory and development of computer systems** able to perform tasks normally requiring **human intelligence**, such as visual perception, speech recognition, decision-making, and translation between languages.*

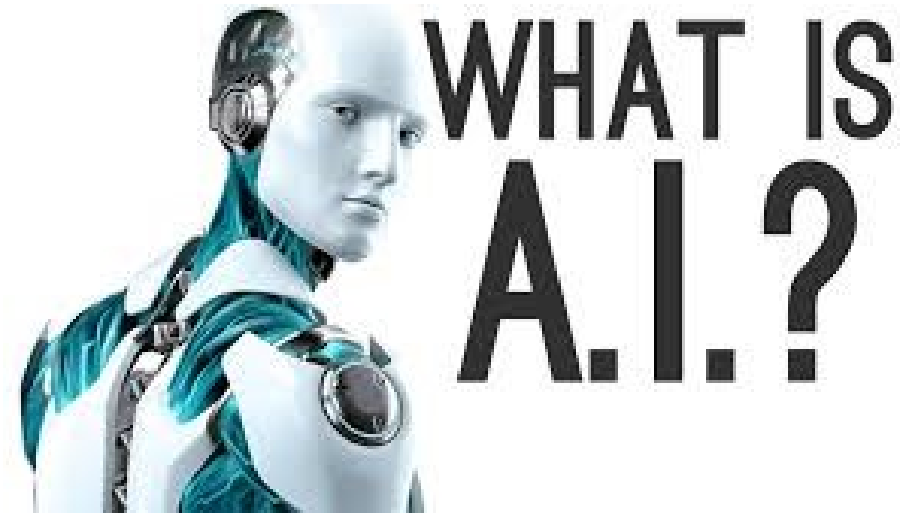
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Artificial Intelligence (AI)

The concept of **AI** was introduced by **John McCarthy** together with Marvin Minsky, Allen Newell and Herbert A. Simon.

McCarthy coined the term "**artificial intelligence**" in 1955.

He also organized the famous **Dartmouth Conference** in Summer 1956. This conference started **AI** as a field.

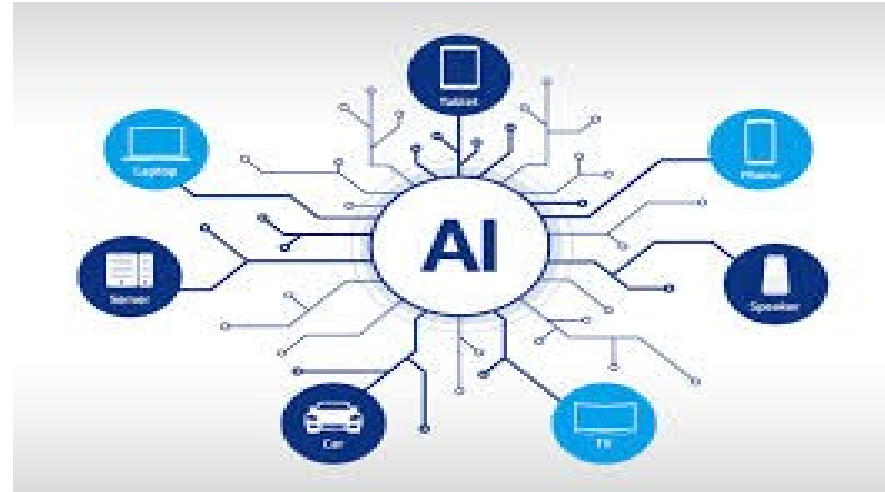


What is AI? (Source: Wikipedia)

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Artificial Intelligence (AI)

What is AI? (Source: Wikipedia)



By Marvin Minsky:

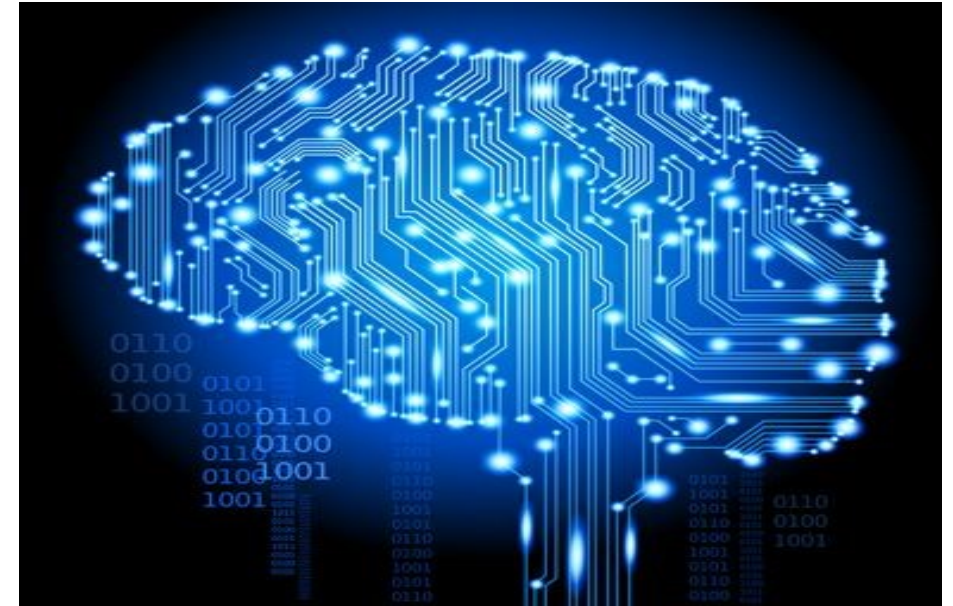
***AI** is involved in **computer programs** that engage in **tasks** that are currently more satisfactorily performed by human beings because they **require high-level mental processes** such as: perceptual learning, memory organization and critical reasoning.*

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Artificial Intelligence (AI)

With **AI**, we – human-beings – want **machine to think like human**, giving them the intelligence of their own by **feeding them lots of information** simulating the environment similar to our real world, given the fact that they can **process huge information** with **extremely high speed and performance**.

The **ultimate goals** of the **AI** computing is to **facilitate humans to perform their tasks** with **more efficiency** where humans can **rely on machine** to **make decisions by itself** on the human's behalf.



Source: ranktechnology.blogspot.com

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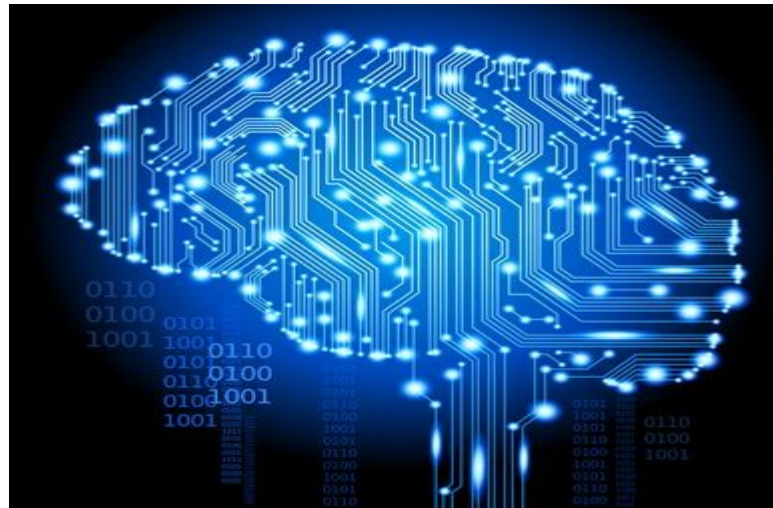
Artificial Intelligence (AI)

Artificial Intelligence has been around for a long time:

- The Greek myths contain stories of mechanical men designed to mimic our own behavior.

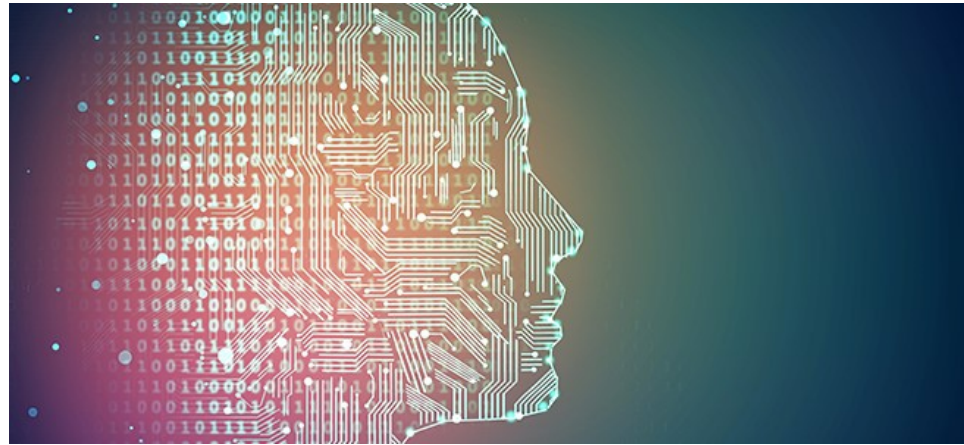
As technology and the understanding of how human minds work have progressed, the **concept of what constitutes AI has changed**:

- Rather than increasingly complex calculations, work in the field of AI concentrated on mimicking human decision making processes and carrying out tasks in ever more human ways.



Source: ranktechnology.blogspot.com

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Source: mindovermachines.com

Artificial Intelligences – devices designed to act intelligently – are often classified into one of **two fundamental groups** – **applied** or **general**.

- **Applied AI** is far more common: Systems designed to perform specific tasks. For example:
 - Systems that can intelligently trade stocks and shares
 - Systems that can “drive” an autonomous vehicle.
- **Generalized AIs** – systems or devices which can in theory handle any task – are less common:
 - This is where some of the **most exciting advancements** are happening today.
 - It is also the area that has led to the **development of Machine Learning**.
 - Often referred to as a subset of AI, machine learning is the **current state-of-the-art AI**.

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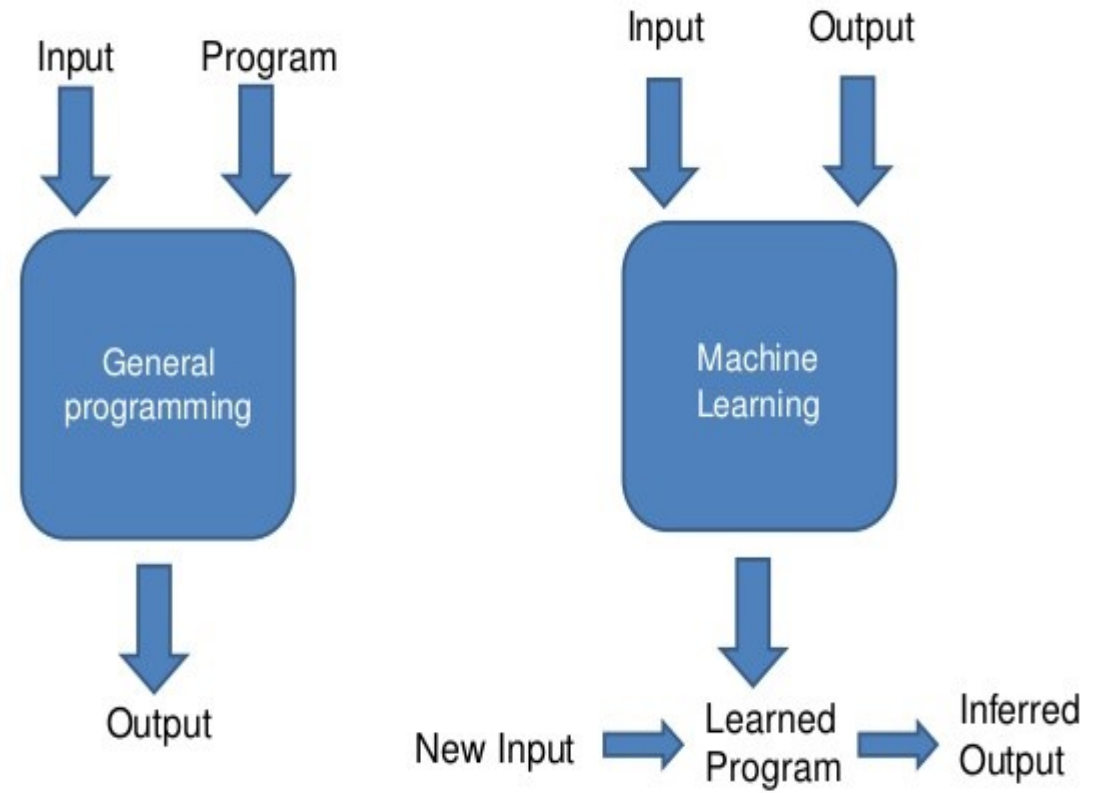
Machine learning is a way to achieve **artificial intelligence** (AI).

The term was coined by Arthur Samuel in 1959 and defined as the **ability of computing devices to learn without** explicitly being programmed.



Source: scitechdaily.com

General Programming vs Machine Learning



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Machine learning & Artificial Intelligence (AI)

In short:

- **Artificial Intelligence (AI)** is the broader concept of **machines** being **able to carry out tasks** in a way that we would consider “**smart**”.
- **Machine Learning** is one of the current applications of AI based on the **idea** that we can **get machines learn** and **complete tasks without** being **explicitly programmed**, i.e., not using rule-based programming.



Source: scitechdaily.com

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Machine Learning (ML)

Two important breakthroughs led to the emergence of Machine Learning as the vehicle that is driving AI development forward with the speed it currently has.

- One of these was the realization that rather than teaching computers everything they need to know about the world and how to carry out tasks, it might be possible to teach them to learn for themselves (*credited to Arthur Samuel in 1959*).
- The second, more recently, was the emergence of the internet, and the huge increase in the amount of digital information being generated, stored, and made available for analysis. In other words, the advent of big data.



Source: scitechdaily.com

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Machine Learning (ML)

Once these innovations were in place, engineers realized that rather than teaching computers and machines how to do everything, it would be **far more efficient**:

--> to **code them** to think like human beings

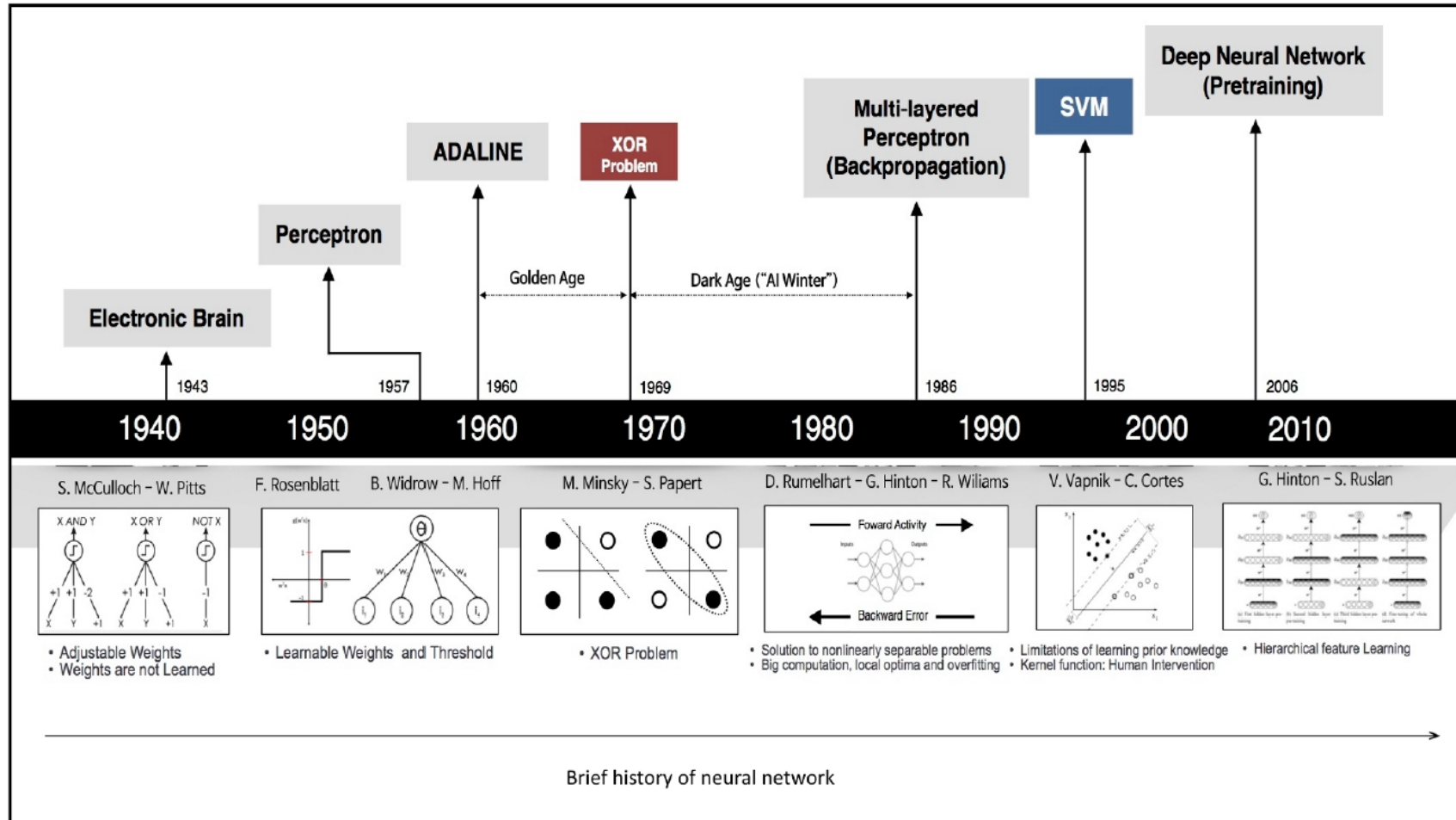
--> and then **plug them into the internet** to give them access to all of the information in the world.



Source: mindovermachines.com

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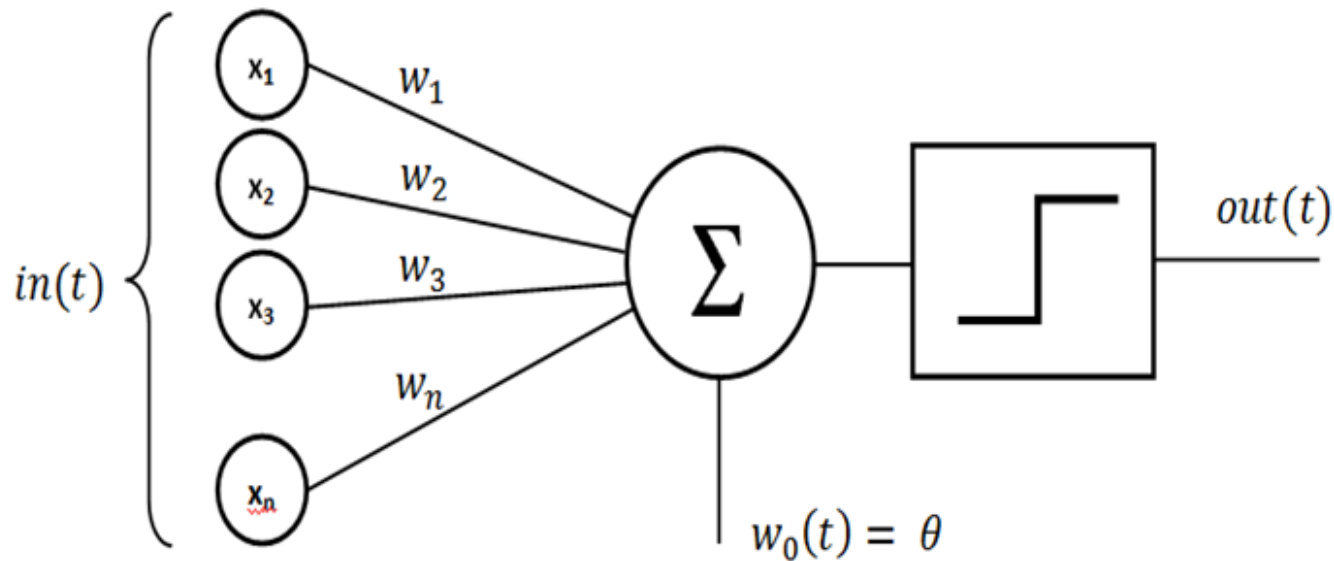
AI: Machine Learning & Deep Learning: The History



Machine Learning and Deep Learning: History (Sources: Di, Bhardwaj, & Wei (2018))

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AI: Machine Learning & Deep Learning: The Start



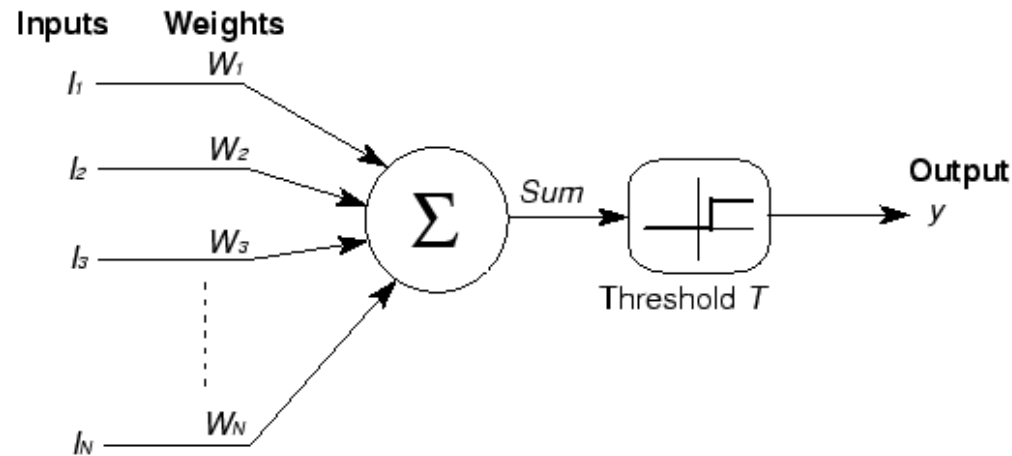
Artificial Neuron Used by Perceptron (Sources: Wikipedia)

- 1943: McCulloch and Pitts
 - Proposed the **McCulloch-Pitts neuron model**.
- 1949: Hebb published his book *The Organization of Behavior*,
 - The **Hebbian learning rule** was introduced.

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AI: Machine Learning & Deep Learning: The Start

- 1943: McCulloch and Pitts proposed the **McCulloch-Pitts neuron model**



McCulloch and Pitts Model of Neuron: (Sources: utep.edu)

- The simplified model of real neurons is also known as a **Threshold Logic Unit**:
 - A set of synapses (i.e. connections) brings in activations, i.e., **inputs**, from other neurons
 - A processing unit **sums the inputs**, and then applies a **non-linear activation function**
 - An **output** line transmits the result to other neurons

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AI: Machine Learning & Deep Learning: The Start

- 1943: McCulloch and Pitts proposed the McCulloch-Pitts neuron model
 - Each input I_i is multiplied by a weight w_{ji} (synaptic strength)
 - These weighted inputs are summed to give the activation level, A_j
 - The activation level is then transformed by an activation function to produce the neuron's output, Y_i
 - W_{ji} is known as the weight from unit i to unit j
 - $W_{ji} > 0$, synapse is excitatory
 - $W_{ji} < 0$, synapse is inhibitory
 - Note that I_i may be
 - External input
 - The output of some other neuron

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AI: Machine Learning & Deep Learning: The Start

- 1943: McCulloch and Pitts proposed the McCulloch-Pitts neuron model

We can now write down the equation for the output Y_j of a McCulloch-Pitts neuron as a function of its inputs I_i :

$$Y_j = \text{sgn}\left(\sum_{i=1}^n I_i - \theta\right)$$

where θ is the neuron's **activation threshold**. When

$$Y_j = 1, \quad \text{if } \sum_{k=1}^n I_k \geq \theta \qquad Y_j = 0, \quad \text{if } \sum_{k=1}^n I_k < \theta$$

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AI: Machine Learning & Deep Learning: The Start

- In mathematics, the **sign function** or **signum function** (from signum, Latin for "sign") is an **odd mathematical function** that extracts the **sign of a real number**. In mathematical expressions the sign function is often represented as **sgn**.

The signum function of a real number x is defined as follows:

$$\text{sgn}(x) := \begin{cases} -1 & \text{if } x < 0, \\ 0 & \text{if } x = 0, \\ 1 & \text{if } x > 0. \end{cases}$$

Alternatively:

$$\text{sgn}(x) = \frac{d}{dx} |x|, \quad x \neq 0$$

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AI: Machine Learning & Deep Learning: First Wave (1958 – 1969)

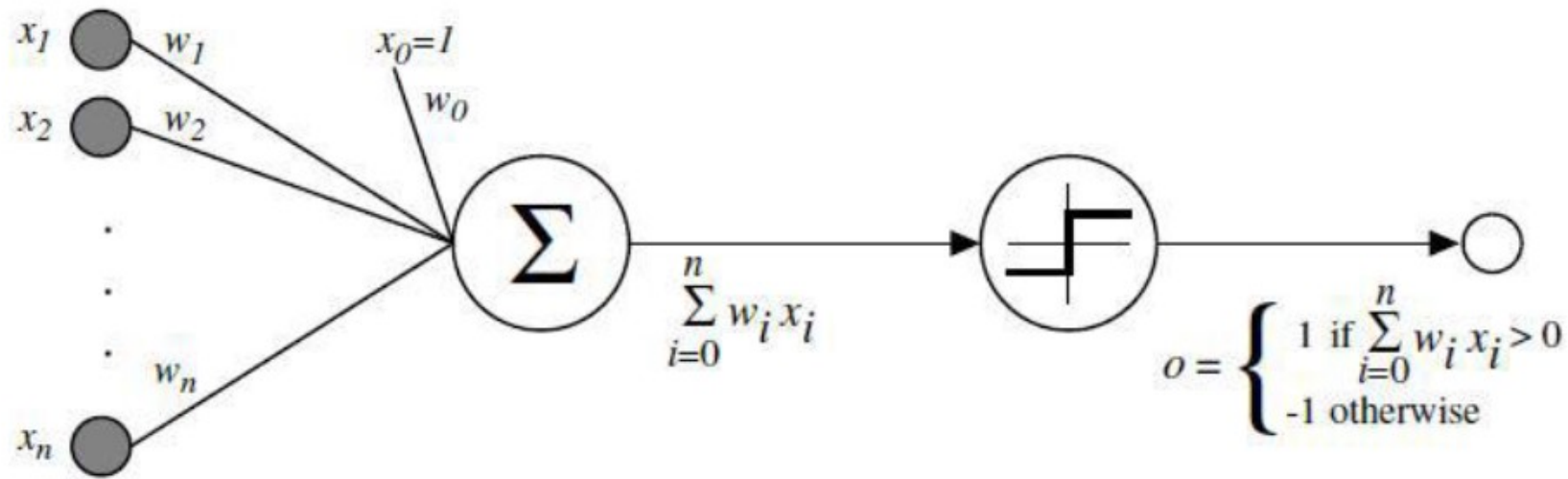


Deep Learning: History (Sources: Wikipedia)

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Rosenblatt proposed **Perceptron** for binary classifications:

- One weight w_i per input x_i
- Multiple weights with respective inputs and add bias $x_0 = +1$
- If the result $>$ threshold, return 1, otherwise 0



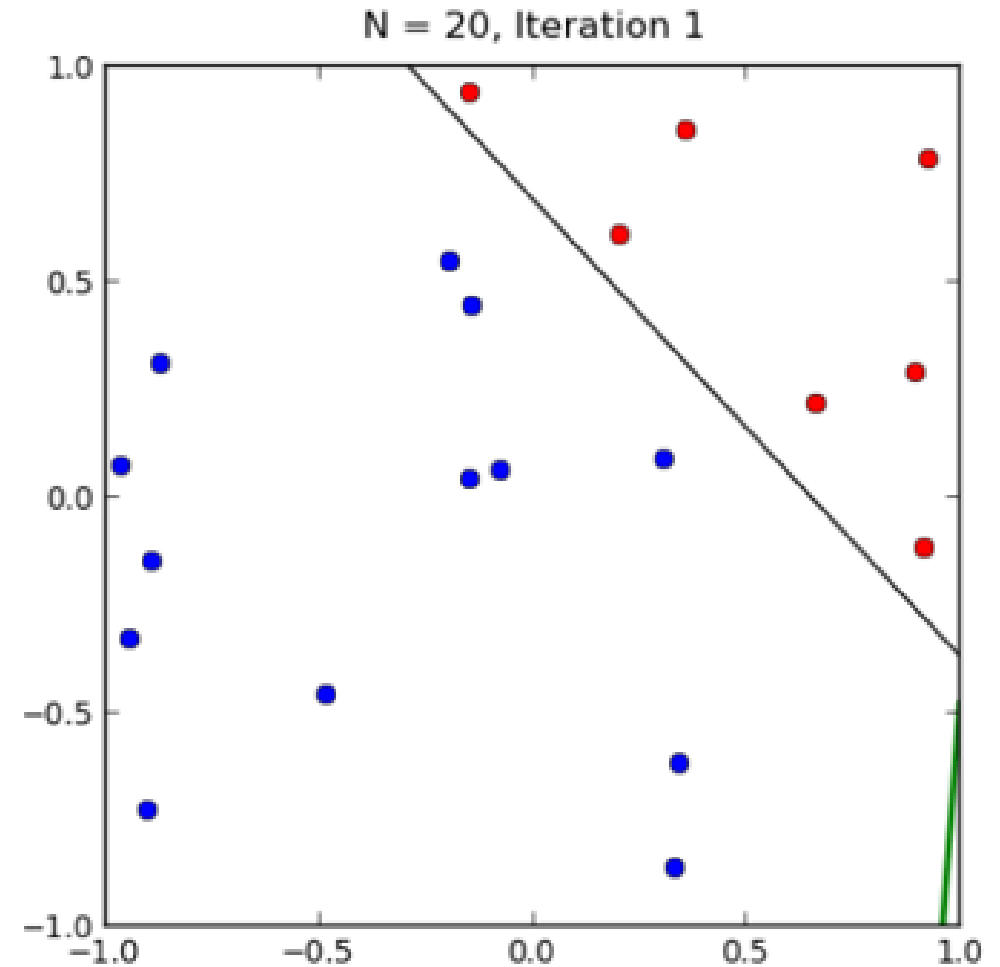
Model of an artificial neuron used for perceptrons (Sources: Wikipedia)

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Training Perceptron

Rosenblatt's main innovation was the invention of a **learning algorithm for perceptron** :

- Initialize weights randomly
- Take one sample x_i and predict y_i
- For erroneous predictions update weights
 - If predicted $y_i = 0$ and the real $y_i = 1$, **increase weights**
 - If predicted $y_i = 1$ and the real $y_i = 0$, **decrease weights**
- Repeat until no errors are made



*Learning Algorithm
of perceptrons (Sources: Wikipedia)*

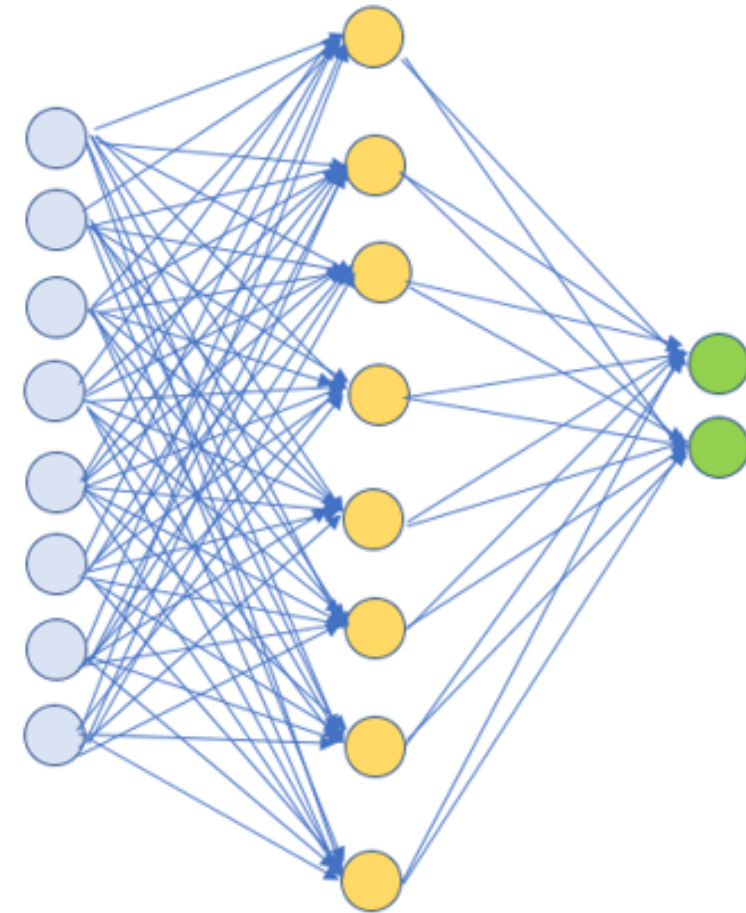
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Multi-layered Perceptrons

- One **perceptron** = One **decision**
- **Multiple decisions**?
 - Requires multiple perceptrons: Layer of perceptrons
 - Stack as many outputs as the possible outcomes into a layer

Multilayer perceptron (MLP)

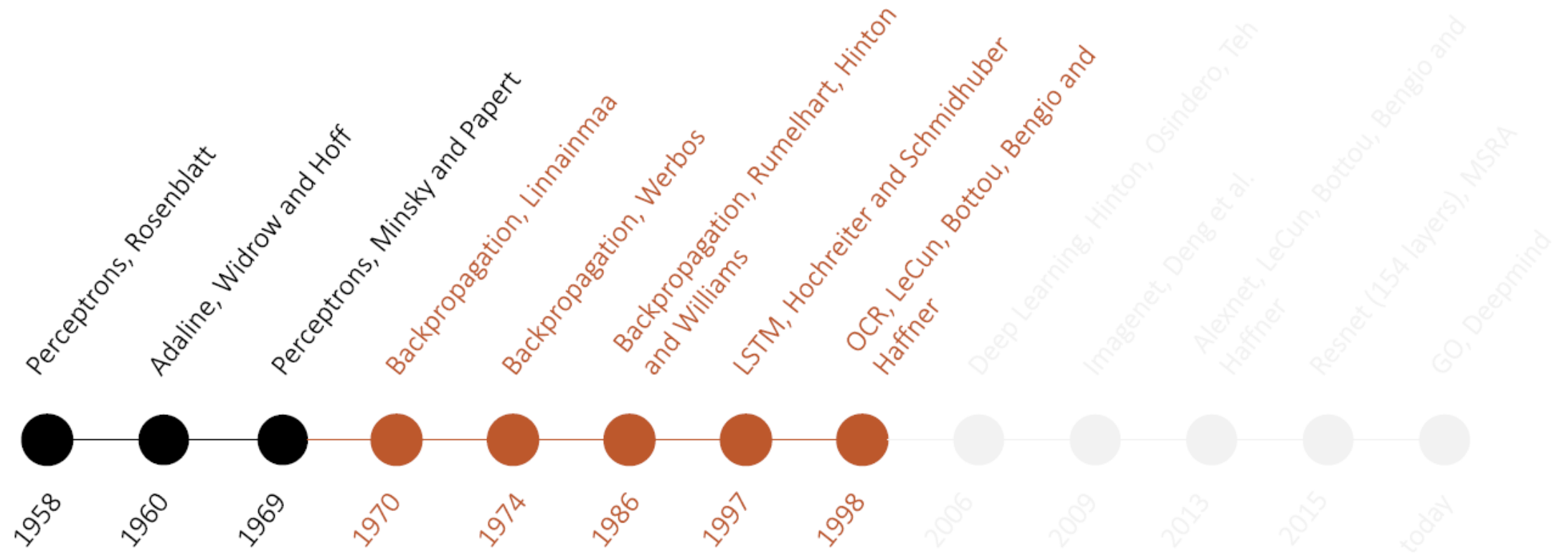
- Use the outputs from one layer as the inputs to the next layer
- Add non-linearities between layers



Multilayer Perceptron (MLP)

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Multi-Layered Perceptrons (Proposed by Minsky)



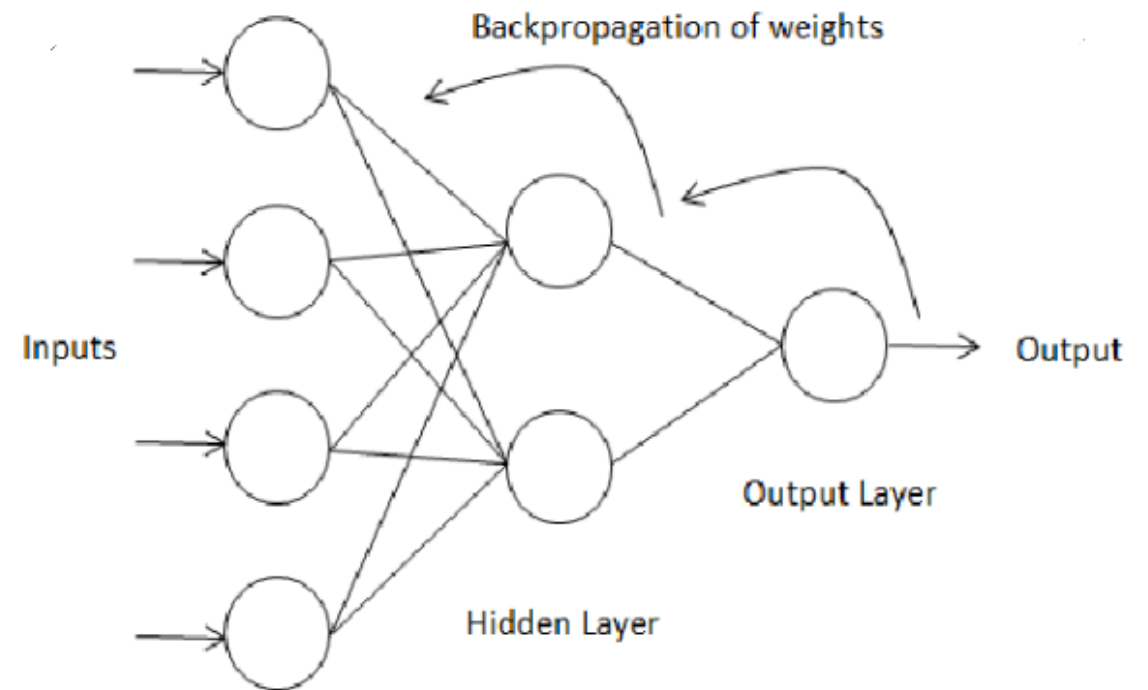
Deep Learning: History (Sources: Wikipedia)

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AI: Machine Learning & Deep Learning: Second Wave (1970 – 1999)

- AI progresses were stalled for decades.

- However, significant progress was made during this period:
 - **Backpropagation:**
 - Learning algorithm for multi-layered perceptrons (MLPs)
 - **Recurrent neural networks:**
 - Neural networks for infinite sequences

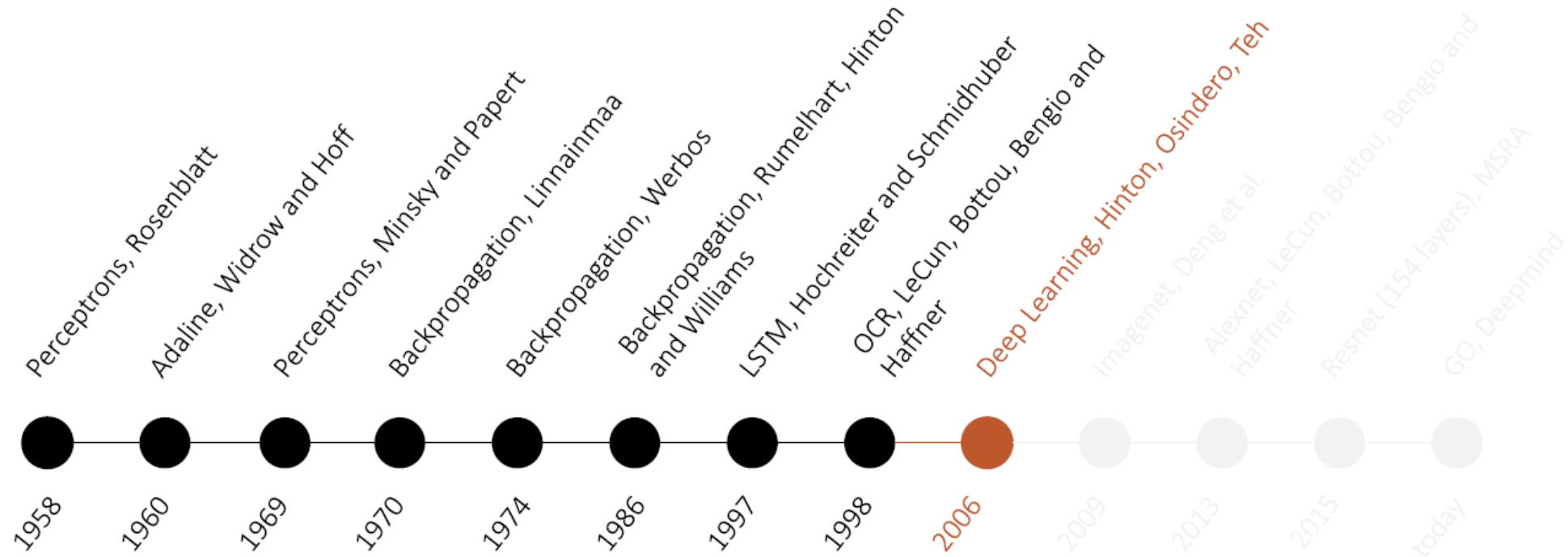


*Deep Learning: back Propagation Algorithm
(Sources: Rozaida Ghazali)*

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AI: Machine Learning & Deep Learning: Third Wave (2006 – Present)

- The “Breakthrough”

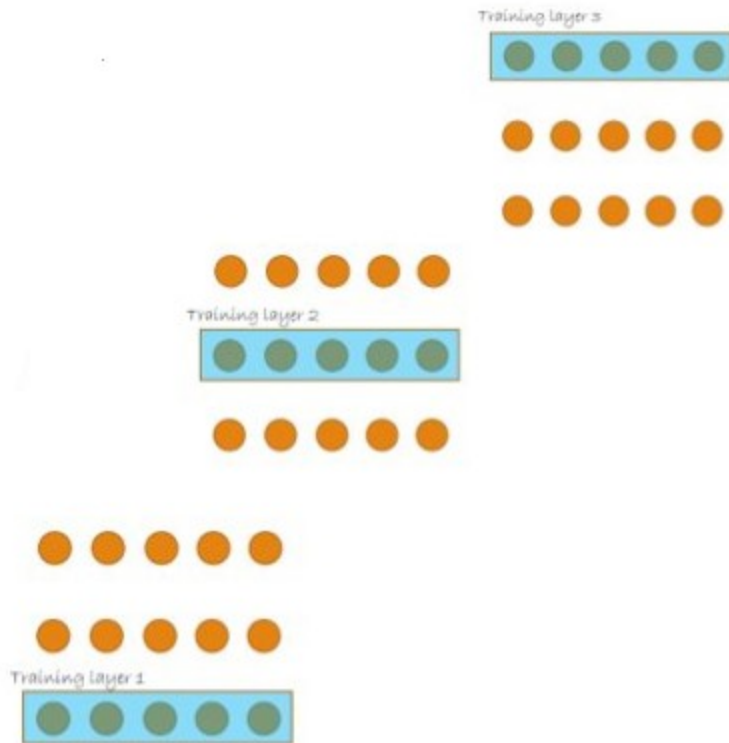


Machine Learning and Deep learning: History (Sources: Wikipedia)

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AI: Machine Learning & Deep Learning: Third Wave (2006 – Present)

- The Breakthrough: The Advent of Deep Learning



Layer by Layer Training (Sources: Wikipedia)

Layer-by-Layer Training:

- Training each layer, individually, is much easier to be done.

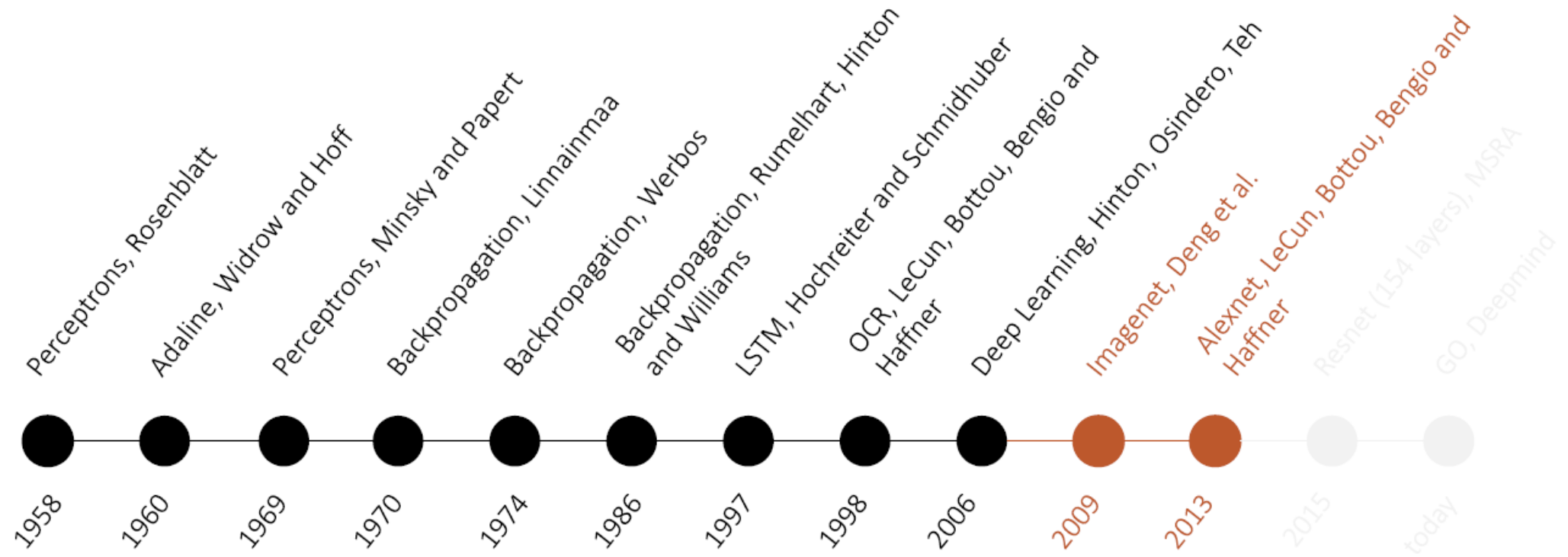
Training multi-layered neural networks became easier

- Use the outputs from one layer as the inputs to the next layer

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AI: Machine Learning & Deep Learning: Third Wave (2006 – Present)

- The Breakthrough: The Advent of Deep Learning



Machine Learning and Deep learning: History (Sources: Wikipedia)

Slide 29: Overview of AI – Machine Learning & Deep Learning

AI: Machine Learning & Deep Learning: Third Wave (2006 – Present)

- Deep Learning & Big Data: A Match in Heaven

ImageNet Dataset:

- In 2009: ImageNet was published
- 16 million images:
 - Collected images for each of the 100,000 terms in Wordnet

Imagenet Large Scale Visual Recognition Challenge (ILSVRC):

- 1,000,000 images
- 1,000 classes

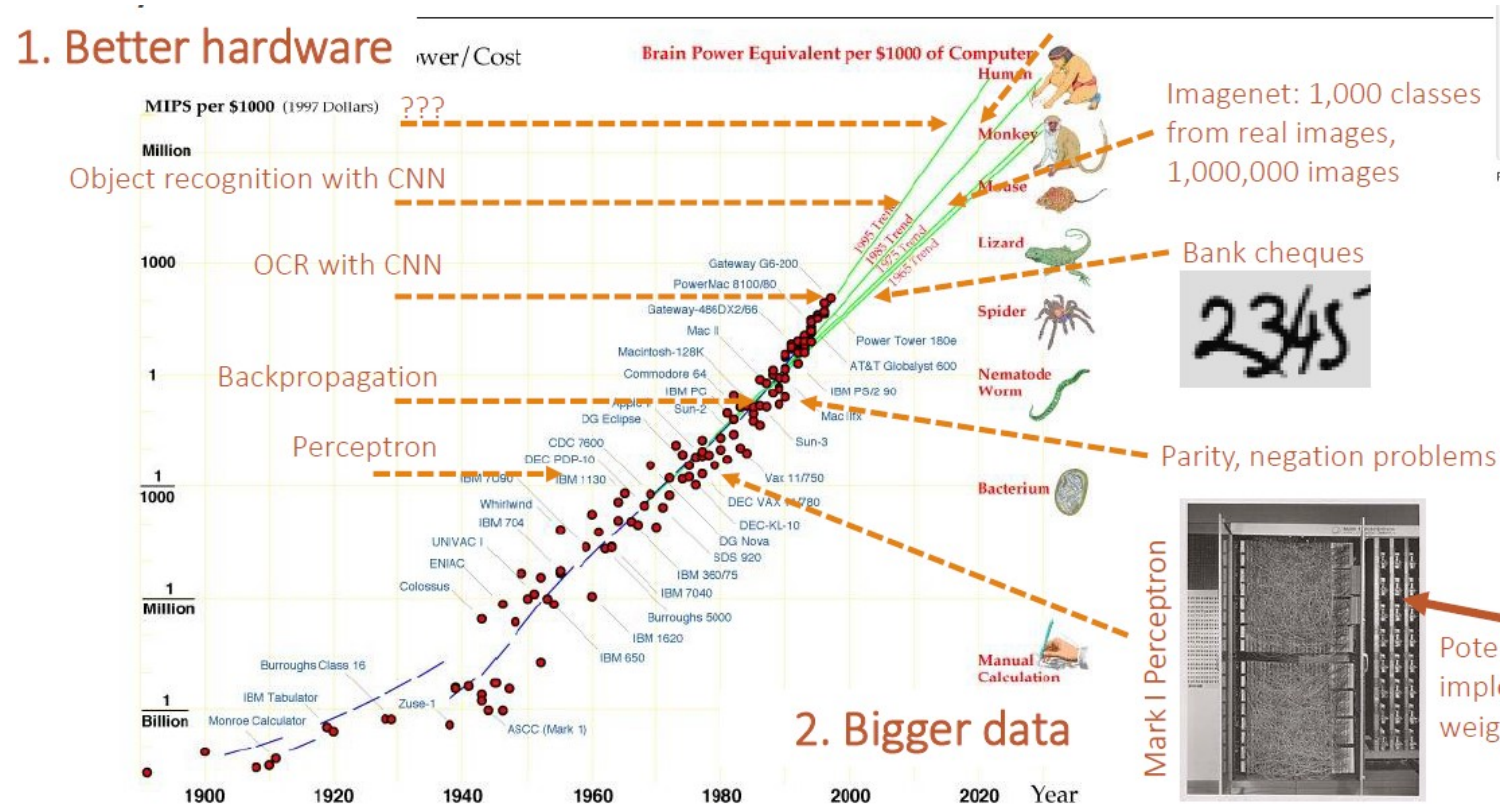


Imagenet Dataset (Sources: image-net.org)

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AI: Machine Learning & Deep Learning: Third Wave (2006 – Present)

- Deep Learning & Big Data: A Powerful Combination

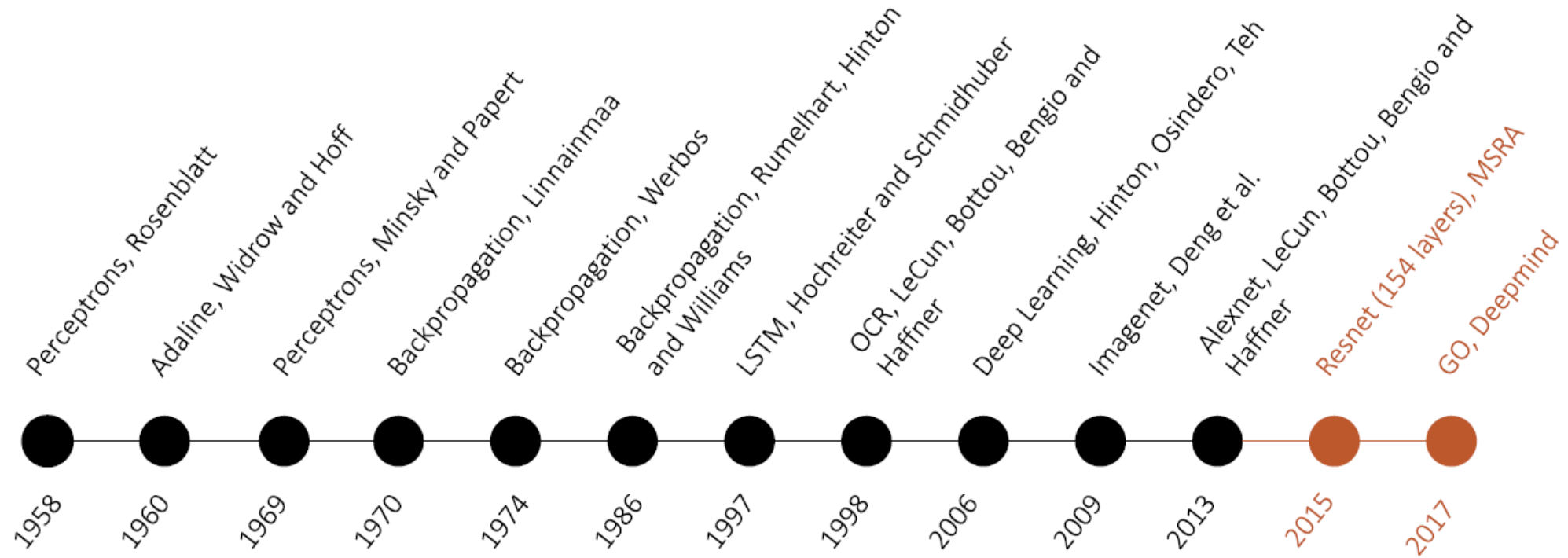


Deep Learning and Big Data: A Powerful Combination (Sources: Wikipedia)

Slide 31: Overview of AI – Machine Learning & Deep Learning

AI: Machine Learning & Deep Learning: Third Wave (2006 – Present)

- Deep Learning & Big Data: **Deep Learning Era**



Machine Learning and Deep learning: History (Sources: Wikipedia)