



DEEP LEARNING FOUNDATION & APPLICATION

WITH A FOCUS ON MEDICAL INFORMATICS

Ahmad P. Tafti, PhD
Division of Digital Health Sciences
Mayo Clinic
<http://aptafti.github.io>



ARTIFICIAL INTELLIGENCE AND DEEP LEARNING; WHAT AND WHY?



The screenshot shows the ACM A.M. Turing Award website. At the top, there's a header with the ACM logo, the text 'A.M. TURING AWARD', and a grid of 24 small portraits of past winners. Below the header, there's a navigation bar with three tabs: 'ALPHABETICAL LISTING', 'YEAR OF THE AWARD', and 'RESEARCH SUBJECT'. The 'ALPHABETICAL LISTING' tab is selected. The main content area is titled 'FATHERS OF THE DEEP LEARNING REVOLUTION RECEIVE ACM A.M. TURING AWARD' and 'Bengio, Hinton, and LeCun Ushered in Major Breakthroughs in Artificial Intelligence'. It features three large portraits of the winners: Yann LeCun, Yoshua Bengio, and Geoffrey E. Hinton. To the right of the portraits, there's a text block describing their achievements and the significance of their work in deep learning.

Yann LeCun

Yoshua Bengio

Geoffrey E Hinton

FATHERS OF THE DEEP LEARNING REVOLUTION RECEIVE ACM A.M. TURING AWARD
Bengio, Hinton, and LeCun Ushered in Major Breakthroughs in Artificial Intelligence

ACM named Yoshua Bengio, Geoffrey Hinton, and Yann LeCun recipients of the 2018 ACM A.M. Turing Award for conceptual and engineering breakthroughs that have made deep neural networks a critical component of computing. Bengio is Professor at the University of Montreal and Scientific Director at Mila, Quebec's Artificial Intelligence Institute; Hinton is VP and Engineering Fellow of Google, Chief Scientific Adviser of The Vector Institute, and University Professor Emeritus at the University of Toronto; and LeCun is Professor at New York University and VP and Chief AI Scientist at Facebook.

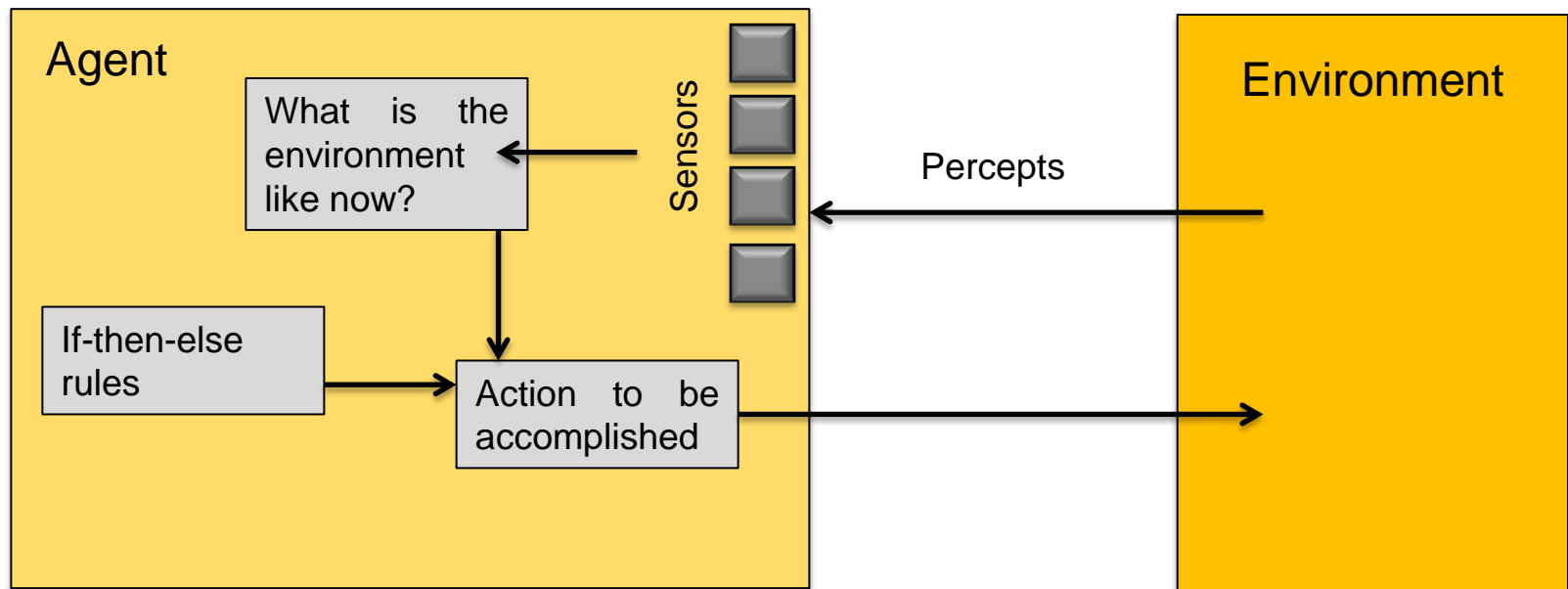
Working independently and together, Hinton, LeCun and Bengio developed conceptual foundations for the field, identified surprising phenomena through experiments, and contributed engineering advances that demonstrated the practical advantages of deep neural networks. In recent years, deep learning methods have been responsible for astonishing breakthroughs in computer vision, speech recognition, natural language processing, and robotics—among other applications.

While the use of artificial neural networks as a tool to help computers recognize patterns and simulate human intelligence had been introduced in the 1980s, by the early 2000s, LeCun, Hinton and Bengio were among a small group who remained committed to this approach. Though their efforts to rekindle the AI community's interest in neural networks were initially met with skepticism, their ideas recently resulted in major technological advances, and their methodology is now the dominant paradigm in the field.

Photos and Content are from:
<https://amturing.acm.org/>

ARTIFICIAL INTELLIGENCE AND DEEP LEARNING; WHAT AND WHY?

- **AI** is all about computerized models targeting at **Perception**, and **Action**.
- It **solves a problem, optimally**.
- It **figures out (alone)** what is the **best action to take**.



AI SUB-SYSTEMS

- Speech Recognition
- Natural Language Processing
- Computer Vision
- Robotics

RULE-BASED VERSUS LEARNING-BASED AI

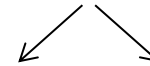


Step



Door

How to implement **singularities**???

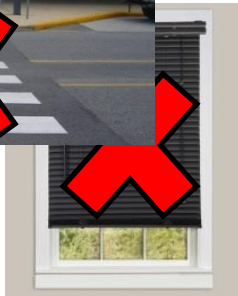
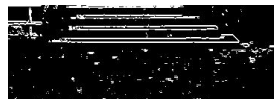
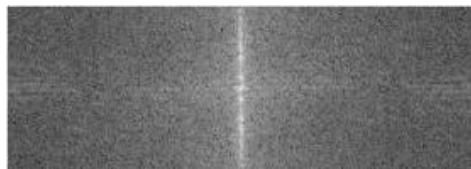


Rule-based algorithms

Learning-based algorithms

Deep and machine learning strategies vs. **Traditional** (rule-based) methods

Traditional (there is no any learning technique)



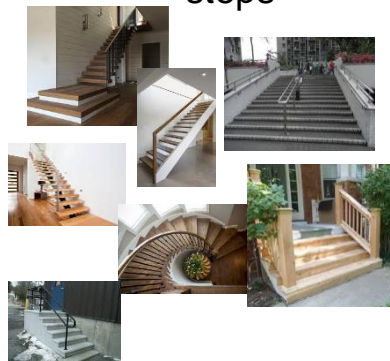
Deep and machine learning techniques

We train computers at recognizing doors from steps by showing them a **large amount** of:

(**object_type**, **picture**) pairs.



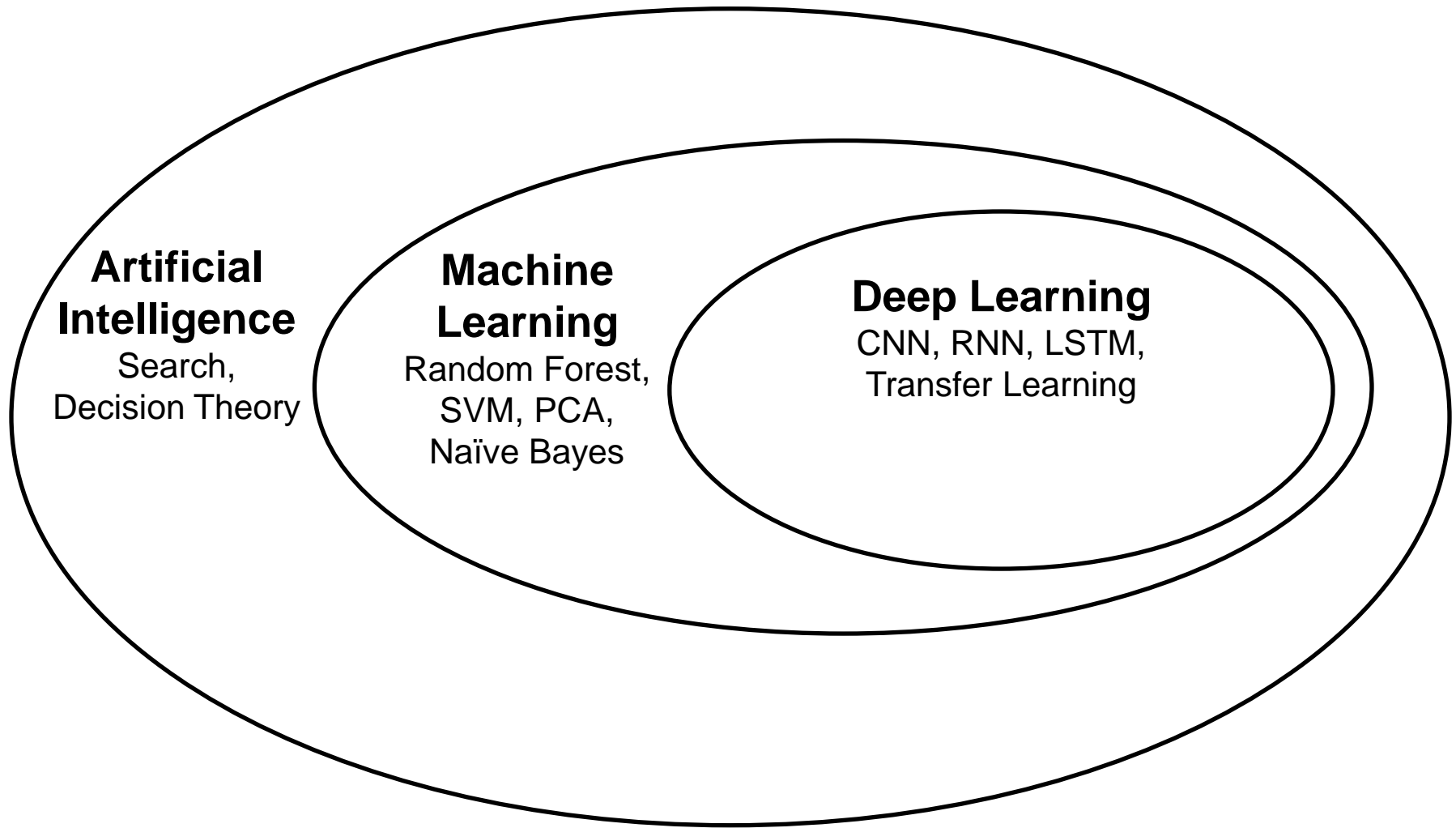
steps



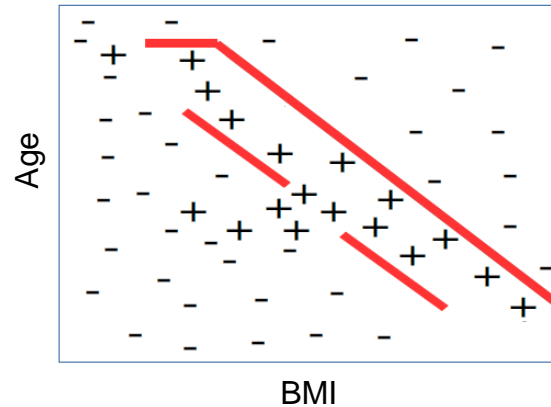
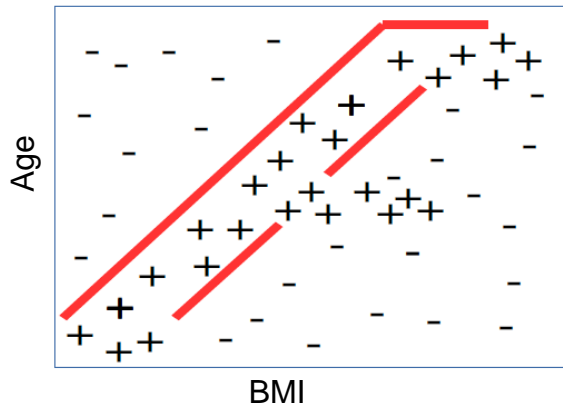
doors



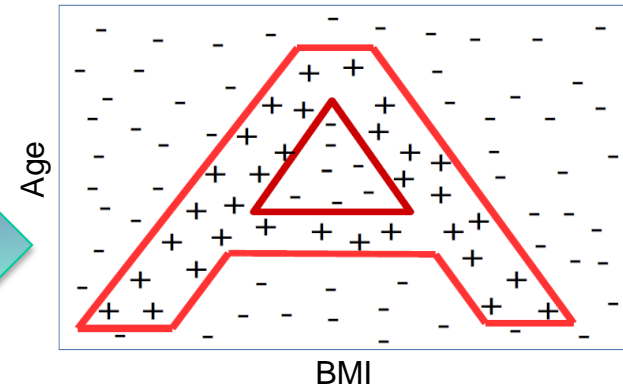
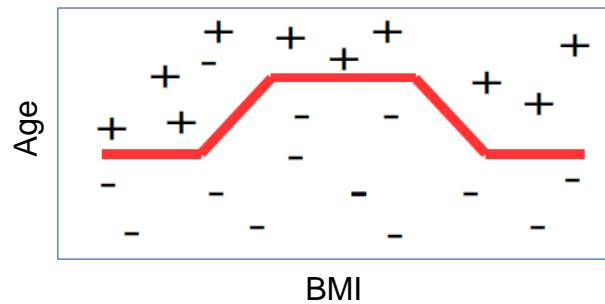
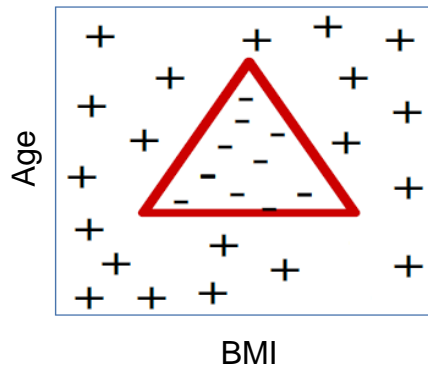
DEEP LEARNING; WHAT AND WHY?



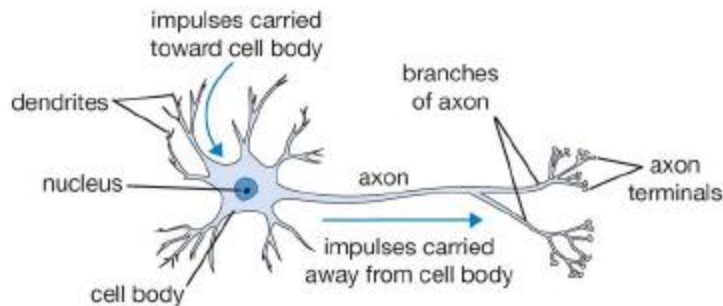
DEEP LEARNING; WHAT AND WHY?



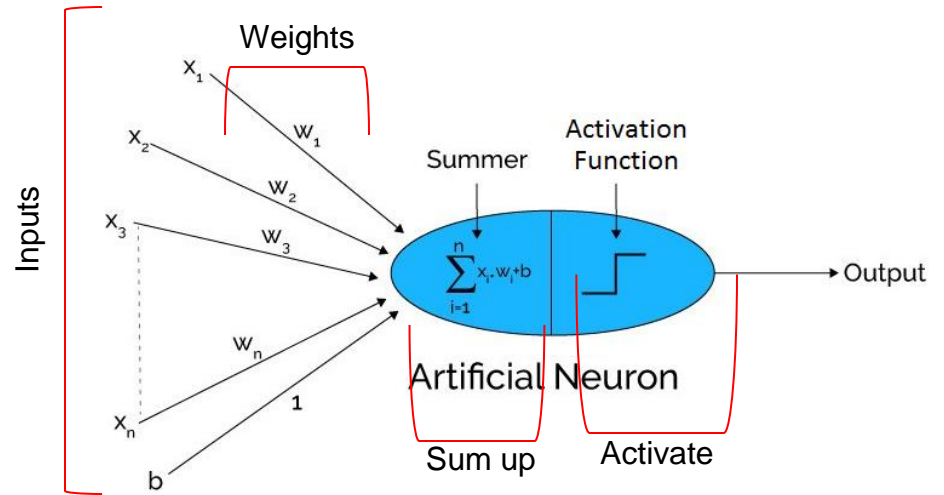
Data amount is being increased, and the model tends to be a complex one



DEEP LEARNING; WHAT AND WHY?



Neuron: Computational building block for the “Brain”
Human Brain: ~100 to 1000 trillion synapses



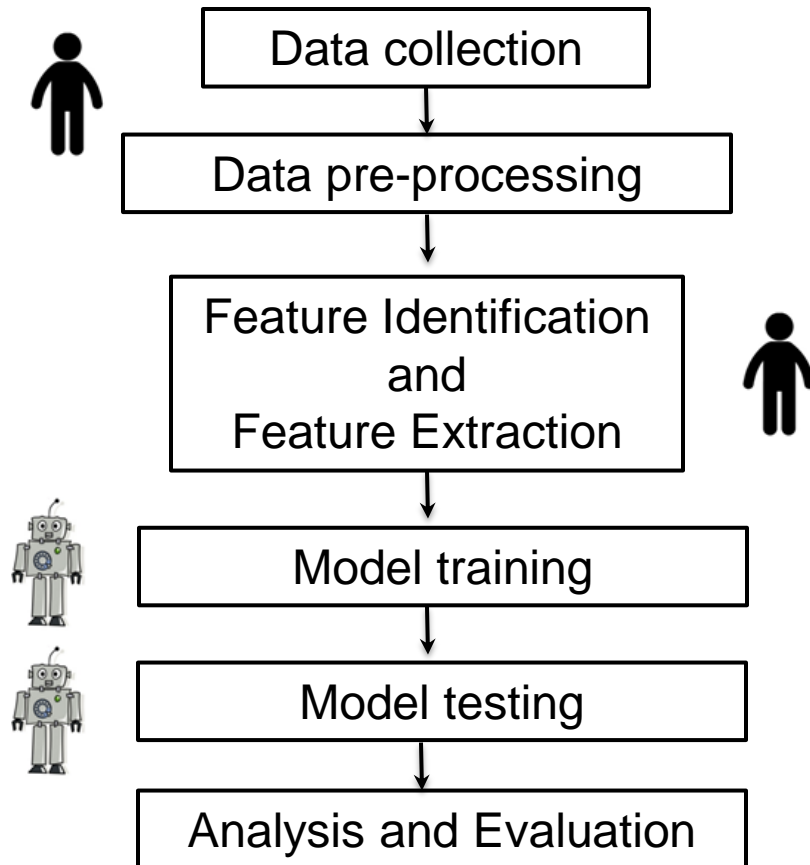
Artificial Neuron: Computational building block for the “Neural Networks”

Neural Network: ~1 to 10 billion synapses

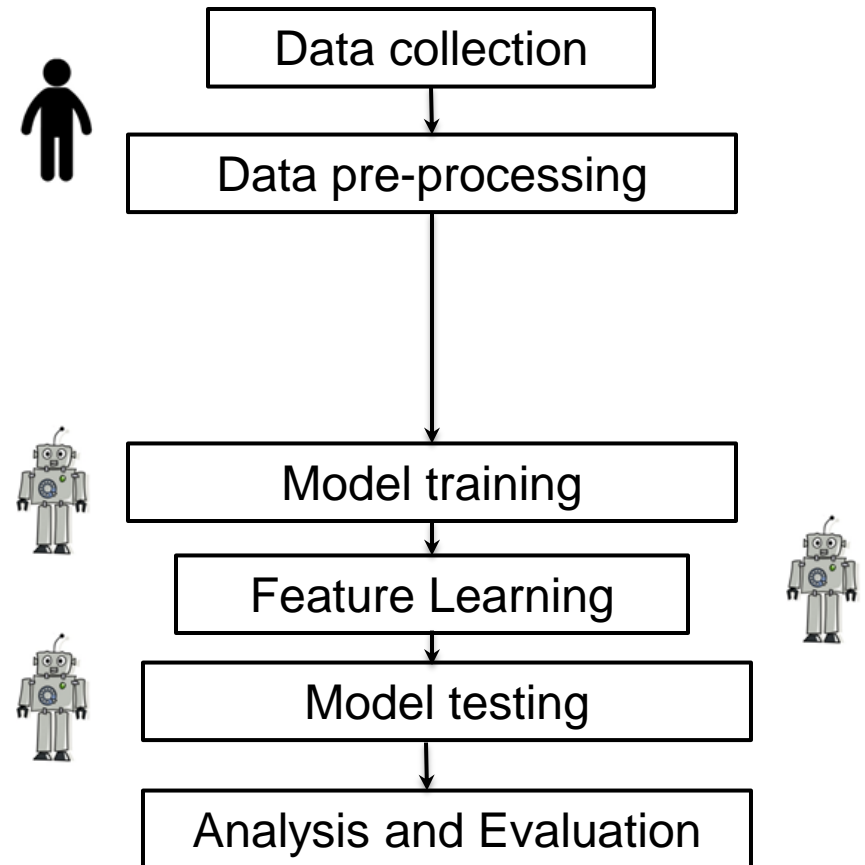
1 0 0 0 0
 1 1 1 0 0 0 0 0 0
 1 1 1 0 0 0 0

Universality: for any arbitrary function $f(x)$, there exists a neural network that closely approximates it for any input x .

DEEP LEARNING; WHAT AND WHY?

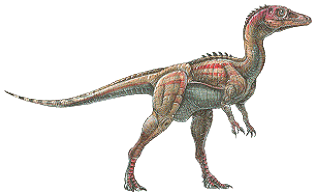


Machine Learning

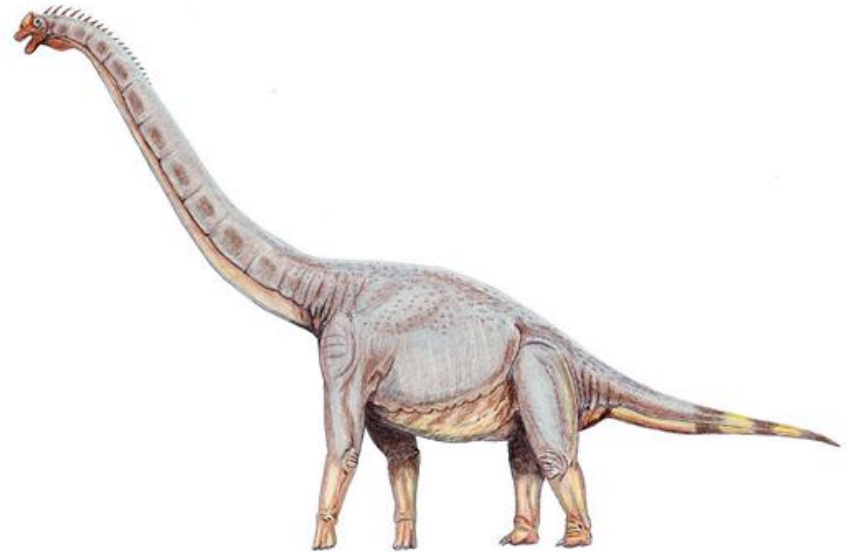


Deep Learning

DEEP LEARNING; WHAT AND WHY?



Machine Learning



Deep Learning

REFERENCES

