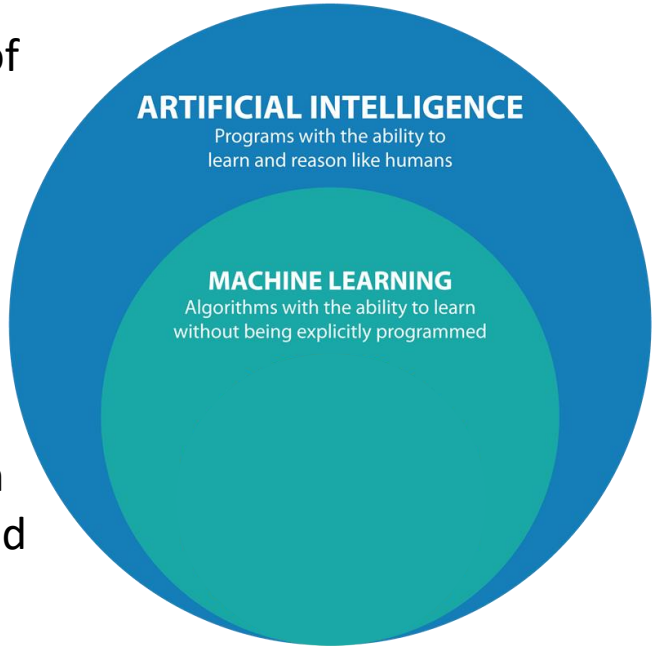
Neural networks

Prof. Asim Tewari
IIT Bombay

What is Artificial Intelligence ?

Artificial Intelligence : (Merriam-Webster) The capability of a machine to imitate **intelligent** human behavior.

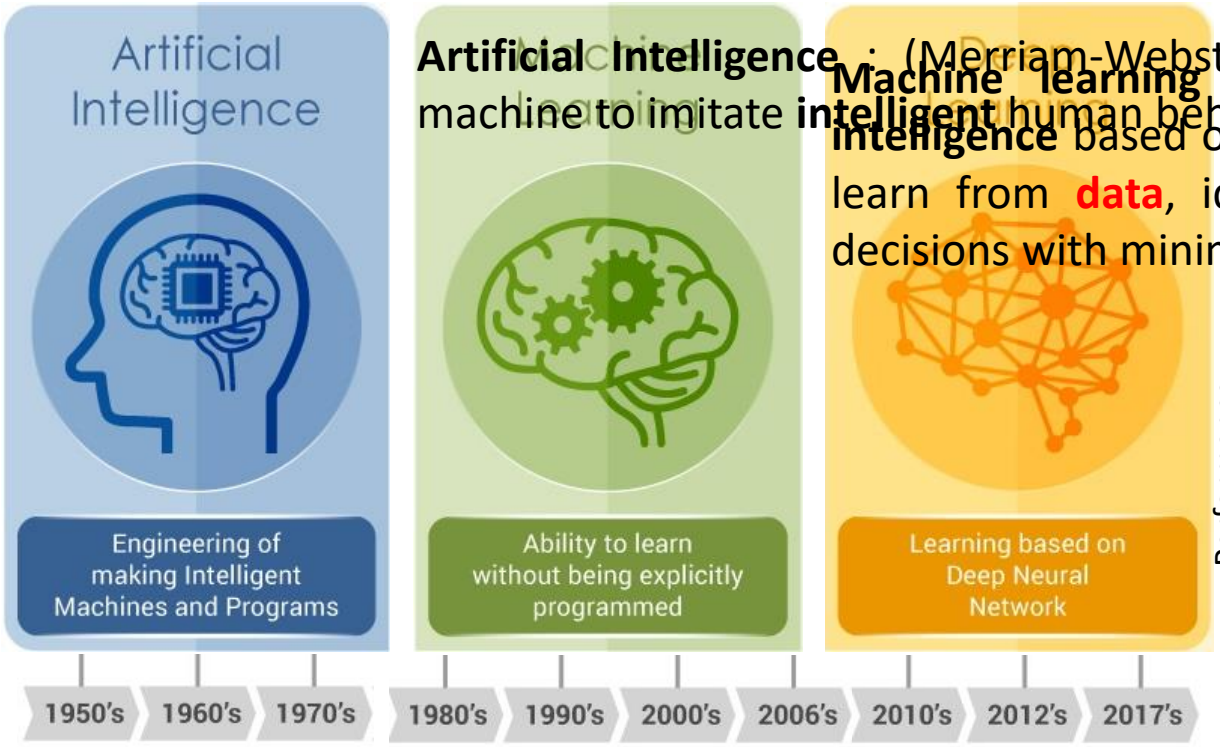


What is Machine Learning ?

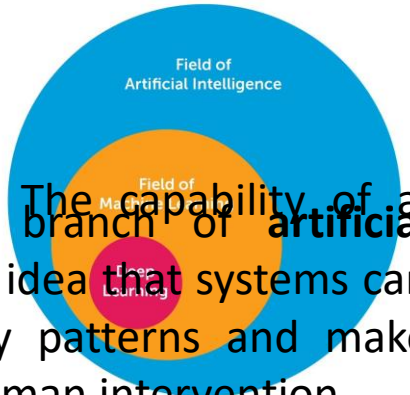
Machine learning is a branch of **artificial intelligence** based on the idea that systems can learn from **data**, identify patterns and make decisions with minimal human intervention.

Prof. Asim Tewari, IIT Bombay

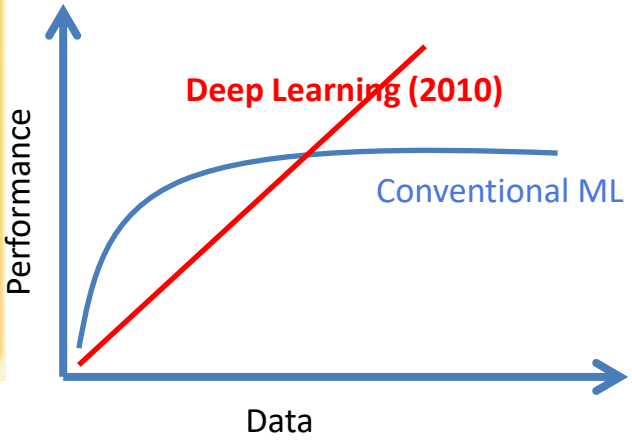
Evolution of Artificial Intelligence



Artificial Intelligence : (Merriam-Webster) The capability of a machine to imitate **intelligent** human behavior.

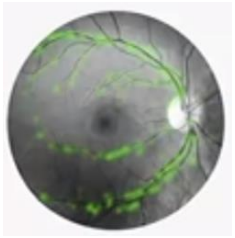


Machine learning is a branch of **artificial intelligence** based on the idea that systems can learn from **data**, identify patterns and make decisions with minimal human intervention.



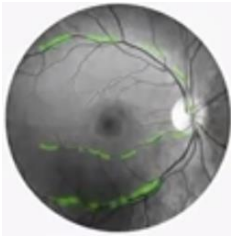
Google DL Retinopathy

Image of retina

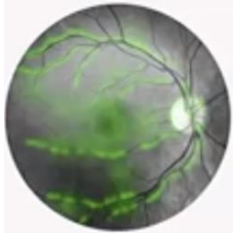


Age
Predicted: 59.1 years
Actual: 57.6 years

Biological Sex
Predicted: Female
Actual: Female

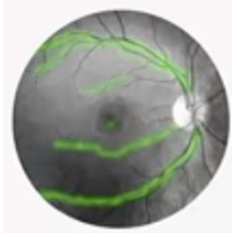


Smoking
Predicted: Non-smoking
Actual: Non-smoking



A1C
Predicted: Non-diabetic
Actual: Non-diabetic

BMI
Predicted: 24.1 kg/m
Actual: 26.3 kg/m



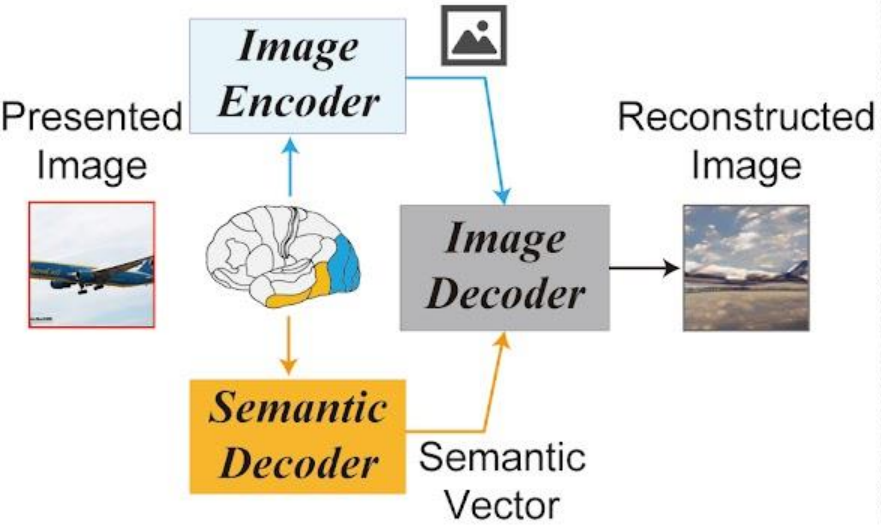
Systolic blood Pressure
Predicted: 148.0 mmHg
Actual: 148.5 mmHg

Lip-reading AI

Google's DeepMind
- AI trained on 5000 hours of TV
- 118,000 sentences

Other resources: LipNet AI, WAS
LipNet: End-to-End Sentence-level Lipreading, 2016

Brain image reconstruction with latent diffusion models



Yu Takagi, Shinji Nishimoto, CVPR, 2023
doi: https://doi.org/10.1101/2022.11.18.517004


What is common in all these persons?

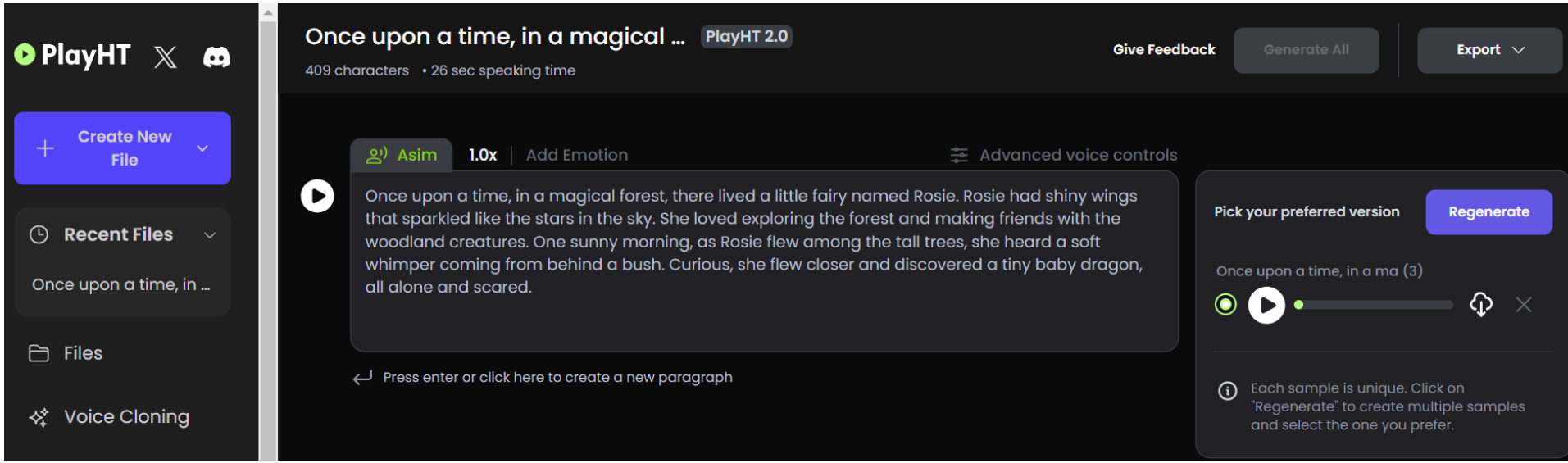
What can Artificially intelligent not do?

https://beta.dreamstudio.ai/generate


SOUNDRAW
Create Music
License
FAQ
API for businesses
Hip Hop
Trap
Drill
R&B
Jersey Club
Latin
Acoustic
Rock
Ambient
Beats
Drum n Bass
Electro & Dance
Funk
Tokyo night pop
Pop
Lofi Hip Hop
World
Electronica
Orchestra
Tropical House
Afrobeats
Christmas
Glamorous
001
Pop
Glamorous
139 BPM
3:01
002
Latin, Ele...
Glamorous
100 BPM
3:04
Pro
0:00
0:09
0:19
0:28
0:38
0:48
0:57
1:07
https://soundraw.io/edit_music?length=180&tempo=normal,high,low&mood=Glamorous
Energy
Low
Medium
High
High
Medium
Medium
Medium
Low

Generate AI Voices, Indistinguishable from Humans

https://play.ht



Forbes

FORBES > INNOVATION > SCIENCE

This AI-Generated Influencer Can Pull In Almost $11,000 A Month

Nov 24, 2023

Prof. Asim Tewari, IIT Bombay

Meet Naina (https://www.instagram.com/naina_avtr/)

CNN World Africa Americas Asia Australia China Europe India Middle East United Kingdom

World / Asia

Finance worker pays out $25 million after video call with deepfake ‘chief financial officer’

By Heather Chen and Kathleen Magramo, CNN

2 minute read · Published 2:31 AM EST, Sun February 4, 2024

Will AI Affect jobs?

The Guardian

Artificial intelligence (AI)

AI will affect 40% of jobs and probably worsen inequality, says IMF head

'Crucial' that countries build social safety nets to mitigate impact on workers, says Kristalina Georgieva

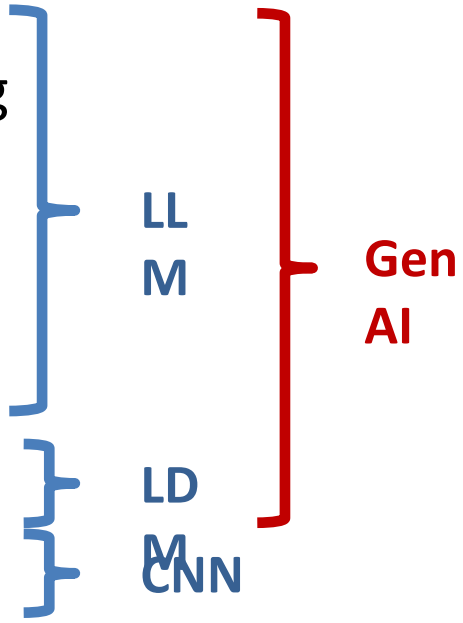
Business live – latest updates

Mon 15 Jan 2024

Who will be the first to get affected?

The first set of jobs lost to AI are:

- Data entry and data cleanup
- General customer support and marketing
- Grammar correction
- Text articles generation
- Small punchline writers
- Entry level programmers
- Creative design artists
- Automobile Drivers



Waymo One

The world's first autonomous ride-hailing service

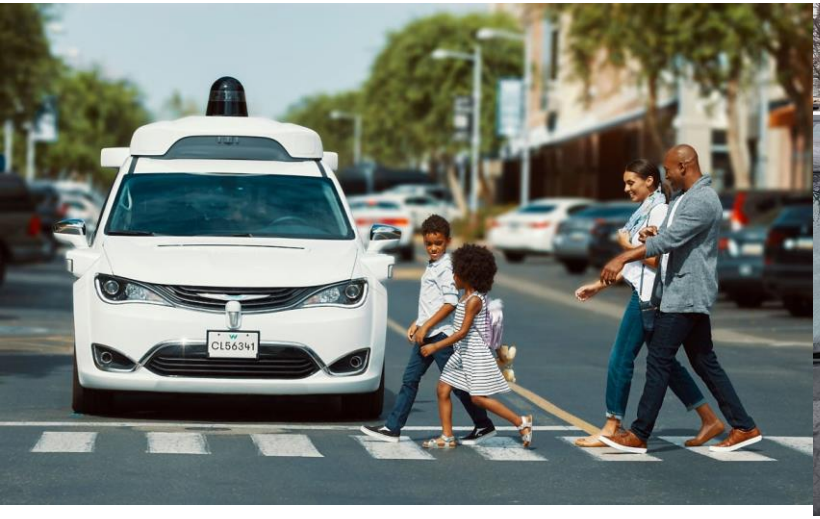
Our service

Phoenix

San Francisco

Los Angeles

Austin



Spot the difference

Easter Parade on Fifth Avenue, New York 1900

Easter Parade on Fifth Avenue, New York 1913

Meet Mika, the world's first AI CEO running a global company

The world's first humanoid CEO, Mika, opens up about what it's like managing a human workforce and the future of corporate leadership.

By Jamie Nonis / JULY 11, 2023

Mika (an AI-powered humanoid robot) is appointed as CEO by the Polish beverage company Dictador.

Projection Pursuit Regression

An input vector X with p components, and a target Y . Let ω_m, m = 1, 2, . . . ,M, be unit p-vectors of unknown parameters. The projection pursuit regression (PPR) model has the form

$$f(X) = \sum_{m=1}^{M} g_m(\omega_m^T X)$$

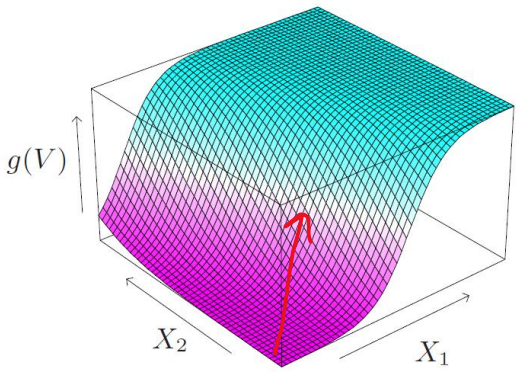
This is an additive model, but in the derived features $V_m = \omega_{Tm} X$ rather than the inputs themselves. The functions g_m are unspecified and are estimated along with the directions m using some flexible smoothing method.

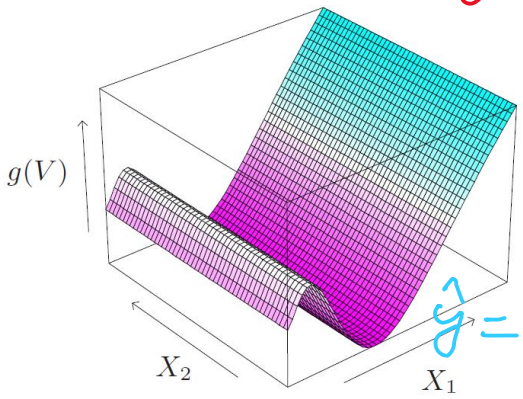
We seek the approximate minimizers of the error function

$$\sum_{i=1}^{N} \left[y_i - \sum_{m=1}^{M} g_m(\omega_m^T x_i) \right]^2$$

Projection Pursuit Regression

$$\hat{y}_i = g_1(\omega_1 x_i) + g_2(\omega_2 x_i) + \cdots + g_m(\omega_m x_i)$$





$\omega = \frac{(1,1)}{\sqrt{2}}$

$\hat{y} = g_1(x_1) + g_2(x_2)$

$\omega = (1,0) \rightarrow x_1$

$\omega = (0,1) \rightarrow x_2$

Perspective plots of two ridge functions.

- (Left:) g(V) = 1/[1 + exp(−5(V − 0.5))], where V = (X1 + X2)/p2.
- (Right:) g(V) = (V + 0.1) sin(1/(V/3 + 0.1)), where V = X1.

$\omega_1 = (1,1)/\sqrt{2}$ $\omega_2 = (1,-1)/\sqrt{2}$

$$f(X_1, X_2) \rightarrow X_1 X_2 = \frac{(X_1+X_2)^2 - (X_1-X_2)^2}{4}$$

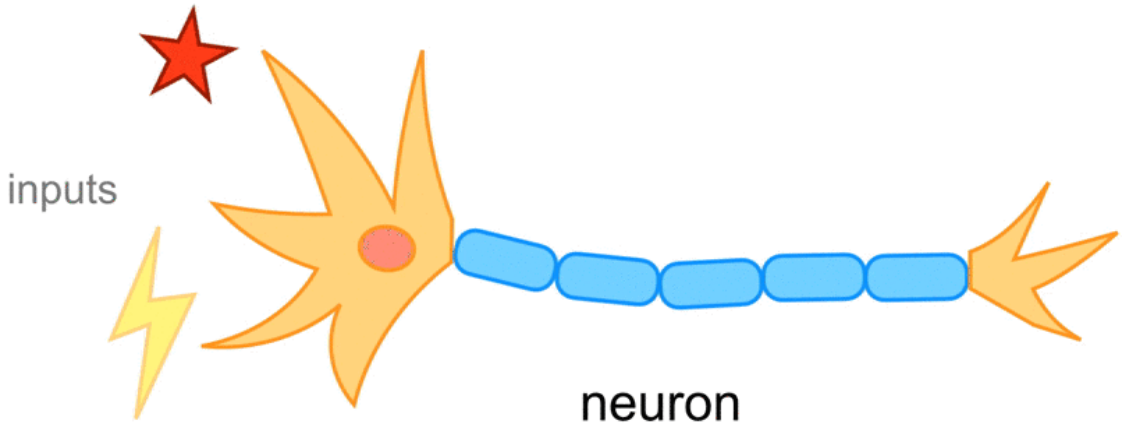
Neural Networks

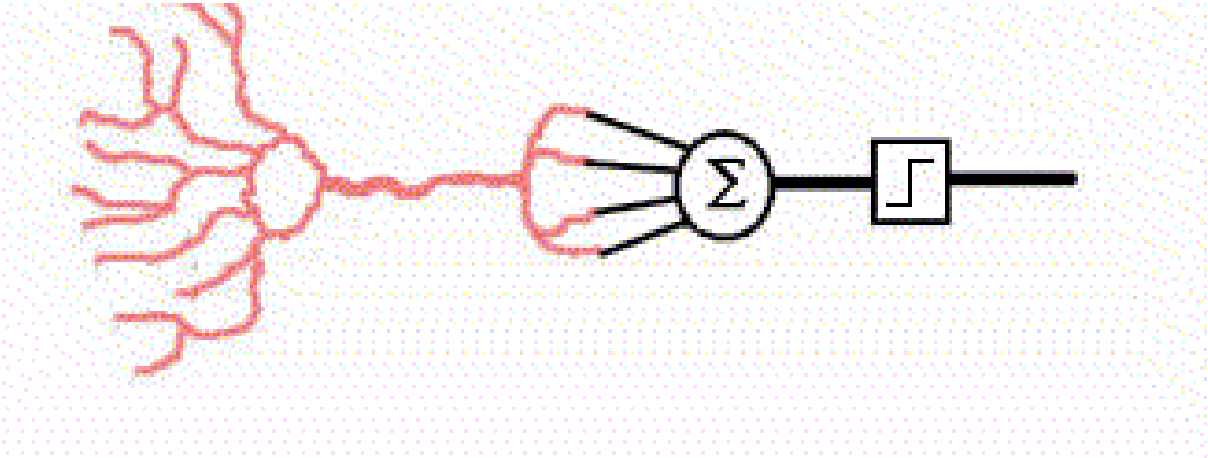
- A popular class of nonlinear regression methods are the so-called universal approximators

A class F of such functions f is called a *universal approximator* if and only if for any $\epsilon > 0$ there exists a function $f^* \in F$ such that

$$|f(x) - f^*(x)| < \epsilon$$

Neuron is a binary switch





Output of a neuron

- The output of each neuron is a real-valued scalar O_i
- The "effective" input to each neuron is the weighted sum of the inputs plus a bias b_i

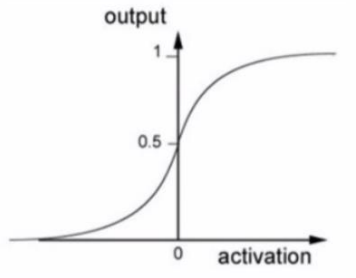
$$I_i = \sum_j w_{ji} O_j + b_i$$

- The output of each neuron is computed from the effective input using a nonlinear *activation function s*

$$O_i = s(I_i)$$

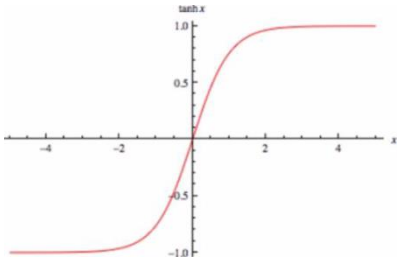
Neuron activation functions

- Frequently used activation functions include
- The *sigmoid* (s-shaped) functions
  - sigmoid(x) = $1/(1 + e^{-x})$

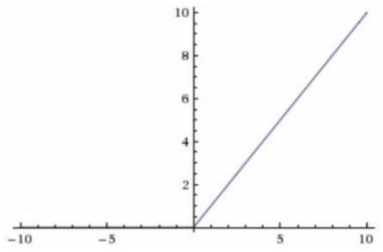


This is same as logistic regression

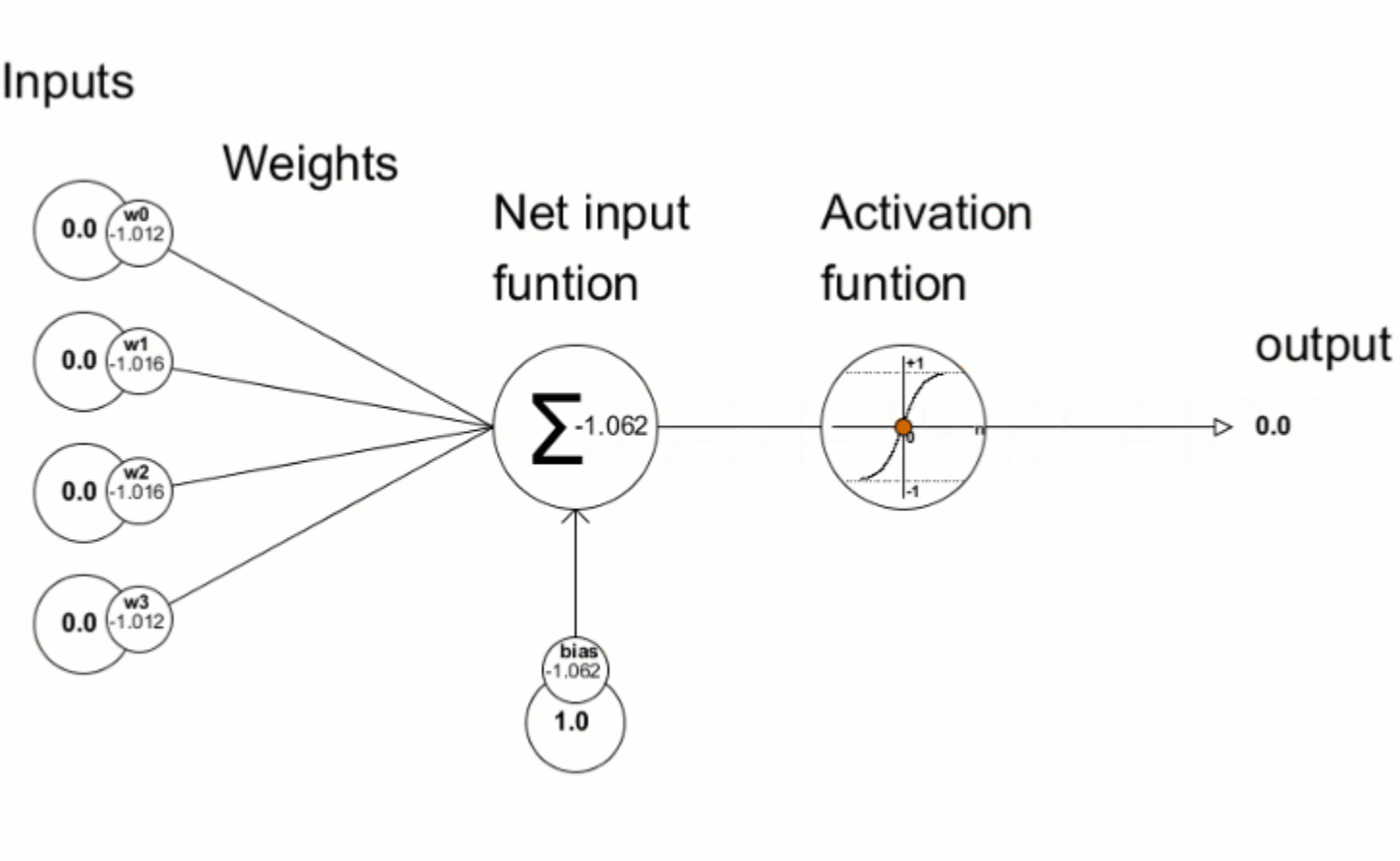
- The hyperbolic tangent function
  - tanh(x) = $(e^{x} - e^{-x})/(e^{x} + e^{-x})$



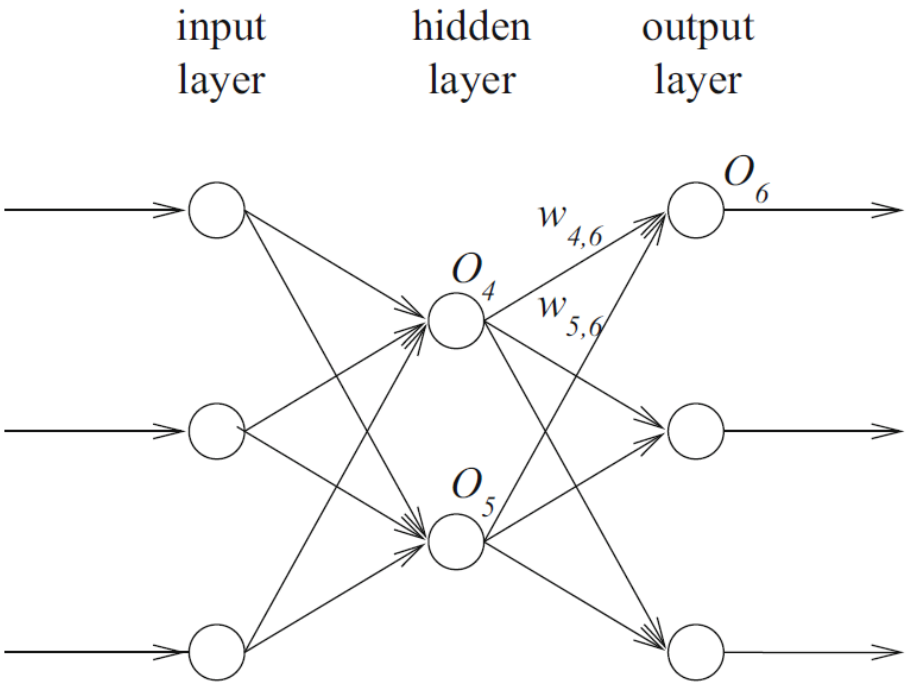
- The rectifier Linear Unit (relu)
  - relu(x) = max(0,x)



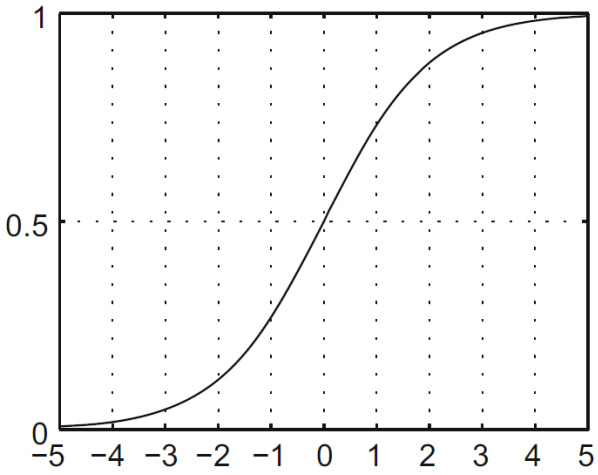
ANN and smooth switch



Multilayer perceptron



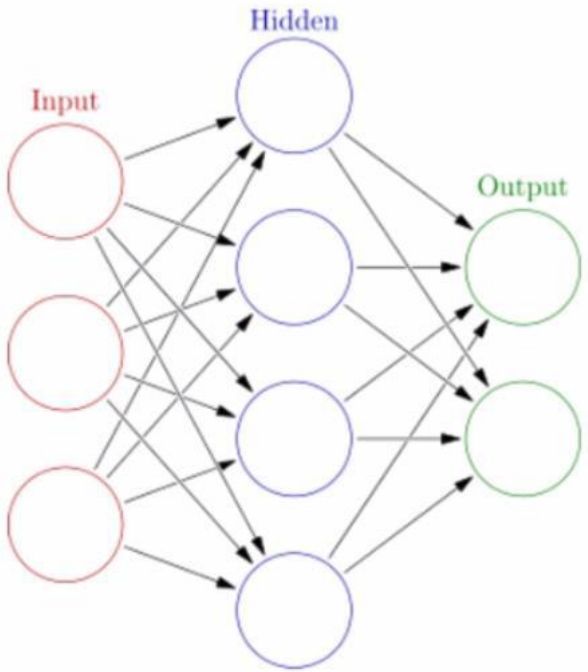
Multilayer perceptron



sigmoidal function

Neural networks

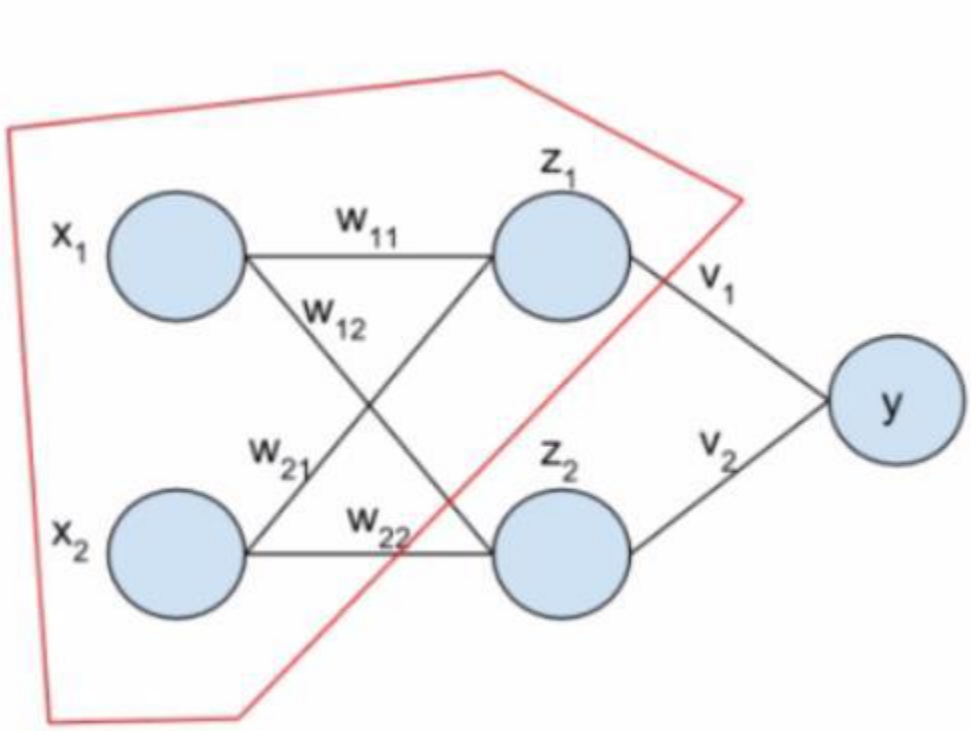
- Hidden layer (one or more)
- From left to right: a node in one layer is connected to every other node in the next layer
- Left-most layer = Input
- Right-most layer = Output



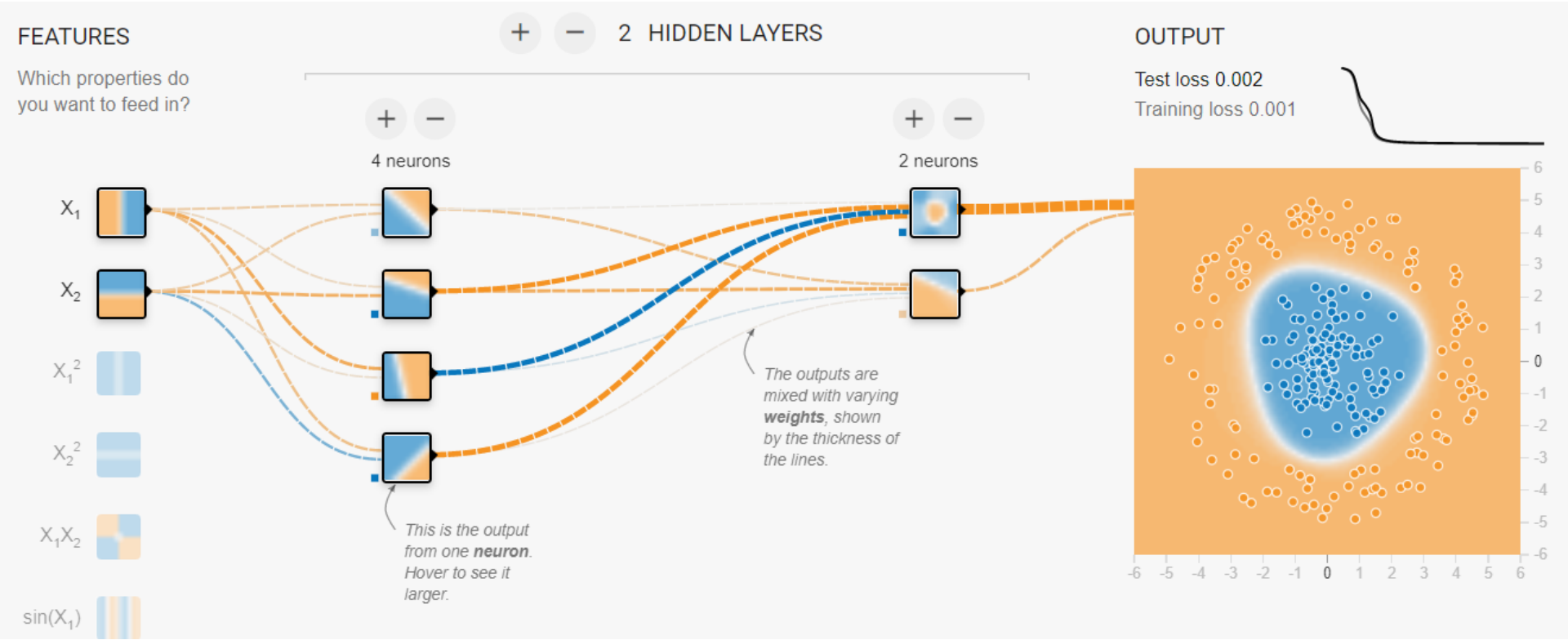
Graphs with nodes and edges

Neural networks

It can be perceived as a multiple layers of logistic regression units



Tinker With a Neural Network



https://playground.tensorflow.org/#activation=tanh&batchSize=10&dataset=circle&regDataset=reg-plane&learningRate=0.03&regularizationRate=0&noise=0&networkShape=4,2&seed=0.75977&showTestData=false&discretize=false&percTrainData=50&x=true&y=true&xTimesY=false&xSquared=false&ySquared=false&cosX=false&sinX=false&cosY=false&sinY=false&collectStats=false&problem=classification&initZero=false&hideText=false