Deep Learning Introduction

California Science and Technology UNIVERSITY

About Me

- Author and Technologist
- Worked for TI, Magma, Apache, Cadence, Paripath and now AITS.
- 20 years n EDA/CAD/ML industry

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- medium.com/@srohit0
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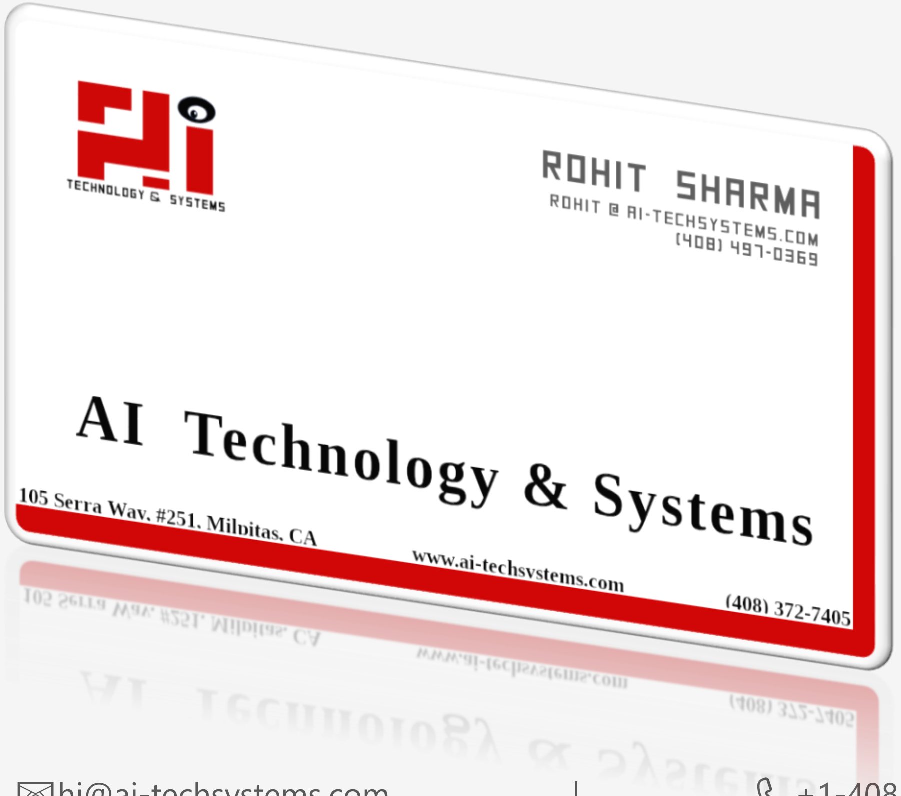
- github.com/srohit0
- twitter.com/srohit



TECHNOLOGY & SYSTEMS

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Course Overview

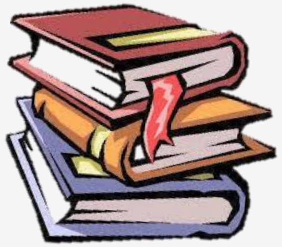
- Pre-requisites
  - basic computer science principles and skills
  - Probability theory
  - Multivariable calculus and Linear algebra
- Applied course with emphasis on real life projects

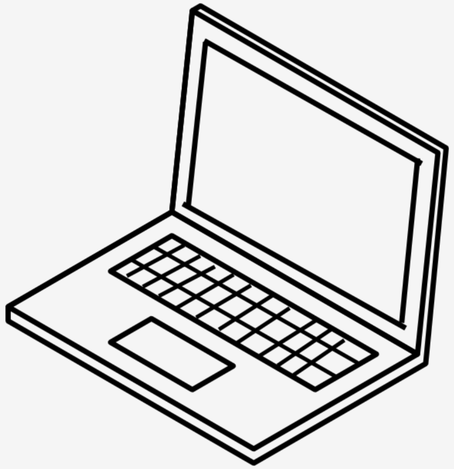
- Math and programming makes it fun and challenging
- Make friends for study groups for projects.
- Reference Book :
  - Machine Intelligence, Rohit Sharma, 2018.
  - srohit0.github.io/mida/

Homework	Quiz	Midterm Project	Final Project	Final Exam	Participation	Total
5%	15%	20%	25%	30%	5%	100%

Material

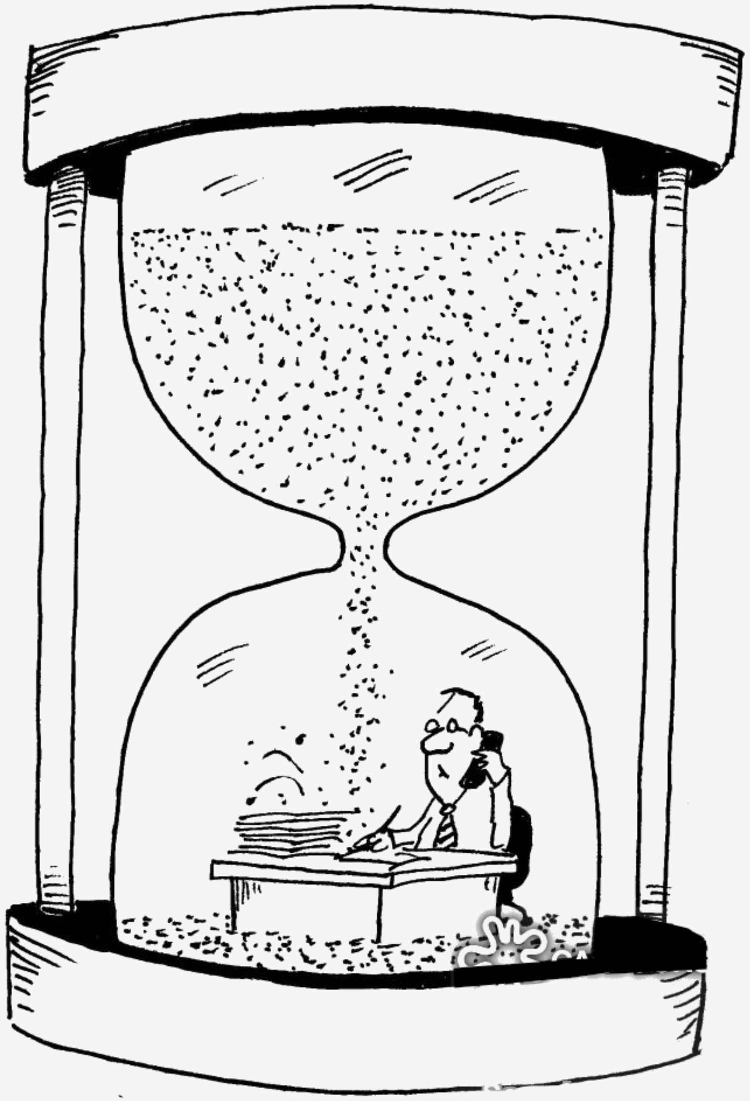
- Text Book:
  - Machine Intelligence by Rohit Sharma
- References Material:
  - Python Machine Learning, 2nd Edition, by Sebastian Raschka
  - Deep Learning, by Ian Goodfellow
- Software
  - Python
  - Google Colab or Jupyter notebook



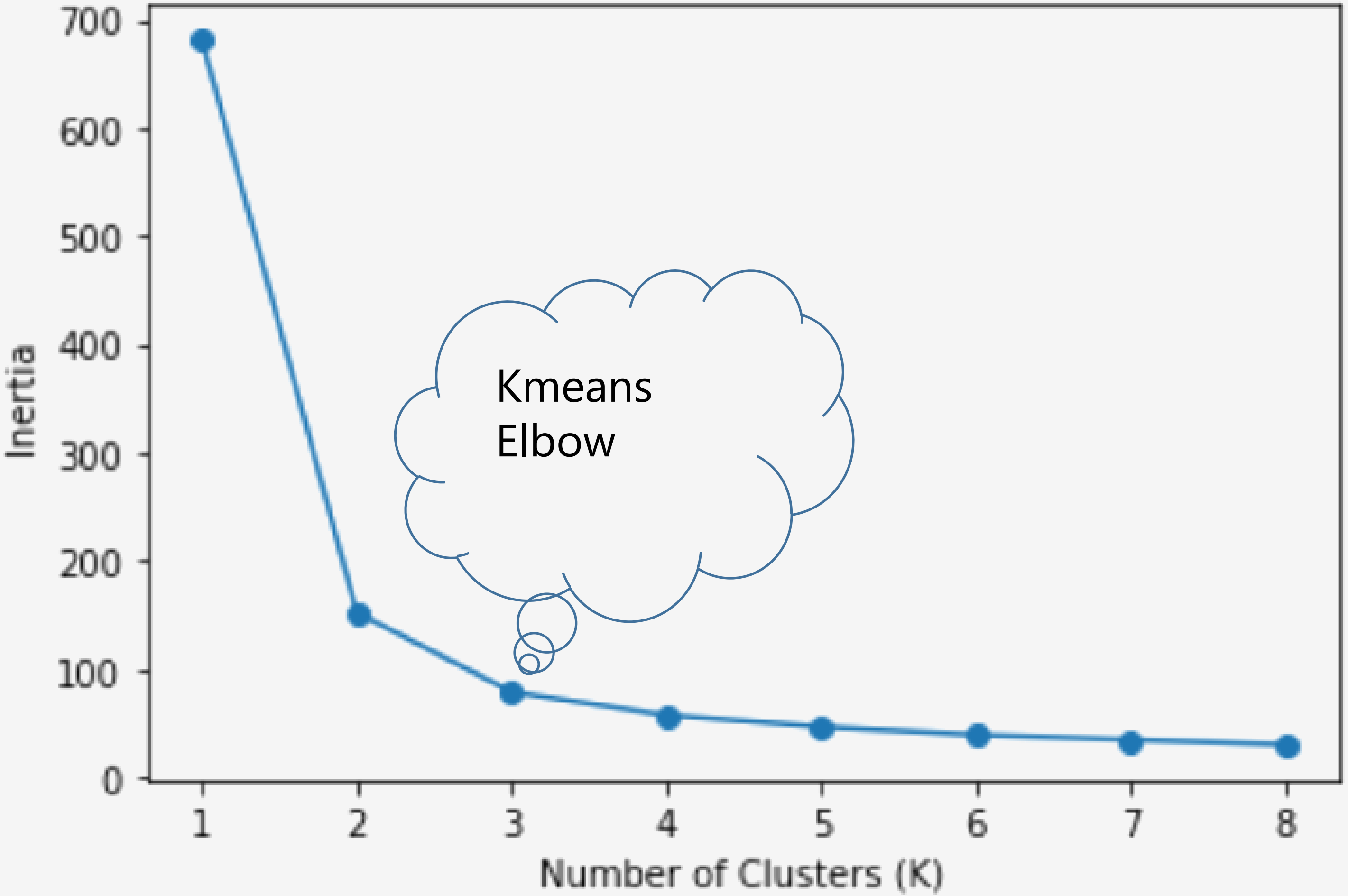


Mid Term Projects Reminder

Mid Tern Project Submission Date – Nov 29th, 2019



Elbow Method for optimal value of k in KMeans



Kmeans Elbow

Credit: Maggie

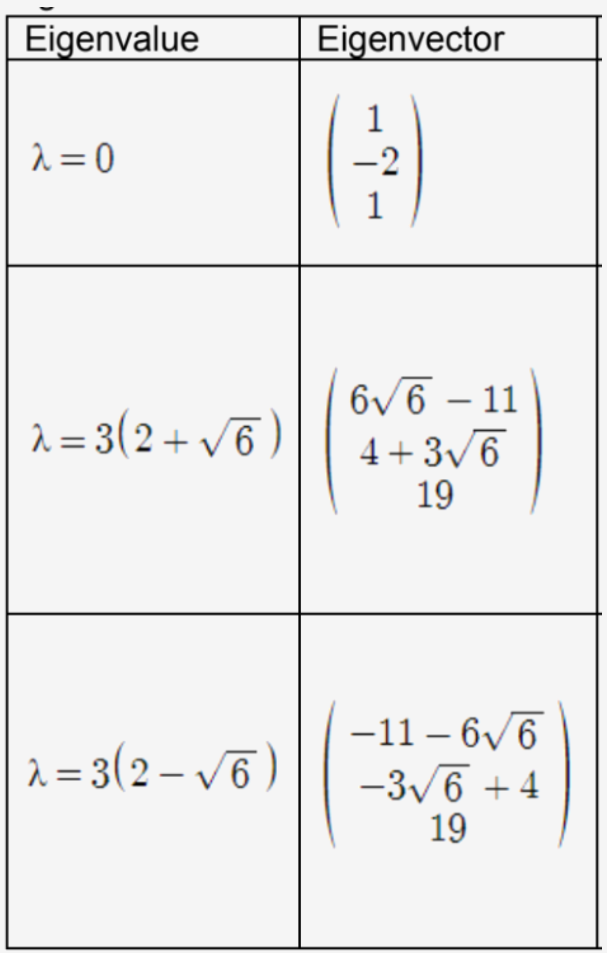
Homework

Question

Find Eigenvalues and Eigenvectors of the matrix

$$\begin{bmatrix} 0 & 1 & 2 \\ 3 & 4 & 5 \\ 6 & 7 & 8 \end{bmatrix}$$

Answer

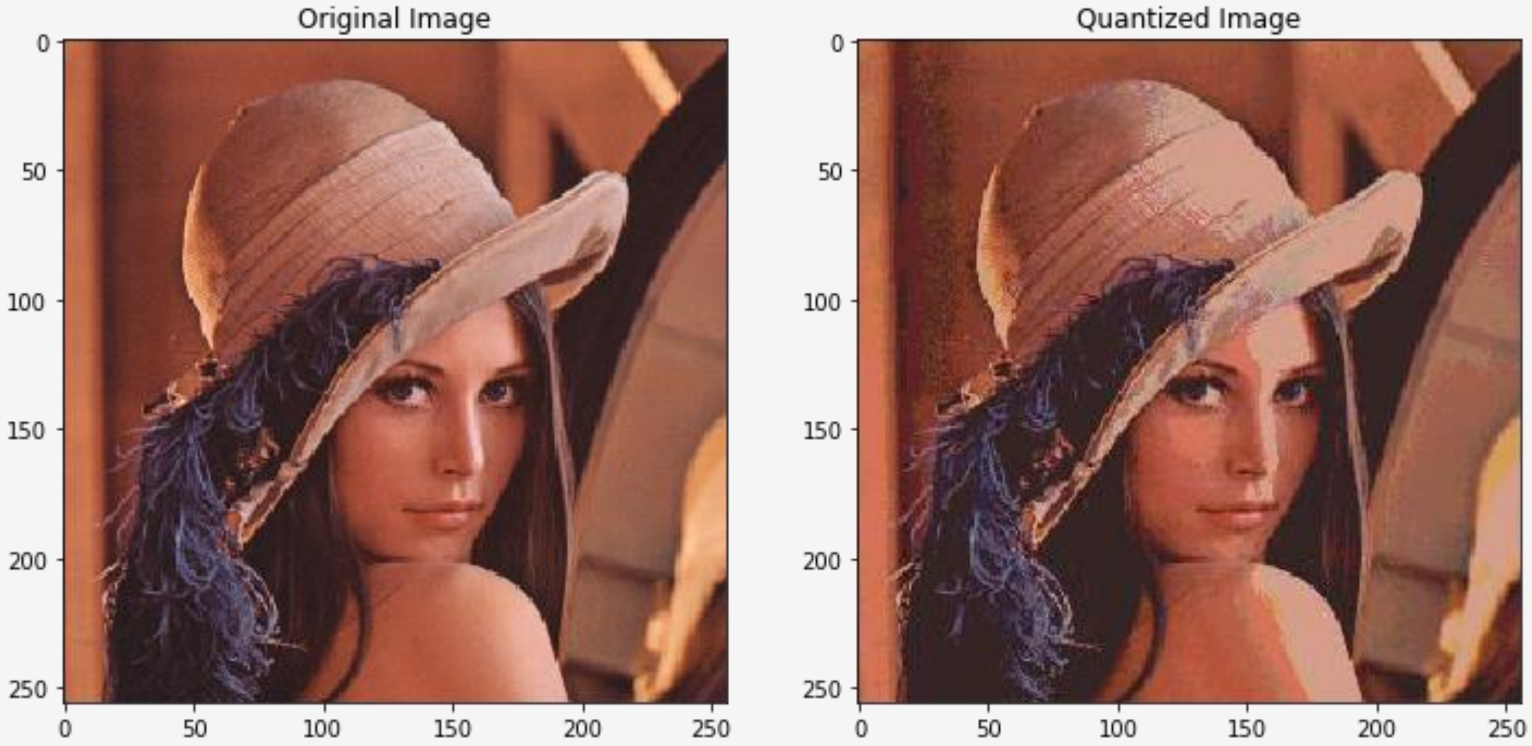


Eigenvalue	Eigenvector
$\lambda = 0$	$\begin{pmatrix} 1 \\ -2 \\ 1 \end{pmatrix}$
$\lambda = 3(2+\sqrt{6})$	$\begin{pmatrix} 6\sqrt{6} - 11 \\ 4+3\sqrt{6} \\ 19 \end{pmatrix}$
$\lambda = 3(2-\sqrt{6})$	$\begin{pmatrix} -11-6\sqrt{6} \\ -3\sqrt{6} + 4 \\ 19 \end{pmatrix}$

Image Color Quantization

- Color Quantization is a lossy compression technique achieved by compressing a range of values to a single quantum value.

- Color quantization reduces the number of colors used in an image;
- Most bitmap editors and many operating systems have built-in support for color quantization.
- Median cut algorithm is typically used in practice.
- In this example, we use Kmeans algorithm for familiarity reasons.

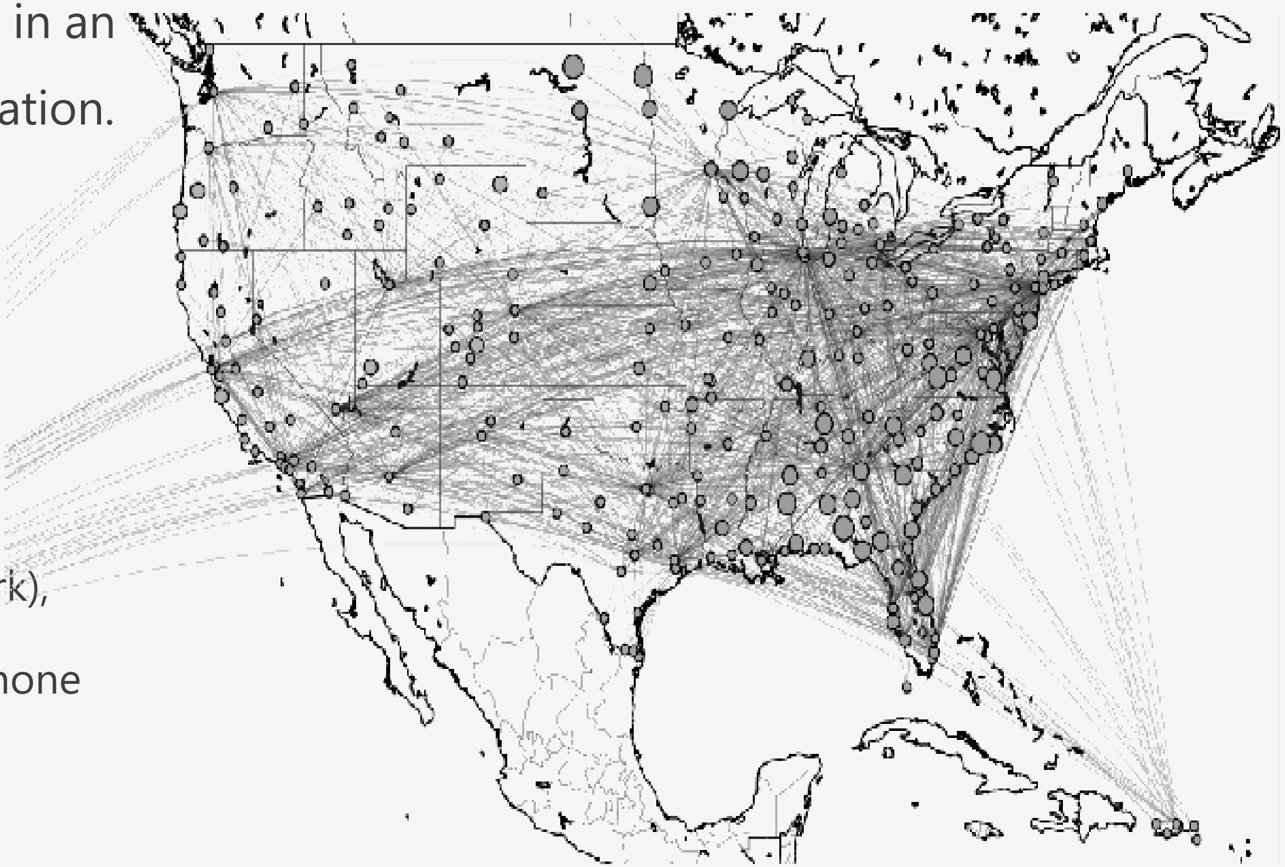


Notebook: https://colab.research.google.com/drive/1VSVmCMj-HPAMRo4t11bVqcn-I4DE9ecg

Deep Learning Introduction

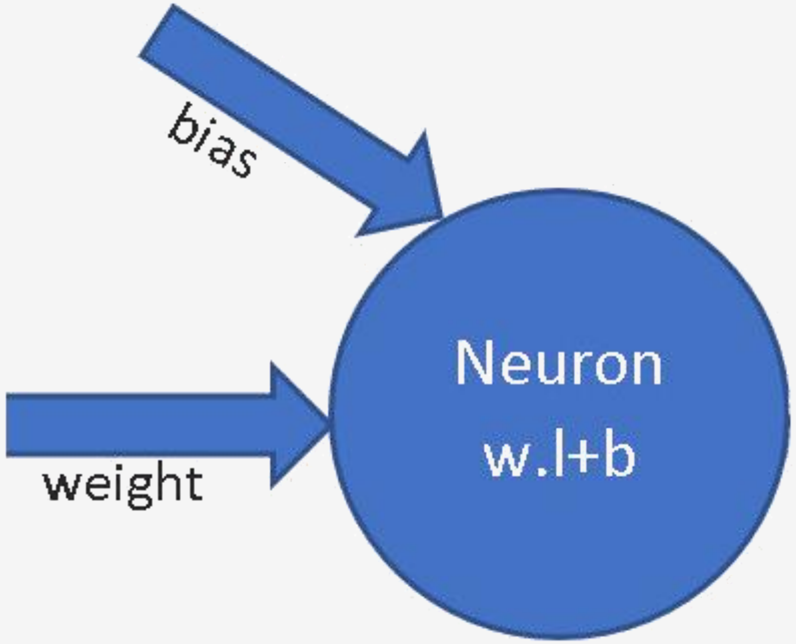
What are networks?

- ❑ Network is a group of entities interconnected in an arbitrarily ordered fashion to exchange information.
- ❑ Popular examples
  - ❑ Social networks (e.g. Facebook),
  - ❑ Professional networks (e.g. LinkedIn),
  - ❑ Road, Railway and port networks,
  - ❑ Electrical circuit networks (e.g. parasitic network),
  - ❑ Communication networks (e.g. switched telephone network),
  - ❑ Computer networks (e.g. the internet)



What are neural networks?

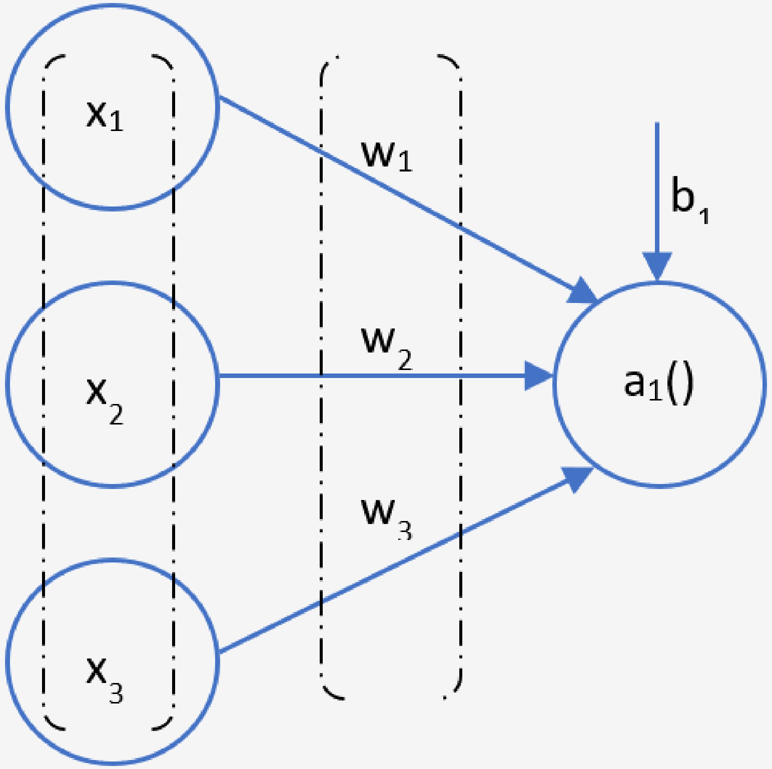
- ❑ When Entities in a network is represented with neurons, it is called neural network.



- ❑ Neuron is a fancy term for a computational node that performs set of mathematical operations with an offset on the information it is fed as input.
- ❑ Arbitrary combination of multiplication and addition has the ability to generate any expression, So **a=w*x+b** is used for generality.

What is deep learning?

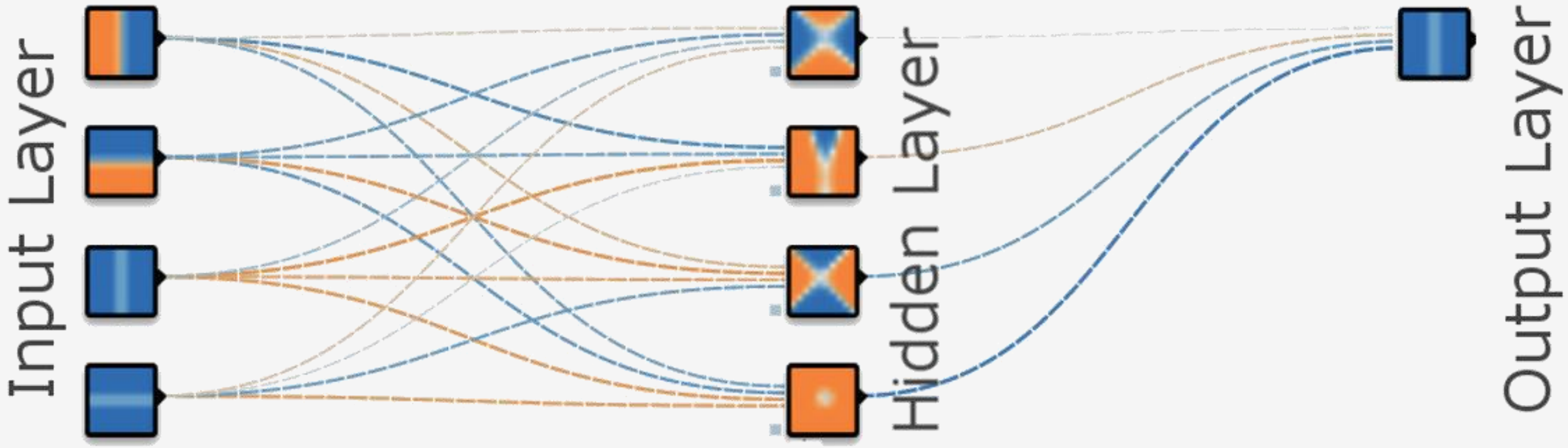
- ❑ Hypothesis is created using a compute graph aka neural network.
- ❑ Relies on the structure of network to compute and propagate values forward.
- ❑ Optimization is non-trivial, since error gradient isn't radially available to find next step.



a=w*x+b

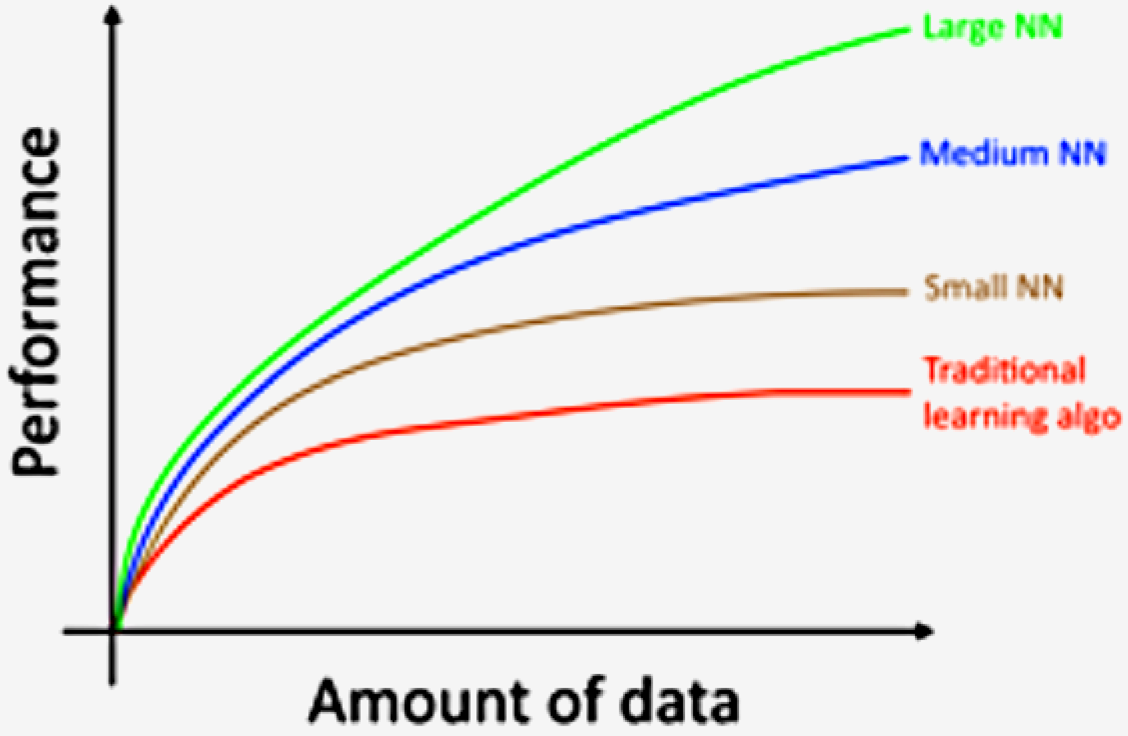
Deep Learning Terminology?

- □ Neurons
- □ Weights & Biases
- □ Model Parameters
- □ Perceptron
- □ Compute Graph
- □ Layer aka operator
- □ Activation functions
- □ Forward Propagation
- □ Backward Propagation
- □ Error Gradient
- □ Vanishing Gradients
- □ Exploding Gradients



Why Deep Learning?

- ❑ Why Now?
  - ❑ Data
  - ❑ Compute Power
  - ❑ Algorithms
- ❑ Performance superiority



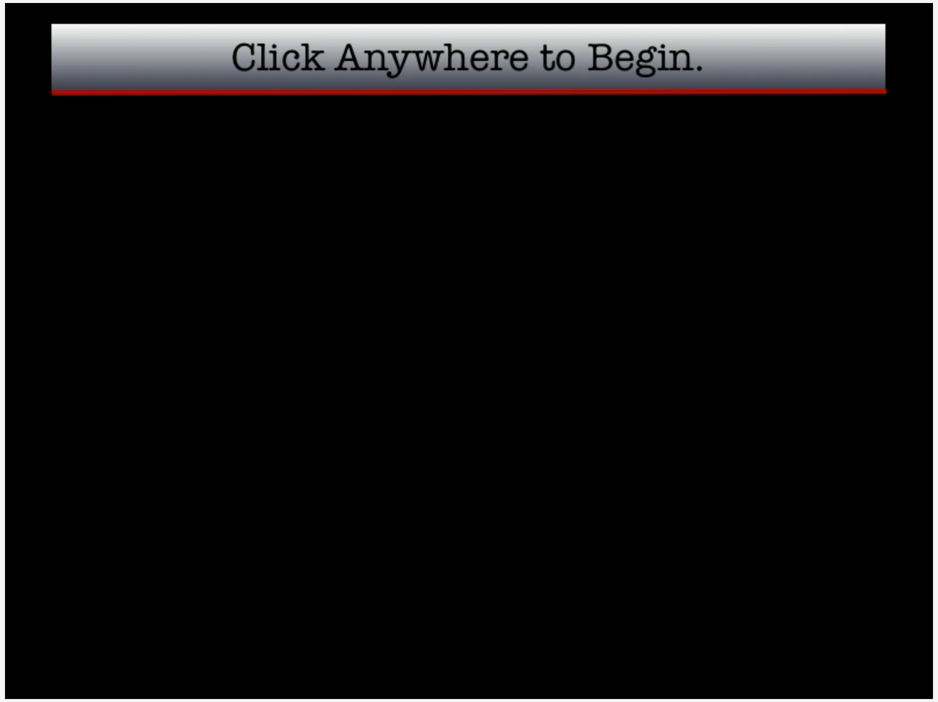
Types and Application

- ❑Neural Network Types
  - ❑Feed Forward
  - ❑Recurrent Neural Network
  - ❑Self Organizing Neural Network
- ❑Applications
  - ❑Prediction
  - ❑Classification
  - ❑Clustering
  - ❑Optimization

Human Vision vs Deep Vision

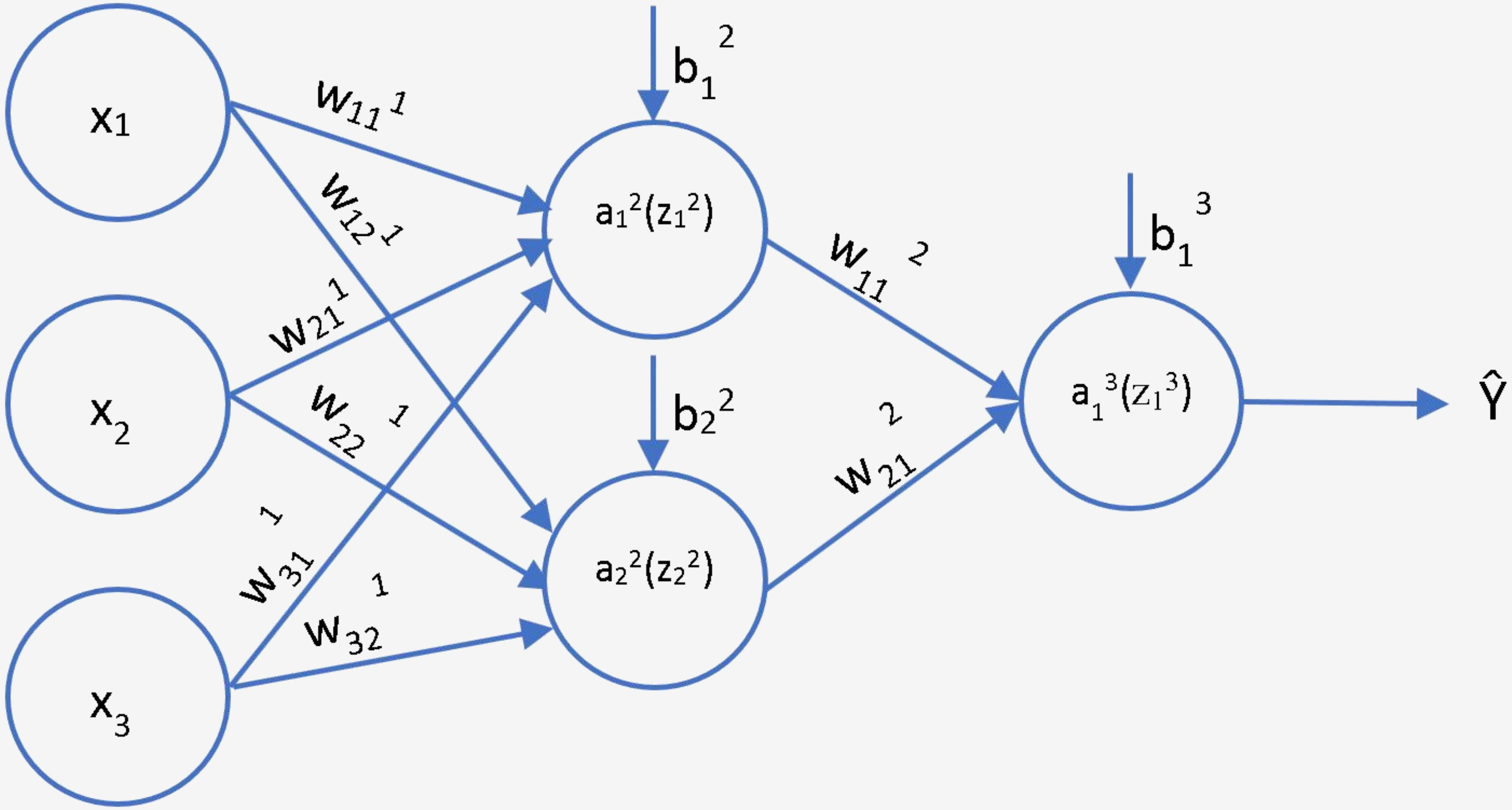
❑ Video on the right is an effort to convince you that deep learning vision is superior to human vision in many ways.

❑ Human vision system is continuously under training.



Linear Feed Forward Neural Network

Compute Function Y for the network shown in the figure.



Linear Feed Forward Neural Network

Compute Function Y for the network shown in the figure.

$a^1 = x$

$z^2 = (w^1)^T . a^1 + b^1.$

$a^2 = \text{sigmoid}(z^2)$

$z^3 = (w^2)^T . a^2 + b^2$

$a^3 = \text{sigmoid}(z^3)$

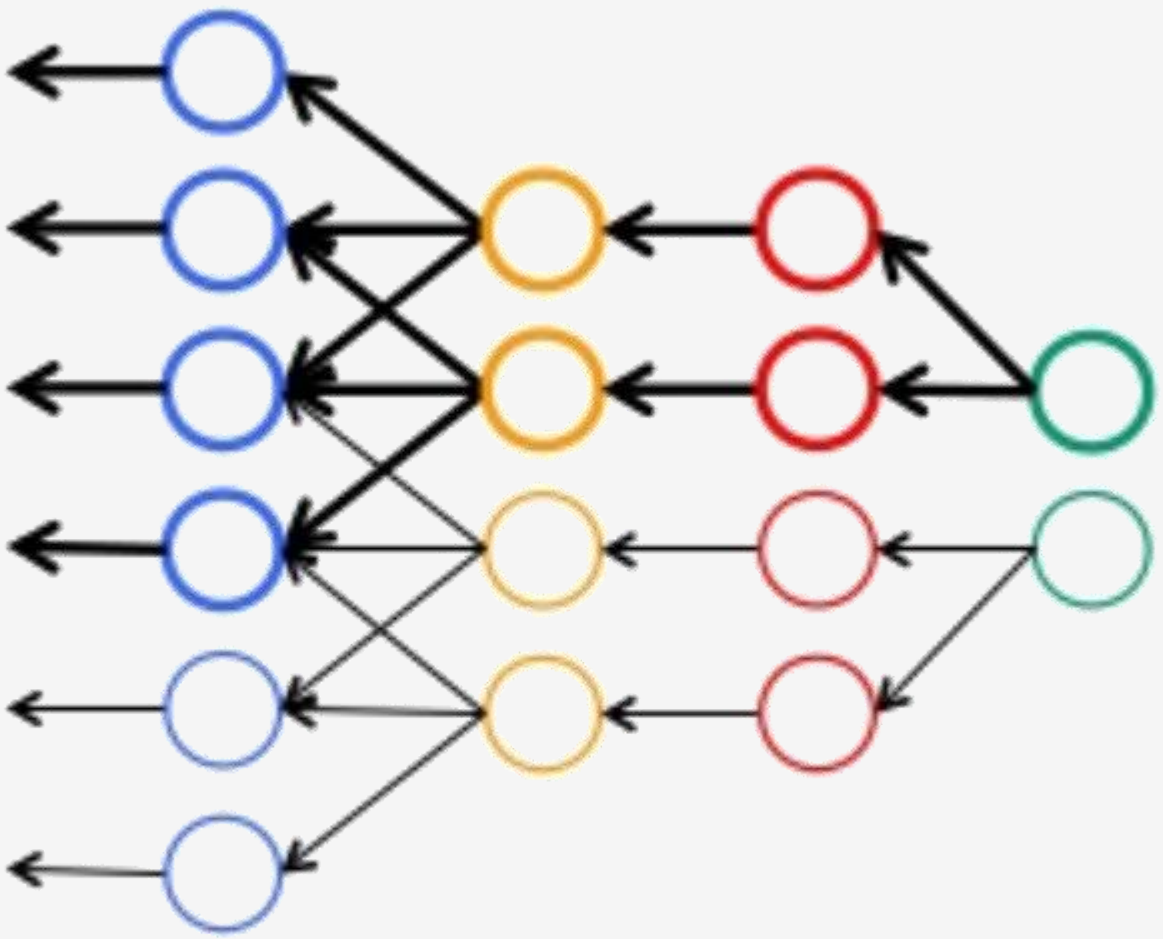
$\hat{Y} = a^3$

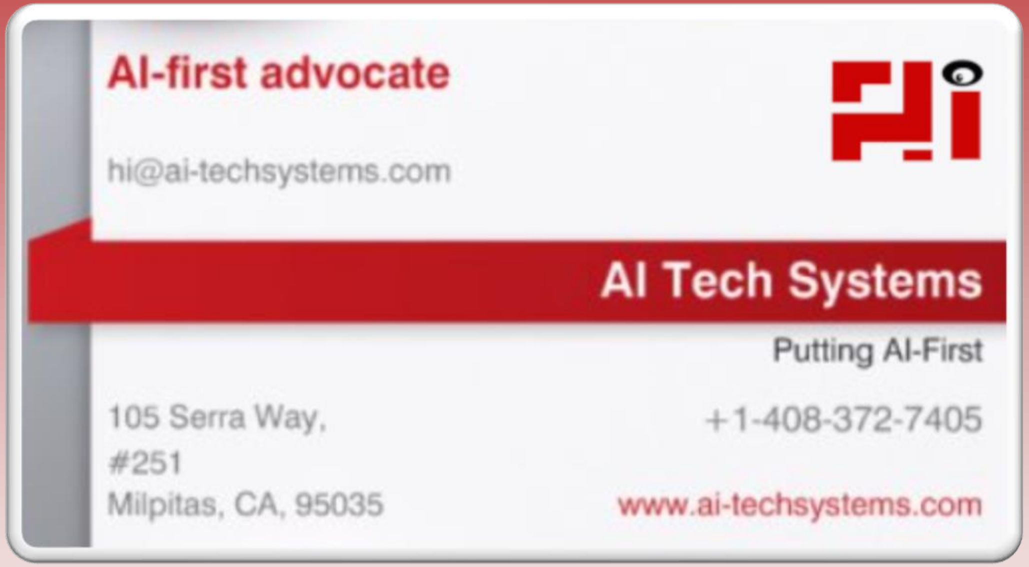
Here, superscript T denotes transpose operator and sigmoid is given as:.$\frac{1}{1+e^{-z}}$

https://playground.tensorflow.org/

Backward Propagation

- ❑Chain Rule
- ❑Computing Error Gradients
- ❑Backprop algorithm
- ❑Vanishing Gradients
- ❑Exploding Gradients
- ❑Workarounds
    - ❑Gradient Clipping
    - ❑Regularization





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