Neural Networks & Machine Learning

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NTUOSS TGIFHacks #119

Agenda

Introduction

What is Data?

Forward Propagation

Activation Functions

Cost & Loss

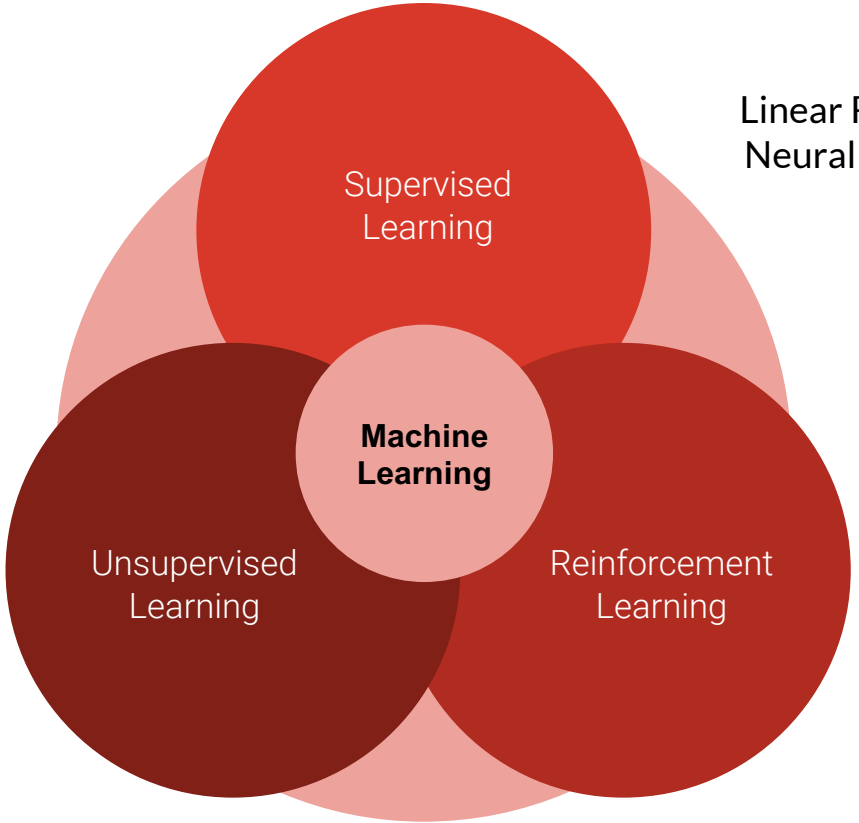
Training a Network

Code – Iris Data Set

Remarks

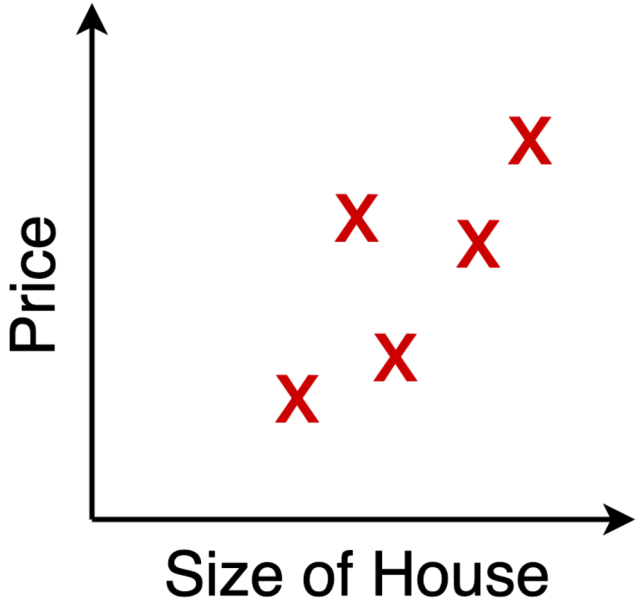
Beyond the workshop

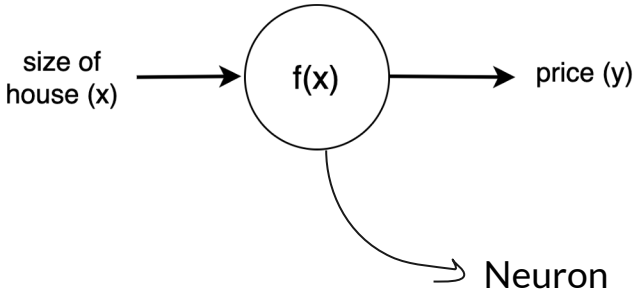
Linear Regression
Neural Networks



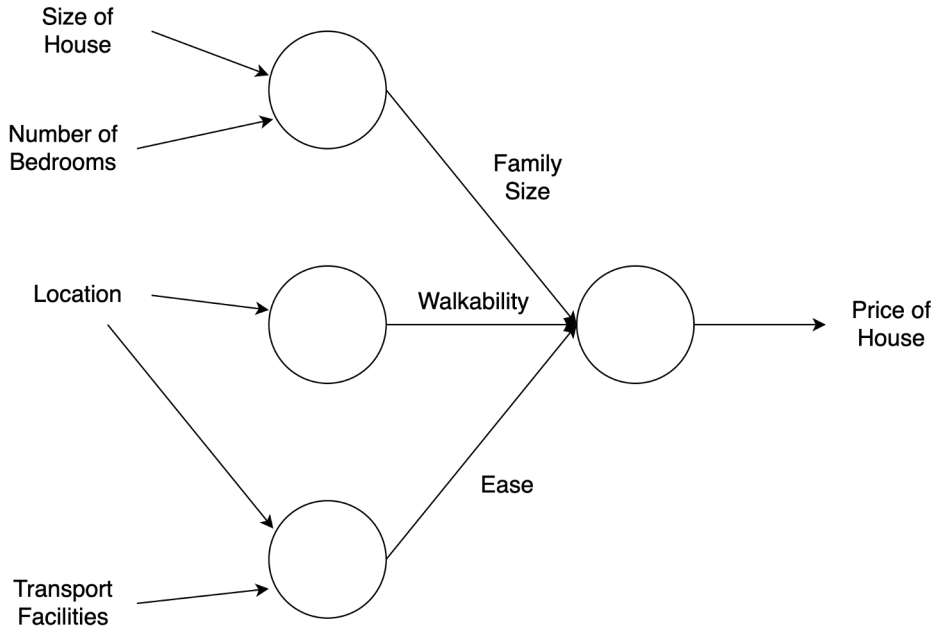
K-Means Clustering
Anomaly Detection

What exactly is a **Neural Network?**





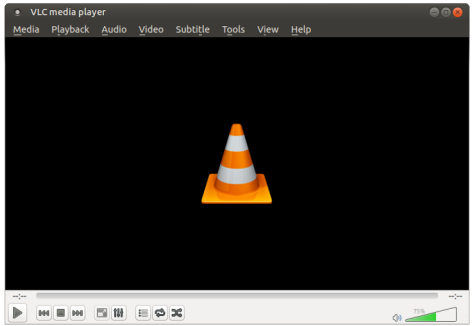
What exactly is a **Neural Network?**



Data Definition (Structured)

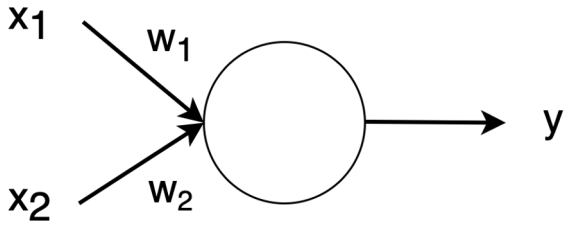
Size of House	# Bedrooms	Location	Transport	Price
1400 sq feet	4	Orchard	MRT, Bus	SGD 22,000
700 sq feet	2	Jurong	Bus	SGD 15,000
...	...	...	...	...

Data Definition (Unstructured)



Inline lists, which are sequential in nature, just like enumerated lists, but are *a*) formatted within their paragraph; *b*) usually labelled with letters; and *c*) usually have the final item prefixed with 'and' or 'or', like this example.

Forward Propagation



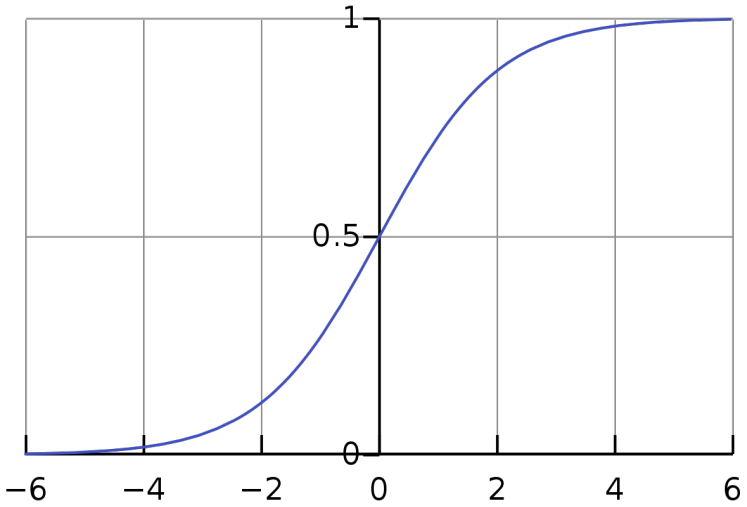
$$z = (w_1 x_1) + (w_2 x_2) + \cdots + (w_n x_n) + b$$
$$= x^T w + b$$

$$a = y = g(z)$$

Activation Functions

Sigmoid

$$g(z) = \frac{1}{1 + e^{-z}}$$

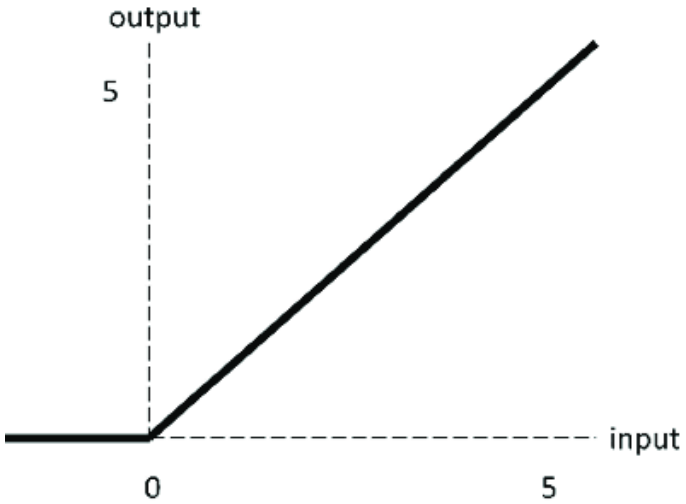


Source: https://commons.wikimedia.org/wiki/File:Logistic-curve.svg

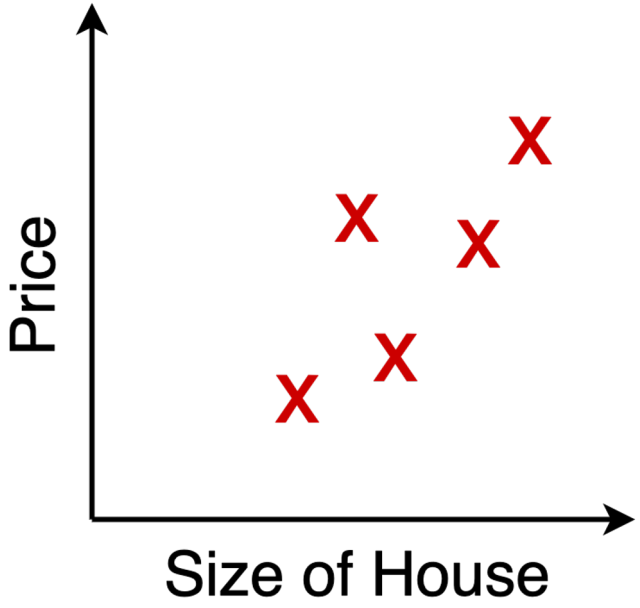
Activation Functions

ReLU

$$g(z) = \max(0, z)$$

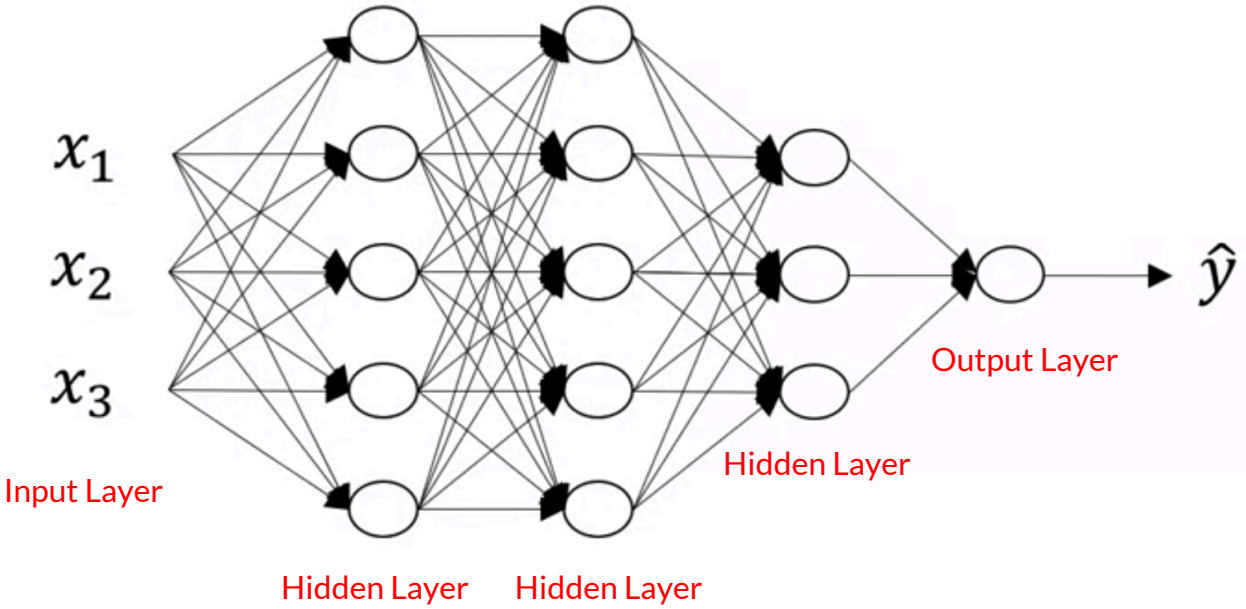


But why?



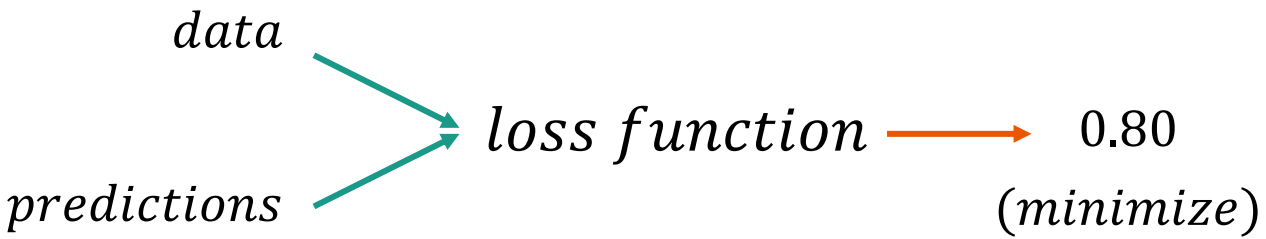
- Turn unbounded output to bounded output.
- Introduce Non-Linearity.

Deep Neural Networks



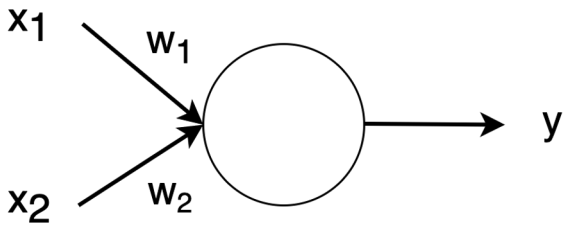
Source: https://www.coursera.org/lecture/neural-networks-deep-learning/deep-l-layer-neural-network-7dP6E

Loss Function



Squared Error

$$loss\ (target, prediction) = (prediction\ - target)^2$$



$$price\ of\ house = 16{,}000\ SGD$$

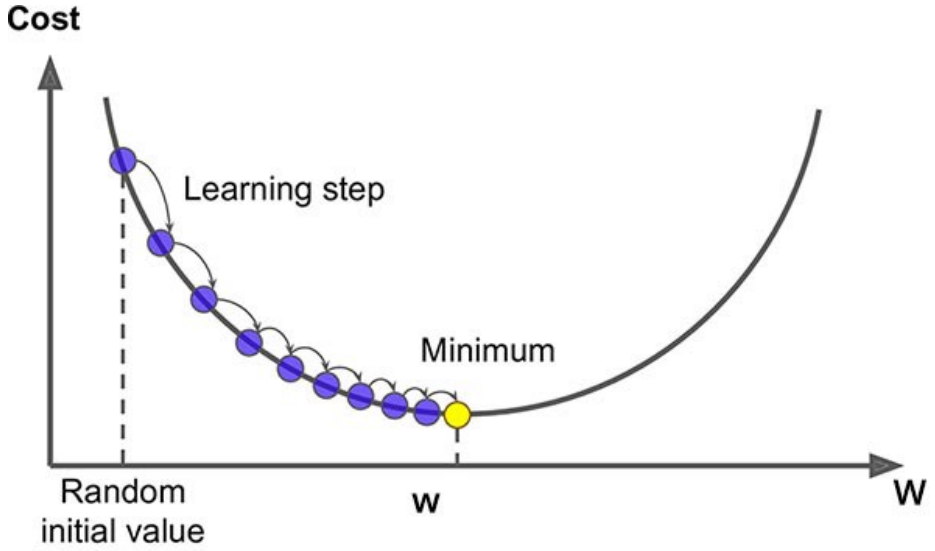
$$predicted\ price = 17{,}000\ SGD$$

$$loss\ = (prediction\ - target)^2$$
$$= (17{,}000\ - 16{,}000)^2$$

Cost Function

$$cost = \frac{1}{2m} \sum_{1}^{m} L(target, prediction)$$

$$\boldsymbol{Aim} \; - \; Minimize \; cost$$

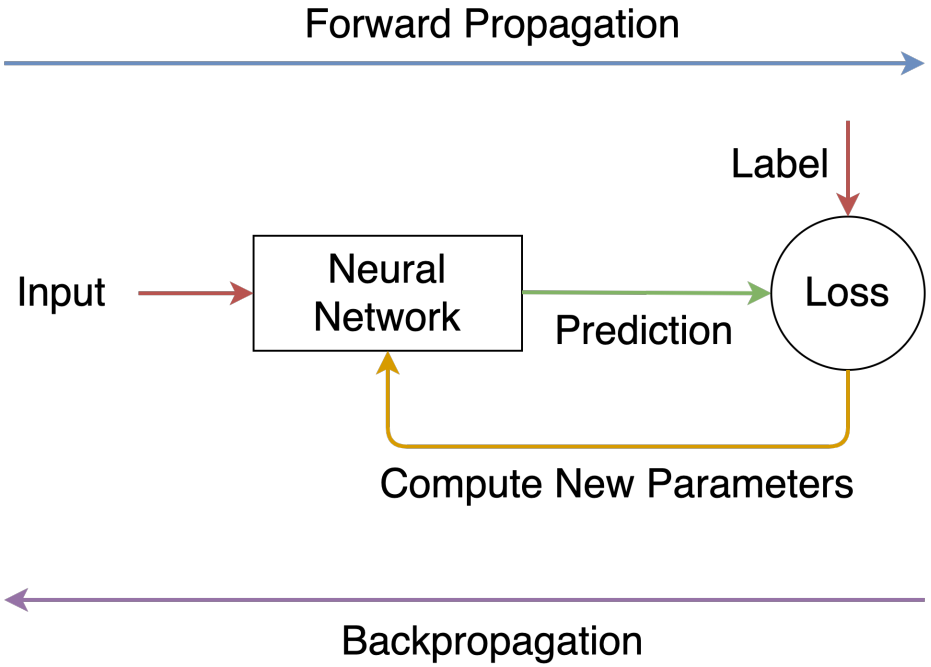


Gradient Descent

Source: https://mc.ai/an-introduction-to-gradient-descent-2/


How to train models?

The Big Picture



Data (e.g., a CSV file)

Size of House	# Bedrooms	Location	Transport	Price
1400 sq feet	4	Orchard	MRT, Bus	SGD 22,000
700 sq feet	2	Jurong	Bus	SGD 15,000
...	...	...	...	...

How to train models?

- All the weights ($w_1, w_2, ..., w_n$) and biases ($b_1, b_2, ..., b_n$) are initialized randomly.*
- Each entry in the dataset is ran through the model through the process of forward propagation and backpropagation.
- A loss function indicates the goodness of the estimate the neural networks makes.
- The model runs through the dataset several times in a random manner (epochs) .
- An independent test set is used to evaluate the performance of the model.

* There can be other types of initializations as well.

Coding Exercises:

github.com/guptajay/NTUOSS-Neural-Networks-Workshop

Iris Flower Data Set

Iris Virginica

Iris Versicolor

Iris Setosa

Source: Iris flower data set (https://en.wikipedia.org/wiki/Iris_flower_data_set)

Iris Flower Data Set

Sepal Length	Sepal Width	Petal Length	Petal Width	Species
5.1	3.5	1.4	0.2	Iris setosa
7.0	3.2	4.7	1.4	Iris versicolor
...	...	...	...	...

Remarks

- Neural Networks is a way of doing Machine Learning, in which a machine learns to do a task by learning from data i.e., training examples.
- It is a vast topic and we have barely skimmed through the fundamental topics governing neural network algorithms.
- Neural Networks is a relatively mature field, with most commercial systems that are run using Machine Learning, use some form of Neural Nets.
- If you are keen to learn more, I highly recommend that you start with the Deep Learning Specialization on Coursera.

Beyond this Workshop

We have barely scratched the surface.

- **Deep Learning:** ICLR
- **Computer Vision:** CVPR/ECCV/ICCV
- **Natural Language Processing:** ACL/EMNLP
- **Robotics:** ICRA
- **General AI:** AAAI, NeurIPS

Beyond this Workshop

We have barely scratched the surface.

- Deep Learning Specialization (Coursera)
- TensorFlow Developer Professional Certificate
- Stanford University, CS230 Course
- Deep Learning, book by Ian Goodfellow et al.

References

- Deep Learning Specialization - https://www.coursera.org/specializations/deep-learning
- Beginner Introduction to Neural Networks - https://www.youtube.com/playlist?list=PLxt59R_fWVzT9bDxA76AHm3ig0Gg9S3So
- Activation Functions in Neural Networks - https://www.geeksforgeeks.org/activation-functions-neural-networks/

Thank you.