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Backpropagation Algorithm | ML LAB 4 | VTU

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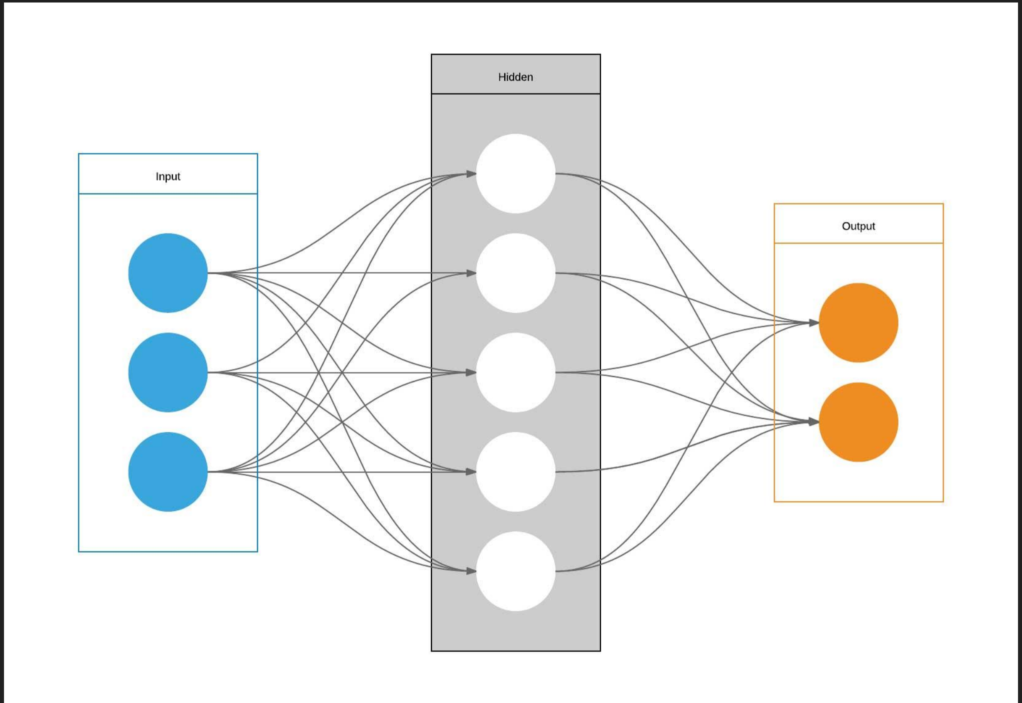
What is ANN or Neural Network?

An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transmit a signal to other neurons. “**An artificial neuron that receives a signal then processes it and can signal neurons connected to it.**”

What is input and output neurons?



What is epochs?

In terms of artificial neural networks, an epoch refers to one cycle through the full training dataset. Usually, training a neural network takes more than a few epochs.

Note: Different model requires different times to train, depending on their size/architecture, and the dateset.

What is learning rate?

- The learning rate is a configurable hyperparameter used in the training of neural networks that has a small positive value, often in the range between **0.0 and 1.0**.
- The learning rate controls how quickly the model is adapted to the problem.
- Smaller learning rates require more training epochs given the smaller changes made to the weights each update, whereas larger learning rates result in rapid changes and require fewer training epochs.

What is Normalization ?

Normalization is a technique often applied as part of data preparation for machine learning. The goal of normalization is to change the values of numeric columns in the dataset to use a common scale, without distorting differences in the ranges of values or losing information.

Normalization Formula

$$X_{normalized} = \frac{(X - X_{minimum})}{(X_{maximum} - X_{minimum})}$$

Before and after normalization

unnormalized

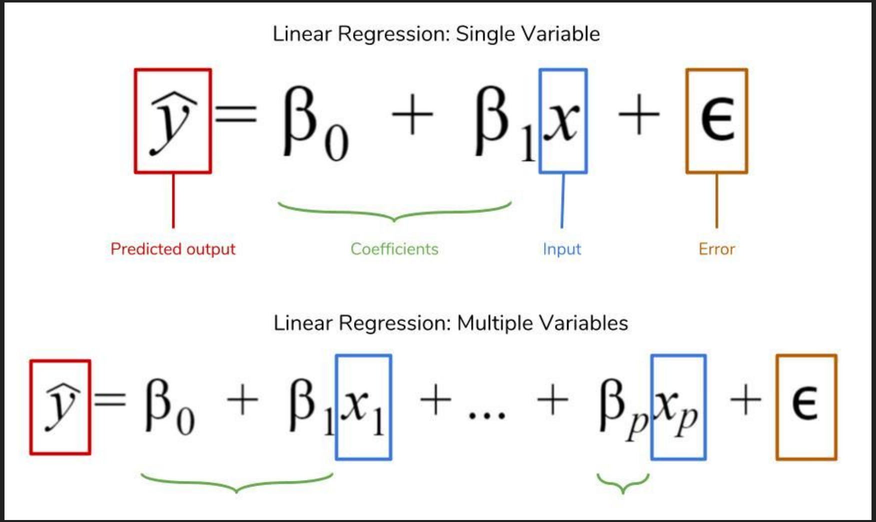
$KM-K-Means	Record_Count	AGE_Mean	NUMCHLD_Mean	LASTGIFT_Mean	TARGET_D_Mean
cluster-1	2520	49.168	3.391	15.325	15.956
cluster-2	5	81.333	$null$	130.000	190.000
cluster-3	374	43.404	1.321	15.885	15.003
cluster-4	143	68.126	1.224	13.811	14.825
cluster-5	1801	75.498	3.500	14.589	14.863

Normalized

$KM-K-Means	Record_Count	...	AGE_Mean	...	NUMCHLD_Mean	...	LASTGIFT_Mean	...	TARGET_D_Mean
cluster-1	1012	...	63.820	...	3.000	...	6.828	...	6.026
cluster-2	1387	...	76.557	...	3.500	...	16.746	...	17.402
cluster-3	375	...	43.501	...	1.317	...	15.963	...	15.109
cluster-4	139	...	68.317	...	1.216	...	13.799	...	14.791
cluster-5	1930	...	48.716	...	3.455	...	18.352	...	19.535

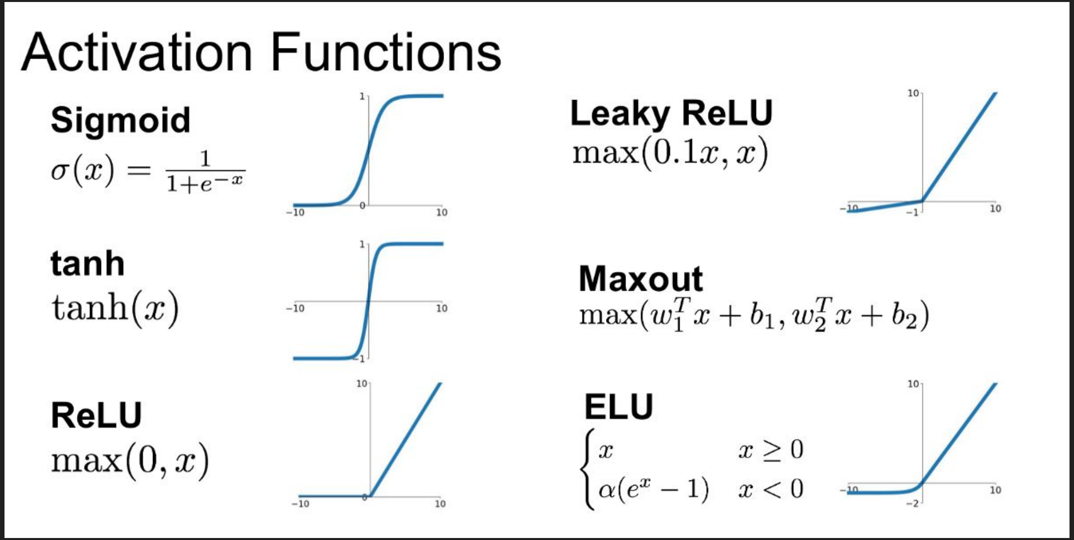
What is Forward Propagation?

Forward propagation is how neural networks make predictions. Input data is "**forward propagated**" through the network layer by layer to the final layer which outputs a prediction.



What is Activation function?

The activation function is responsible for transforming the summed weighted input from the node into the activation of the node or output for that input.



Sigmoid & Derivative Sigmoid

Sigmoid

$$S(x) = \frac{1}{1 + e^{-x}}$$

Derivative of Sigmoid

$$\frac{d\sigma(x)}{d(x)} = \sigma(x) \cdot (1 - \sigma(x)).$$

Backpropagation Equations

2. For each network output unit k, calculate its error term δk

$$\delta_k \leftarrow o_k(1 - o_k)(t_k - o_k)$$

3. For each hidden unit h, calculate its error term δh

$$\delta_h \leftarrow o_h(1 - o_h) \sum_{k \in outputs} w_{kh}\delta_k$$

Backpropagation Equations

3. For each hidden unit h, calculate its error term δh

$$\delta_h \leftarrow o_h(1 - o_h) \sum_{k \in outputs} w_{kh} \delta_k$$

4. Update each network weight wji

$$w_{ji} \leftarrow w_{ji} + \Delta w_{ji}$$

Where

$$\Delta w_{ji} = \eta \, \delta_j \, x_{ji}$$