Deep Learning for Business

Basics of Deep Learning Neural Networks

NN (Neural Network)

Neural Network

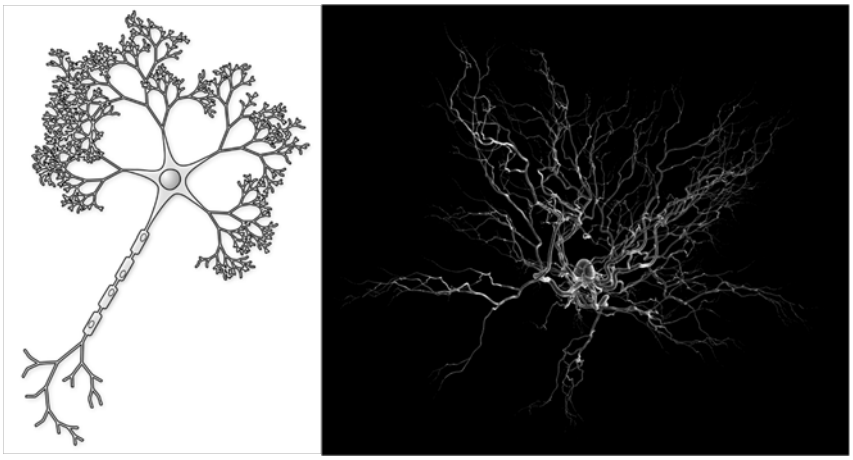
DL (Deep Learning) Technology

- **NN** (Neural Network) or **ANN** (Artificial NN)
  - NNs start with one Neuron (Nerve Cell)

- In DL, intelligence is obtained from data using
  - **CNN** (Convolutional Neural Network)
  - **RNN** (Recurrent Neural Network)

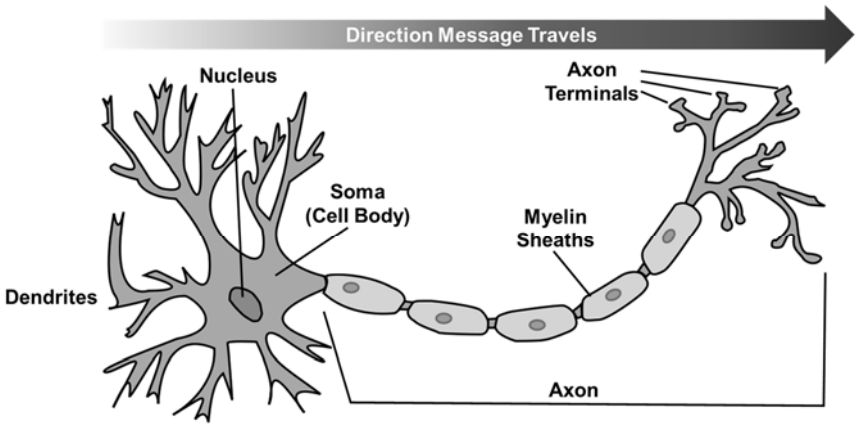
Neural Network

Neuron (Nerve Cell)



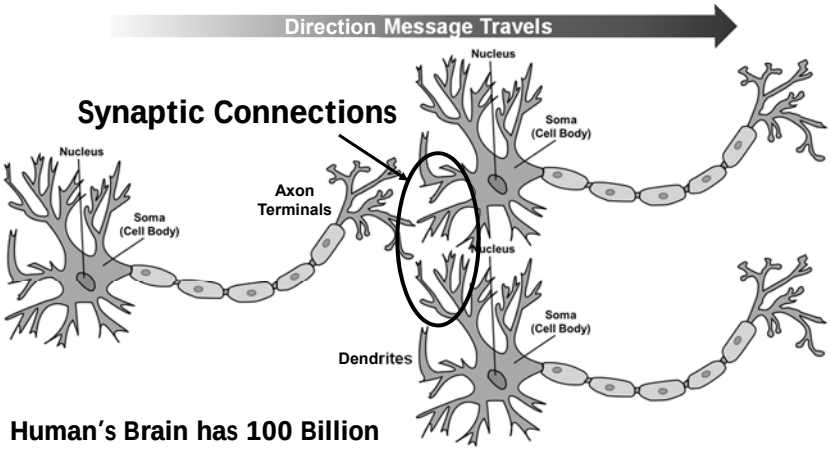
Neural Network

Neuron (Nerve Cell)



Neural Network

Neuron Signal Transfer

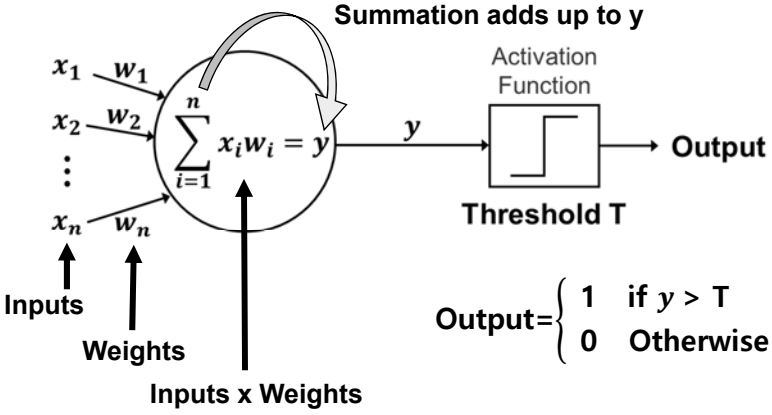


Human's Brain has 100 Billion neurons with 1 Quadrillion (10^{15}) synaptic connections

Deep Learning & Machine Learning

Neuron with Threshold Logic Unit

– W. McCulloch & W. Pitts (1943) model



Deep Learning & Machine Learning

Activation Function

- Hard output binary values (0 or 1) result from the Threshold T activation function

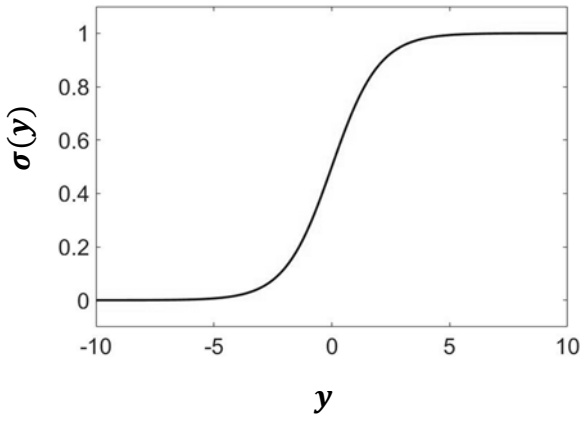
$$\text{Output}=\begin{cases} 1 & \text{if } y > T \\ 0 & \text{Otherwise} \end{cases}$$

- Soft output values can be made by using one of the following activation functions (instead of the Threshold T)

Big Data Intelligence, DL & ML

Activation Function types

- Logistic sigmoid $\sigma(y) = \dfrac{1}{1+\exp(-y)}$



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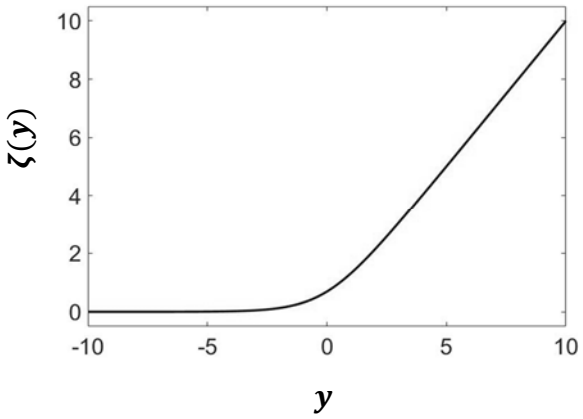
Activation Function types

– Softplus $\zeta(y) = \log(1 + \exp(y))$



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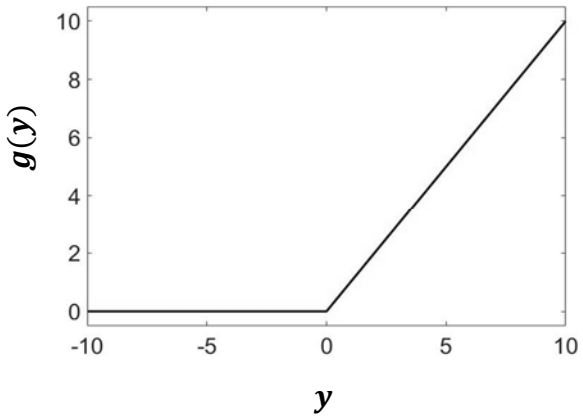
Activation Function types

– ReLU (Rectified Linear Unit) $g(y) = \max(0, y)$



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Soft Output Activation Functions

- Logistic sigmoid $\sigma(y) = \frac{1}{1 + \exp(-y)}$
- Softplus $\zeta(y) = \log(1 + \exp(y))$
- ReLU (Rectified Linear Unit)

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

Neural Network Terminology

Perceptron

- ML (Machine Leaning) algorithm that conducts supervised learning of linear (binary) classification
- Perceptrons are trained to determine if an input (vector or scalar value) belongs to one class or another

Neural Network Terminology

MLP (Multi-Layer Perceptron)

- Feed forward NN (Neural Network) that is formed of multiple layers of perceptrons, where each layer may use multiple perceptrons in parallel

- MLPs use BP (Back Propagation) based supervised learning to train the outputs (to accurately conduct nonlinear classification)

Neural Network Terminology

SoftMax

- Logistic function that maps a K dimensional vector (e.g., a set of K data inputs) of real values to values in the range of 0~1 such that all values of the vector add up to 1
- ML (Machine Learning) NNs (Neural Networks) often use the Softmax function to enhance the accuracy of the classification process

Neural Network Terminology

SoftMax transfer example

- Original Inputs: a_1, a_2, a_3

- SoftMax Outputs

$$\begin{cases} \tilde{a}_1 = \frac{e^{a_1}}{e^{a_1}+e^{a_2}+e^{a_3}} \\ \tilde{a}_2 = \frac{e^{a_2}}{e^{a_1}+e^{a_2}+e^{a_3}} \\ \tilde{a}_3 = \frac{e^{a_3}}{e^{a_1}+e^{a_2}+e^{a_3}} \end{cases}$$

- Constraint Satisfied: ($\tilde{a}_1$ + $\tilde{a}_2$ + $\tilde{a}_3$) = 1

Neural Network Terminology

SoftMax transfer example

- a_1=9, a_2=20, a_3=25 → $\tilde{a}_1$=0.00000011178, $\tilde{a}_2$=0.00669285018, $\tilde{a}_3$=0.99330703804

- ($\tilde{a}_1$ + $\tilde{a}_2$ + $\tilde{a}_3$) = 1
- Weights (w_1, w_2, w_3) and SoftMax values ($\tilde{a}_1, \tilde{a}_2, \tilde{a}_3$) combined

$$w_1\tilde{a}_1 + w_3\tilde{a}_2 + w_3\tilde{a}_3$$

Neural Network Terminology

AutoEncoder

- AutoEncoder (AutoAssociator) is a NN used to learn the characteristics of a data set such that the representation (encoding) dimensionality can be reduced

- Simplest form of an AutoEncoder is a feedforward non-recurrent neural network

Deep Learning for Business

Basics of Deep Learning Neural Networks

References

References

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References

Image sources

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