# Program Structures and Algorithms

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Final Project Report

# Number Recognition Neural Network

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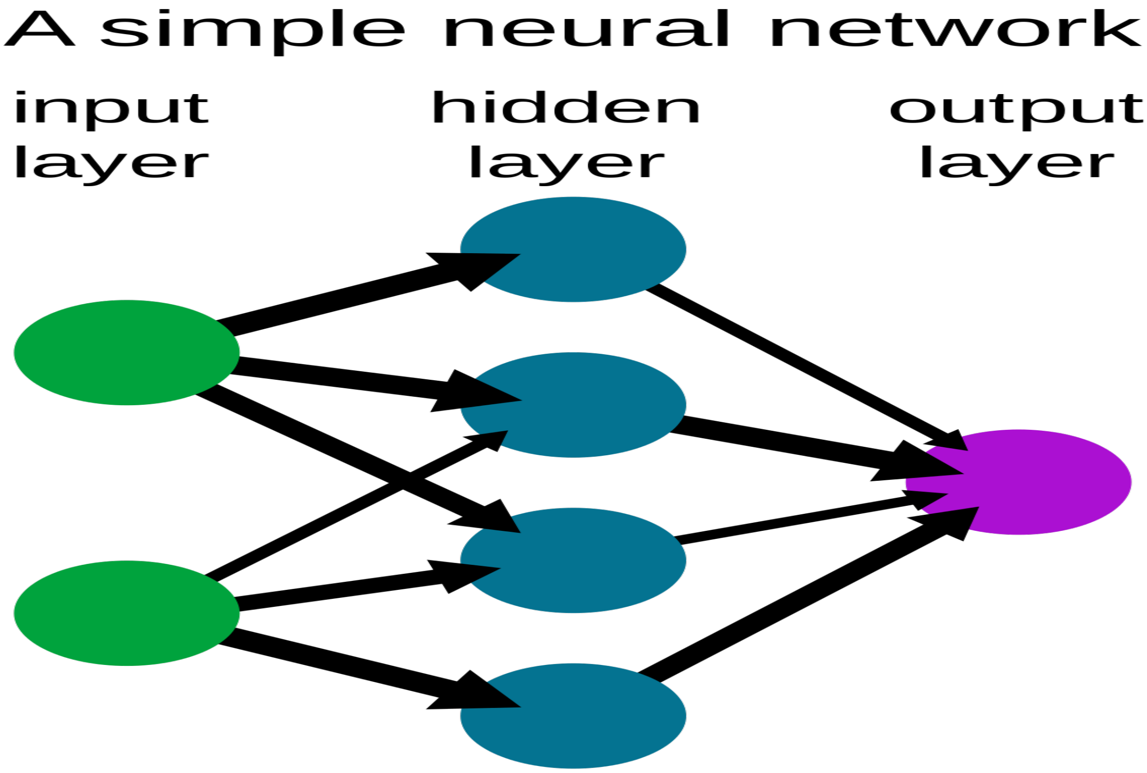
# 1.Introduction of project

## 1.1Neural Network

Neural networks are a set of algorithms, modeled loosely after the human brain, that are designed to recognize patterns. They interpret sensory data through a kind of machine perception, labeling or clustering raw input. The patterns they recognize are numerical, contained in vectors, into which all real-world data, be it images, sound, text or time series, must be translated.



- Activation Function:

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

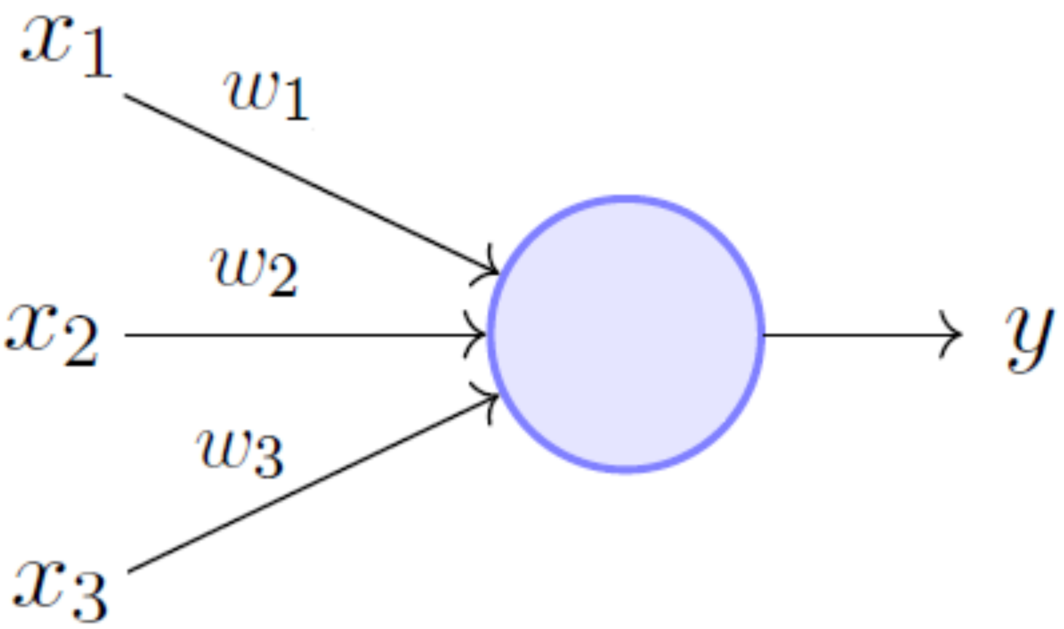
- Output in Neural Network

$$x_n^l = b_n^l + \sum_k w_{kn}^l \, O_k^{l-1}$$

$$l = layer$$
$$p = previous\ neuron$$
$$n = neuron\ in\ layer\ l$$

## 1.2Perceptron

Perceptron is an algorithm for supervised learning of binary classifiers. A binary classifier is a function which can decide whether or not an input, represented by a vector of numbers, belongs to some specific class.[1] It is a type of linear classifier, i.e. a classification algorithm that makes its predictions based on a linear predictor function combining a set of weights with the feature vector.



Perceptron Model (Minsky-Papert in

## 1.3Synapse

Synapse is a structure that permits a neuron (or nerve cell) to pass an electrical or chemical signal to another neuron or to the target effector cell. Synapses are essential to neuronal function: neurons are cells that are specialized to pass signals to individual target cells, and synapses are the means by which they do so. At a synapse, the plasma membrane of the signal-passing neuron (the presynaptic neuron) comes into close apposition with the membrane of the target (postsynaptic) cell. Both the presynaptic and postsynaptic sites contain extensive arrays of a molecular machinery that link the two membranes together and carry out the signaling process. In many synapses, the presynaptic part is located on an axon and the postsynaptic part is located on a dendrite or soma. Astrocytes also exchange information with the synaptic neurons, responding to synaptic activity and, in turn, regulating neurotransmission.[7] Synapses (at least chemical synapses) are stabilized in position by synaptic adhesion molecules (SAMs) projecting from both the pre- and post-synaptic neuron and sticking together where they overlap; SAMs may also assist in the generation and functioning of synapses.

# 2.Description of the Project

## 2.1About Project

- Network providing a layer Object is taken.

- MNIST Data set is loaded.
- Network is trained using MNIST training Data set.
- Neural Network is tested with the help of MNIST Data set and its accuracy is calculated corresponding to it.

## 2.2Important Classes Used

- ### Perceptron.java

  Class consist of  initial weights, bias and learning rate.

- ### Layer.java

  Class consist of an array to hold hidden layers. This array, contains n number of hidden layers described in Neural Network.
  Functions used in this class as follows:
  - Feed Forward
  - Add Perceptron

- NeuralNetwork.java

This is our multi-layered Perceptron aka Neural Network which contains all the neural network functionalities such as Adjusting Weights, Calculating Back Propagation, Training the Neural Network, Calculating the final output.

*Variables used*

- Name
- List of layer class
- Input Layer
- Output Layer

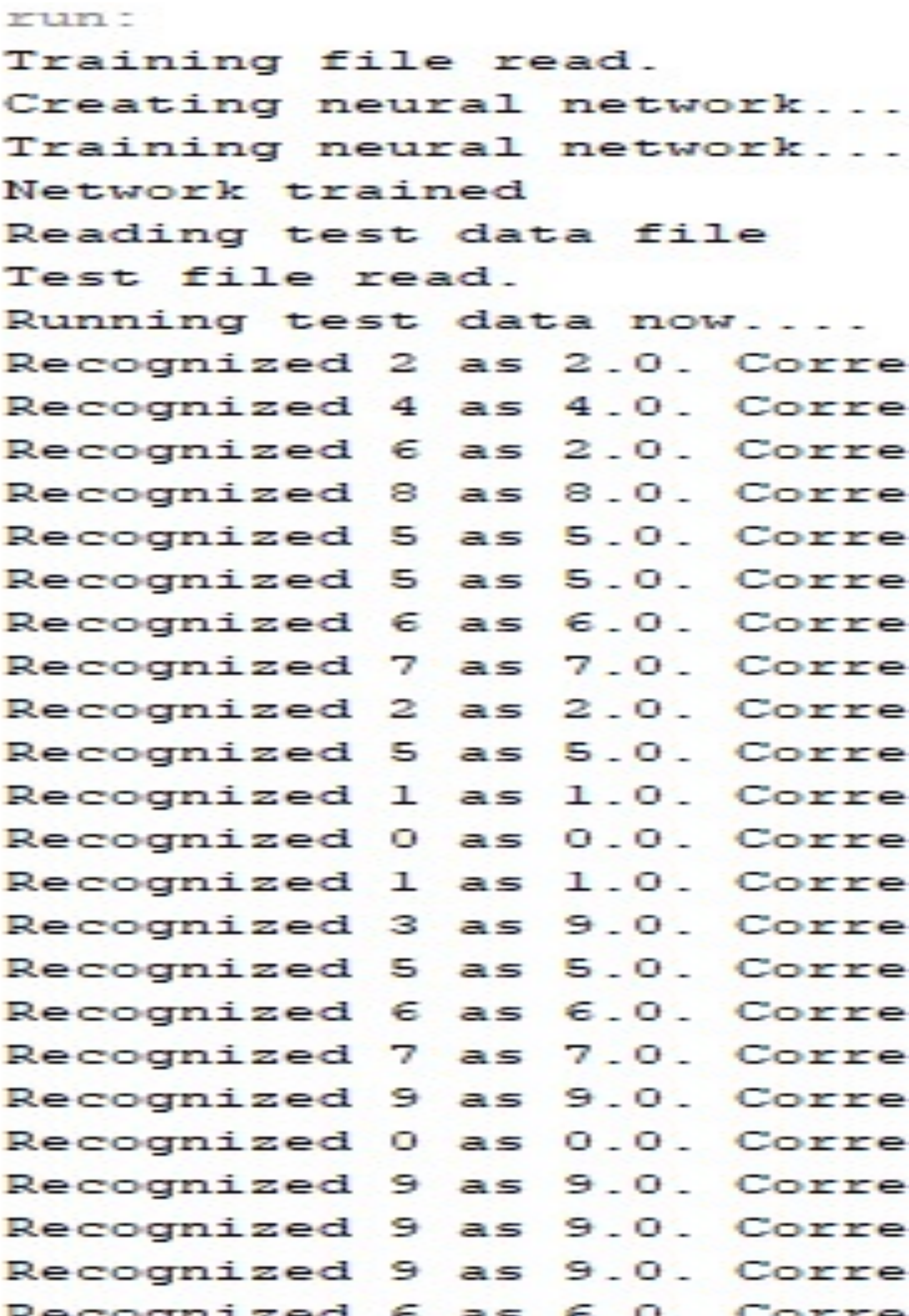
*Functions used*

- addLayer
- getWeights
- setInputs
- getOutput
- reset

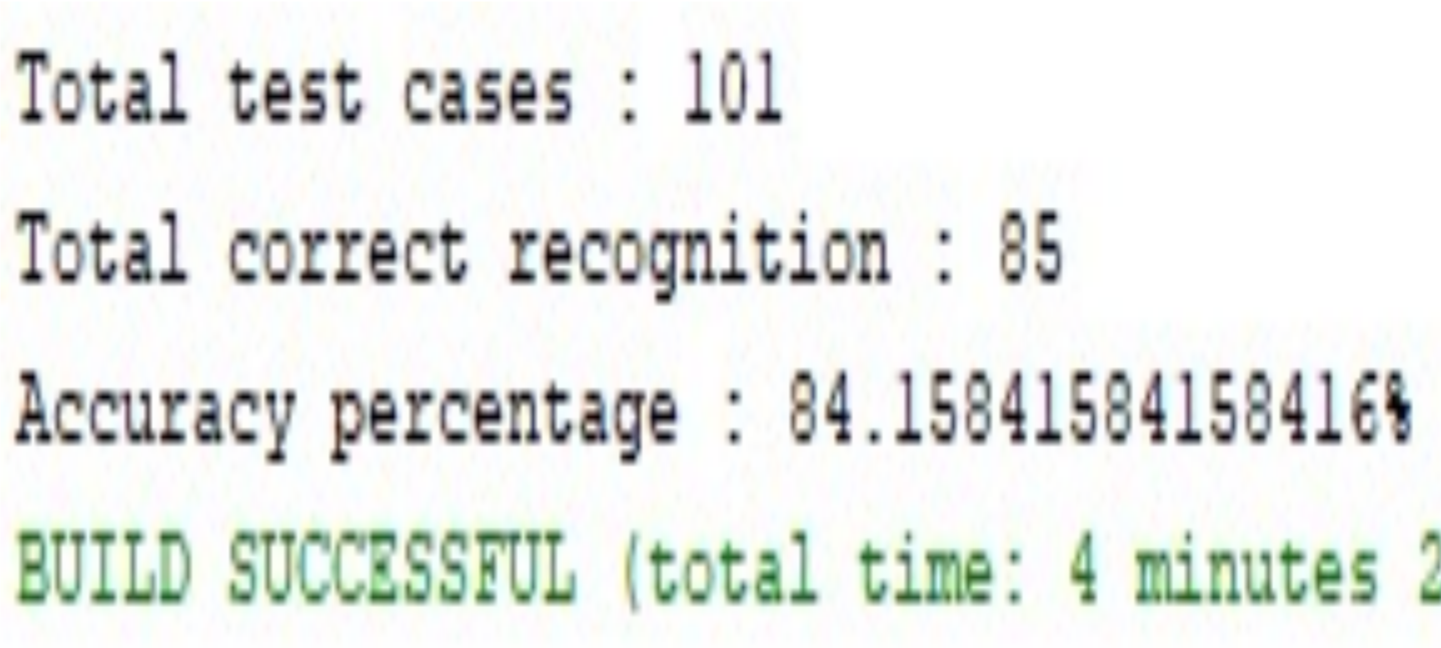
- Utils.java

  Helper class that consist of functions to obtain random values which can be used to create random arrays for weights and the highest value of index value is obtained corresponding to output array.

## 3.Screenshot of the code



```
run:
Training file read.
Creating neural network...
Training neural network...
Network trained
Reading test data file
Test file read.
Running test data now....
Recognized 2 as 2.0. Corre
Recognized 4 as 4.0. Corre
Recognized 6 as 2.0. Corre
Recognized 8 as 8.0. Corre
Recognized 5 as 5.0. Corre
Recognized 5 as 5.0. Corre
Recognized 6 as 6.0. Corre
Recognized 7 as 7.0. Corre
Recognized 2 as 2.0. Corre
Recognized 5 as 5.0. Corre
Recognized 1 as 1.0. Corre
Recognized 0 as 0.0. Corre
Recognized 1 as 1.0. Corre
Recognized 3 as 9.0. Corre
Recognized 5 as 5.0. Corre
Recognized 6 as 6.0. Corre
Recognized 7 as 7.0. Corre
Recognized 9 as 9.0. Corre
Recognized 0 as 0.0. Corre
Recognized 9 as 9.0. Corre
Recognized 9 as 9.0. Corre
Recognized 9 as 9.0. Corre
Recognized 6 as 6.0. Corre
```



```
Total test cases : 101
Total correct recognition : 85
Accuracy percentage : 84.15841584158416%
BUILD SUCCESSFUL (total time: 4 minutes 2
```

## 4.References

- https://towardsdatascience.com/perceptron-the-artificial-neuron-4d8c70d5cc8d
- https://www.youtube.com/watch?v=ntKn5TPHHAk&list=PLRqwX-V7Uu6aCibgK1PTWWu9by6XFdCfh&index=2
- https://en.wikipedia.org/wiki/Artificial_neural_network
- https://www.youtube.com/watch?v=aircAruvnKk
- https://www.digitaltrends.com/cool-tech/what-is-an-artificial-neural-network/