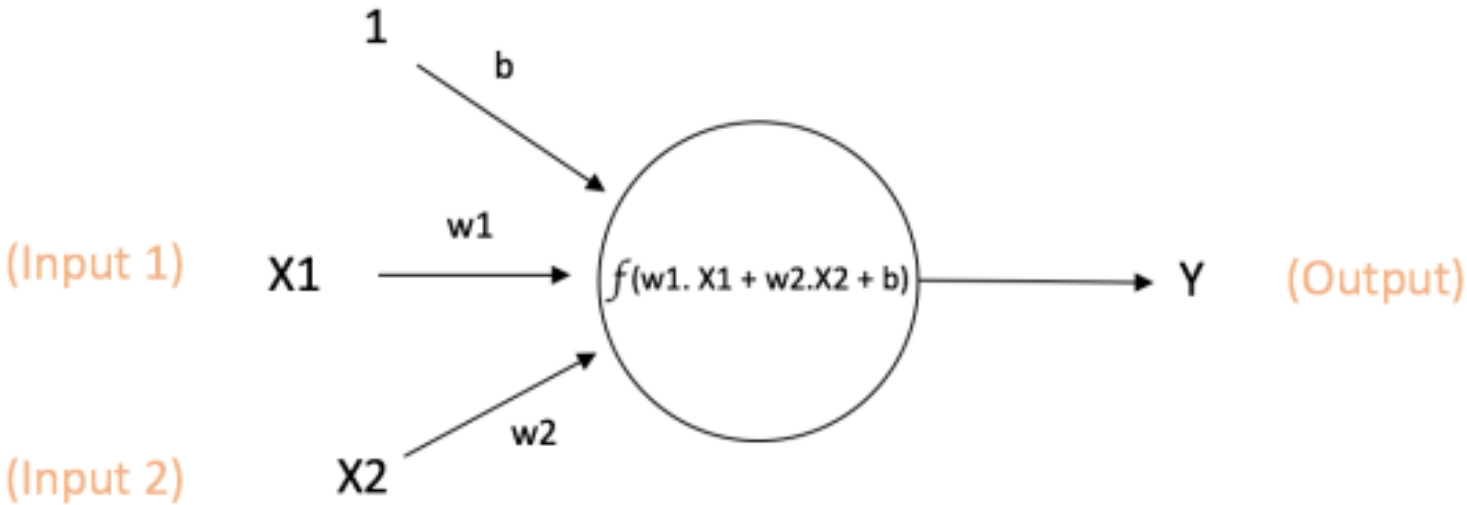
Week 1 Outline

- Basic Neural Network
- Models on Accelerometer Dataset (CNN)
- Models on Gyroscope Dataset (CNN, LSTM and RNN)
- Useful Link for Accelerometer/Gyroscope Dataset

Basics of Neural Network



Output of neuron = Y= $f(w1.\ X1 + w2.X2 + b)$

Activation function

- Sigmoid:

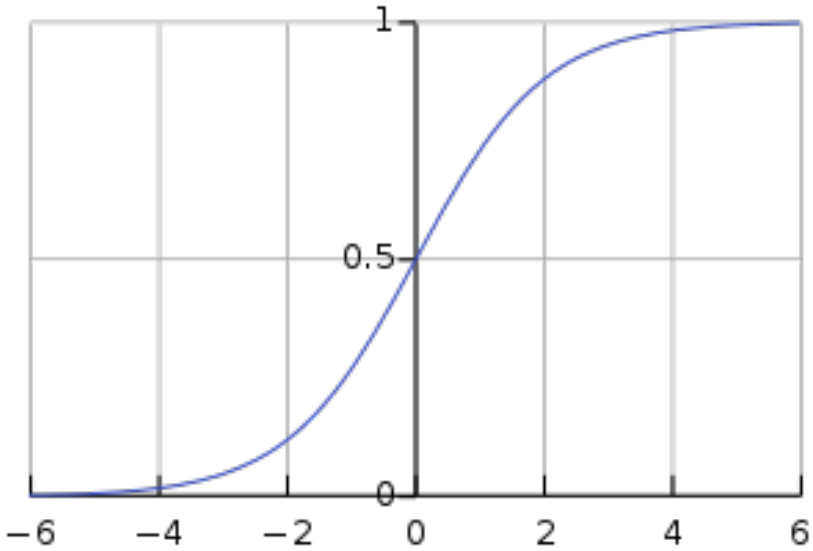
$$\sigma(x) = \frac{1}{1 + exp(-x)}$$

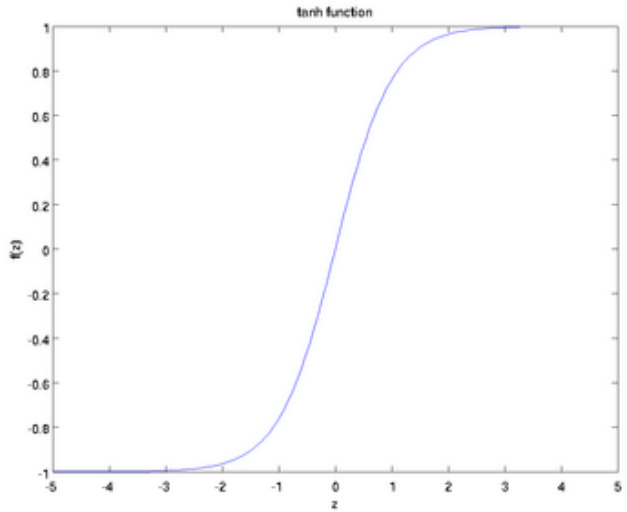
- tanh:

$$tanh(x) = 2\sigma(2x) - 1$$

- ReLU:

$$f(x) = max(0, x)$$





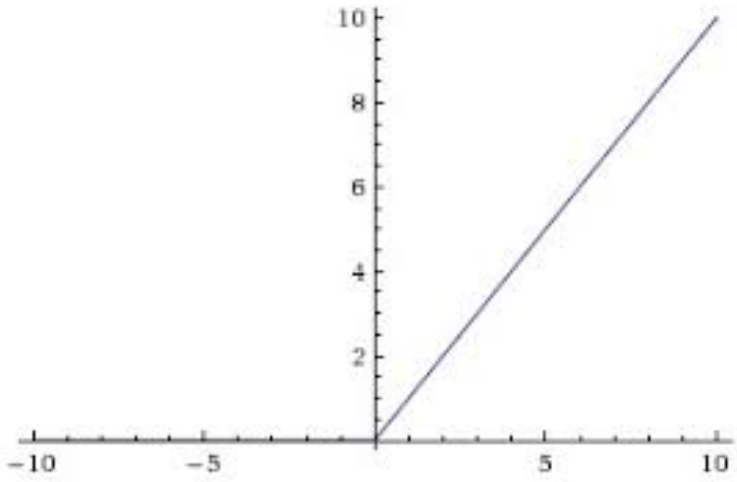


Figure: Activation functions - Sigmoid, tanh and ReLU

Multi Layer Perceptron

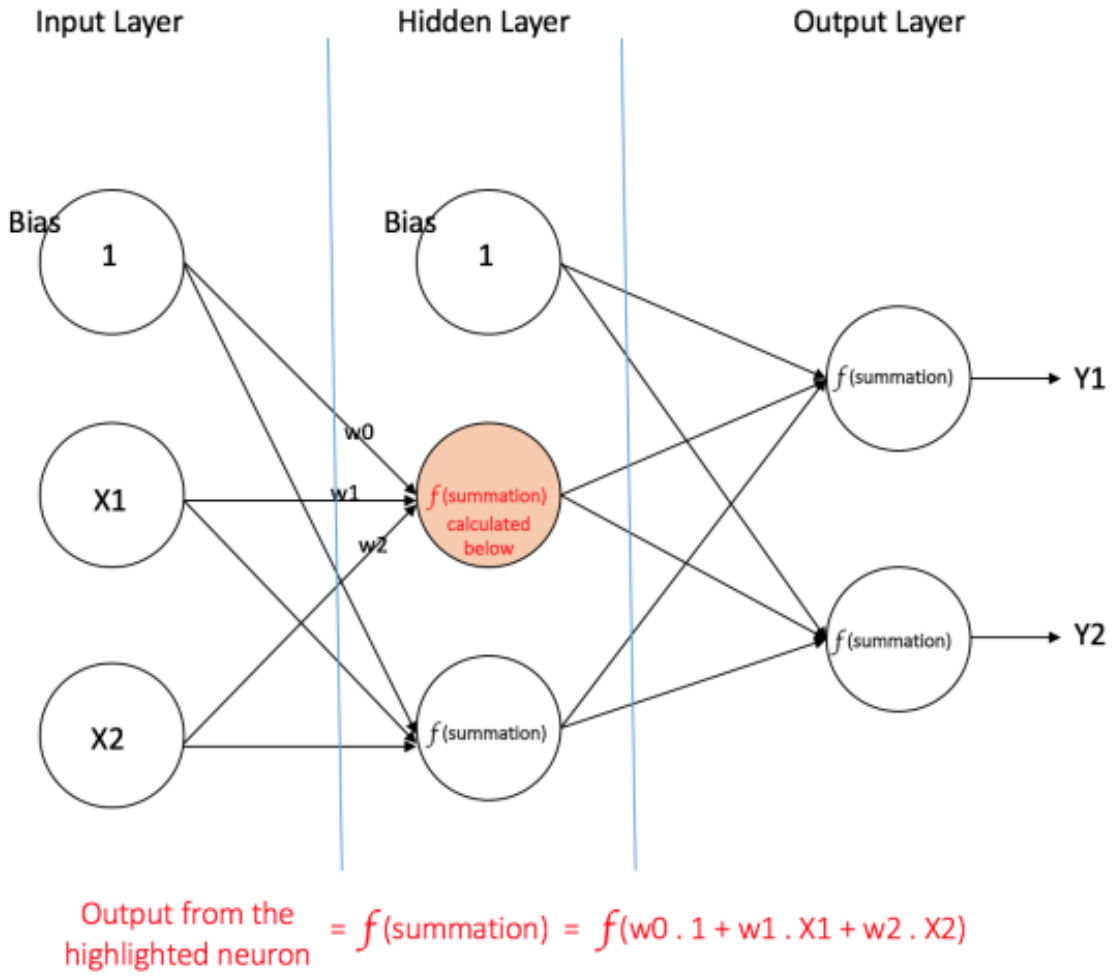


Figure: Forward propagation

Multi Layer Perceptron

Backpropagation
+
Weights Adjusted

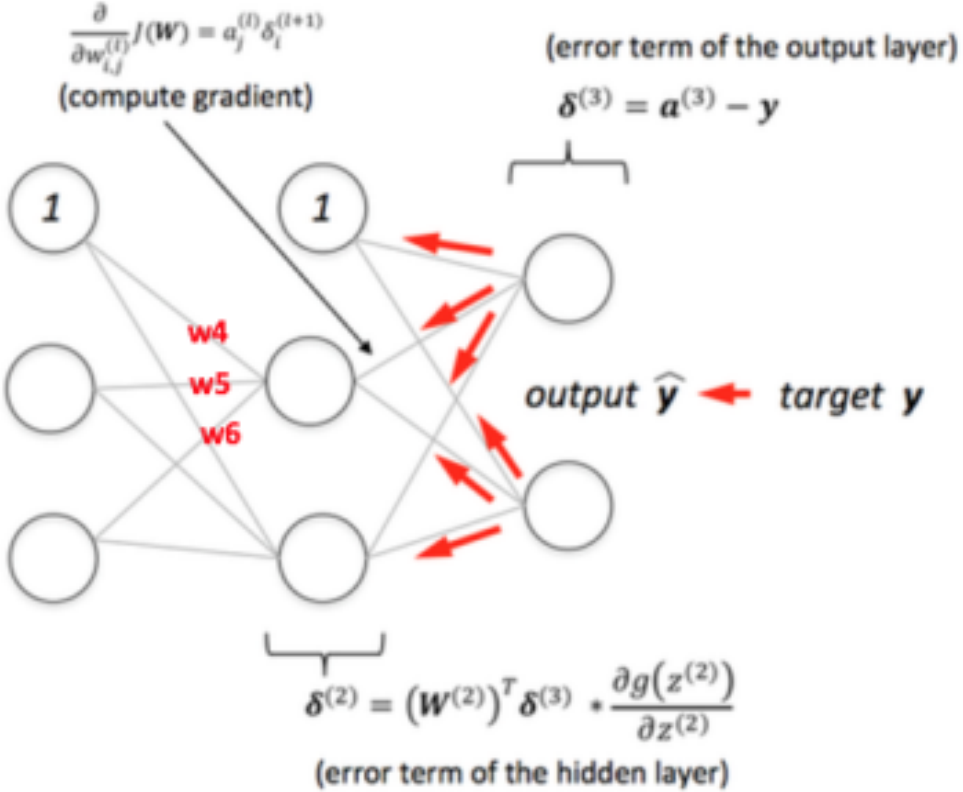
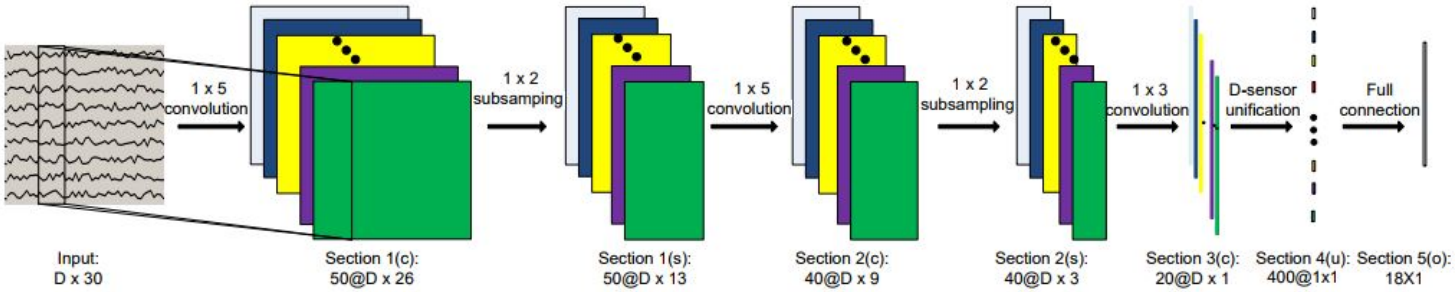


Figure: Backward propagation

CNN Model on Accelerometer Dataset

- Deep Convolutional Neural Network

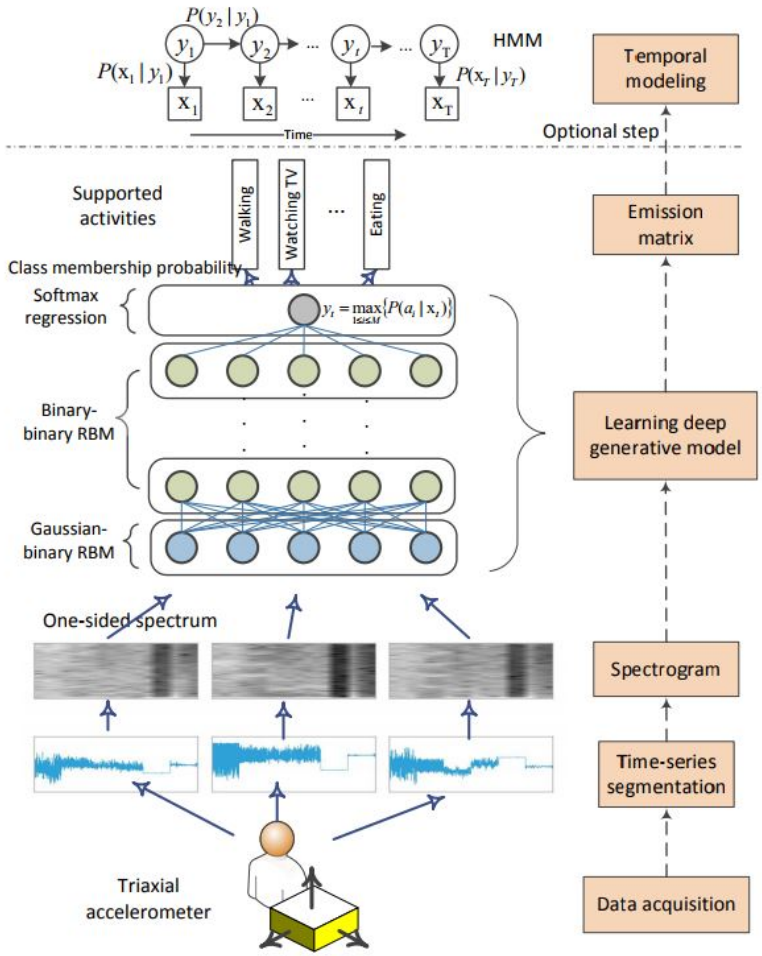


The CNN model includes convolution, subsampling, unification and output operations layers. This model also include one Data normalization layer. The activation function is ReLU (Rectified Linear Unit) function.

- The CNN model illustrated a higher accuracy on the gesture classification than other models [1].
- [1]JB. Yang *et al*, Deep Convolutional Neural Networks On Multichannel Time Series For Human Activity Recognition

Hybrid of Neural Networks and Hidden Markov Model

- Hybrid of Deep Neural Networks and Hidden Markov



Hybrid of Neural Networks and Hidden Markov Model

Step by Step Process

(1) Takes triaxial acceleration time series

(2) Extracts the spectrogram of windowed excerpts (from time domain to frequency domain)

(3) Computes intrinsic features using a deep generative model (Restricted Boltzman Machine (RBM), softmax regression)

(4) Recognizes the underlying human activities by finding the posterior probability distribution (Hidden Markov Model)

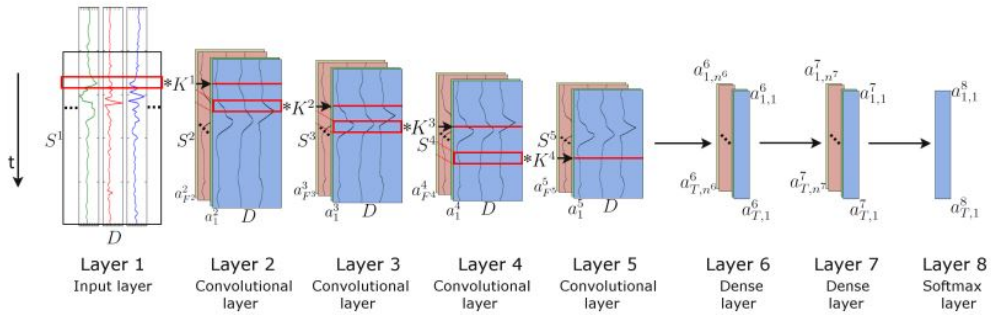
Results: Approximately 3.5% increase in the accuracy

[2] Reference M.A Alsheikh *et al* Reference: Deep Activity Recognition Models with Triaxial Accelerometers

CNN and LSTM Recurrent Neural Network

The data format of the accelerometer and gyroscope data are both 3-dimensional and the the Conventional Deep Convolutional Neural Network can also be applied to the Gyroscope dataset.

- Process flowchart



- This model is actually a cohesion of the CNN and LSTM (Long Short-term Memory) Recurrent Neural Network.

References
[3] F.J. Ordonez *et al.*, Deep Convolutional and LSTM Recurrent Neural Networks for Multimodal Wearable Activity Recognition, 2015
[4] S.C Yao *et al.*, DeepSense: A Unified Deep Learning Framework for Time-Series Mobile Sensing Data Processing, 2017

Useful Dataset Links

- WISDM: Wireless Sensor Data Mining
  `http://www.cis.fordham.edu/wisdm/dataset.php`
  This website provide some dataset and the basic human body movement classifications are given.
- UCI Machine Learning Repository
  This dataset is the Accelerometer and gyroscope data. Some basic body motion classifications are given.
  `https://archive.ics.uci.edu/ml/datasets/human+activity+recognition+using+smartphones`

Week 1 Summary

- The single Deep Learning Model, CNN and LSTM RNN can have good performance on data classification.
- Cohesion of different models may increase the performance.
- Sensor fusion is a common method of data pre-processing for the training of the Accelerometer and Gyroscope dataset.