

Introduction to Deep Learning

Tassadaq Hussain Riphah International University Barcelona Supercomputing Center UCERD Pvt Ltd

Artificial Intelligence

- Inspired by the brain
 - Input Data
 - Memorize
 - Process
 - Learn
 - Decision





Types of Learning

- Supervised learning: Your training data contain the known outcomes. The model is trained relative to these outcomes.
- Unsupervised learning: Your training data does not contain any known outcomes. In this case the algorithm self-discovers relationships in your data.





RIPHAH INTERNATIONAL UNIVERSITY

Biological Neuron

- A Biological neurons pass signals or messages to each other via electrical signals.
- Neighboring neurons receive these signals through their dendrites.
- Information flows from the dendrites to the main cell body, known as the soma, and via the axon to the axon terminals.
- In essence, biological neurons are computation machines passing messages between each other about various biological functions.
- At the heart of an artificial neural network is a mathematical node, unit or neuron. It is the basic processing element.





Workings of an individual neuron

 Given a sample of input attributes {x1,...,xn} a weight wij is associated with each connection into the neuron; and the neuron then sums all inputs according to:

$$f(u) = \sum_{i=1}^{n} w_{ij} x_j + b_j$$

• The parameter bj is known as the bias and is similar to the intercept in a linear regression model. It allows the network to shift the activation function "upwards" or "downwards".







• In their simplest form, feed-forward neural networks propagate attribute information through the network to make a prediction, whose output is either continuous for regression or discrete for classification.



• Illustrates a typical feed forward neural network topology. It has 2 input nodes, 1 hidden layer with 3 nodes, and 1 output node. The information is fed forward from the input attributes to the hidden layers and then to the output nodes which provide the classification prediction. It is called a feed forward neural network because the information flows forward through the network.



Neural Network

- A Neural network is constructed from a number of interconnected nodes known as neurons. These are usually arranged into a number of layers.
- A typical feed forward neural network will have at a minimum an input layer, a hidden layer and an output layer.
- The input layer nodes correspond to the number of features or attributes you wish to feed into the neural network.
- These are akin to the co-variates to use in a linear regression model.
- The number of output nodes correspond to the number of items you wish to predict or classify.
- The hidden layer nodes are generally used to perform non-linear transformation on the original input attributes.



AN: Artificial Neuron

A collection of simple, trainable mathematical units that collectively learn complex functions

Biological neuron



From Stanford cs231n lecture notes

Artificial neuron



F(x)=max(0,x)



NN: Neural Networks





Al using NN





Importance of Deep Learning



Deep Learning

 Deep learning is an area of machine learning that emerged from the intersection of neural networks, artificial intelligence, graphical modeling, optimization, pattern recognition and signal processing.





- Deep learning is about supervised or unsupervised learning from data using multiple layered machine learning models.
- The layers in these models consist of multiple stages of nonlinear data transformations, where features of the data are represented at successively higher, more abstract layers.



What is DL







- Deep learning methods aim at learning feature hierarchies with features from higher levels of the hierarchy formed by the composition of lower level features.
- The power of deep learning models comes from their ability to classify or predict nonlinear data using a modest number of parallel nonlinear steps.



DL Training





Importance of Deep Learning

Robust

- No need to design the features ahead of time features are automatically learned to be optimal for the task at hand
- Robustness to natural variations in the data is automatically learned

Generalizable

The same neural net approach can be used for many different applications and data types

Scalable

Performance improves with more data, method is massively parallelizable



Advantages of DL



INTERNATIONAL

Usage



Pedestrian Detection, Traffic Sign Recognition

Breast Cancer Cell Mitosis Detection, Volumetric Brain Image Segmentation



INTERNATIONAL

DL Architectures

- Deep learning architectures are basically artificial neural networks of multiple nonlinear layers and several types have been proposed according to input data characteristics and research objectives.
 - Deep Neural Network
 - Convolution Neural Network
 - Recurrent Neural Network
 - Emergent Architecture



Deep Neural Network

A collection of simple, trainable mathematical units that collectively learn complex functions

Hidden layers

Output layer

Input layer

Given sufficient training data an artificial neural network can approximate very complex functions mapping raw data to output decisions



Deep Neural Network





Convolution NN



- Inspired by the human visual cortex
- Learns a hierarchy of visual features
- Local pixel level features are scale and translation invariant
- Learns the "essence" of visual objects and generalizes well







Recurrent NN





Deep Learning is Everywhere



INTERNET & CLOUD

Image Classification Speech Recognition Language Translation Language Processing Sentiment Analysis Recommendation



MEDICINE & BIOLOGY

Cancer Cell Detection Diabetic Grading Drug Discovery



MEDIA & ENTERTAINMENT

Video Captioning Video Search Real Time Translation



SECURITY & DEFENSE

Face Detection Video Surveillance Satellite Imagery



AUTONOMOUS MACHINES

Pedestrian Detection Lane Tracking Recognize Traffic Sign





Deep Learning Frameworks



Deep Learning System







- Process Modeling and Control.
- Health Diagnostics.
- Investment Portfolio Management.
- Military Target Recognition.
- Analysis of MRI and X-rays.
- Credit Rating of individuals by banks and other financial institutions.
- Marketing campaigns.
- Voice Recognition.



Task

- Download 2 Papers of DL published after 2016.
- Read at least abstract, introduction and conclusion.
- Write the synopsis that includes
 - Importance of big data (one paragraph)
 - Challenges of big data (one paragraph)
 - Importance of DL (one paragraph)
 - Challenges of DL (one paragraph)
 - Your solution/suggestion (one paragraph)
- Deadline is 10th of April

