**Principles of AI Surprise Test-3**

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**Q1. What is the difference between Forward propagation and Backward Propagation in Neural Networks?**

**Answer.**

**Forward Propagation**  
As the name suggests, the input data is fed in the forward direction through the network. Each hidden layer accepts the input data, processes it as per the activation function and passes to the successive layer.

In order to generate some output, the input data should be fed in the forward direction only. The data should not flow in reverse direction during output generation otherwise it would form a cycle and the output could never be generated. Such network configurations are known as feed-forward network. The feed-forward network helps in forward propagation.

At each neuron in a hidden or output layer, the processing happens in two steps:

1. **Pre-activation**: it is a weighted sum of inputs i.e., the linear transformation of weights w.r.t to inputs available. Based on this aggregated sum and activation function the neuron makes a decision whether to pass this information further or not.
2. **Activation**: the calculated weighted sum of inputs is passed to the activation function. An activation function is a mathematical function which adds non-linearity to the network. There are four commonly used and popular activation functions — sigmoid, hyperbolic tangent(tanh), ReLU and Softmax.

A [Feed-Forward Neural Network](http://en.wikipedia.org/wiki/Feedforward_neural_network) is a type of Neural Network **architecture** where the connections are "fed forward", i.e. do not form cycles (like in recurrent nets).

The term "Feed forward" is also used when you input something at the input layer and it *travels* from input to hidden and from hidden to output layer.

**Backward Propagation**  
Back-propagation is the essence of neural net training. It is the practice of fine-tuning the weights of a neural net based on the error rate (i.e., loss) obtained in the previous epoch (i.e., iteration). Proper tuning of the weights ensures lower error rates, making the model reliable by increasing its generalization.

Backpropagation is a **training algorithm** consisting of 2 steps:

1) **Feed forward** the values

2) Calculate the error and **propagate it back** to the earlier layers.

So to be precise, forward-propagation is part of the backpropagation **algorithm** but comes before back-propagating.

Backpropagation is algorithm to train (adjust weight) of neural network. Input for backpropagation is output\_vector, target\_output\_vector, output is adjusted\_weight\_vector.

Feed-forward is algorithm to calculate output vector from input vector. Input for feed-forward is input\_vector, output is output\_vector.

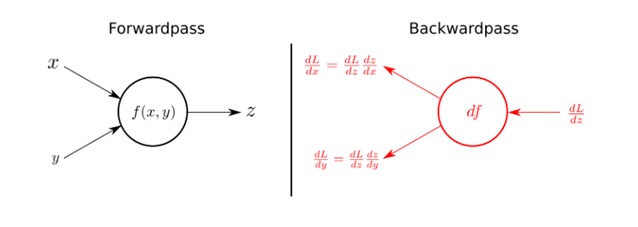
When you are training neural network, you need to use both algorithms.

When you are using neural network (which have been trained), you are using only feed-forward.

Basic type of neural network is multi-layer perceptron, which is Feed-forward backpropagation neural network.

The overall steps are:

* In the forward propagate stage, the data flows through the network to get the outputs
* The loss function is used to calculate the total error
* Then, we use backward propagation algorithm to calculate the gradient of the loss function with respect to each weight and bias
* Finally, we use gradient descent to update the weights and biases at each layer
* We repeat above steps to minimize the total error of the neural network.



Using the input variables x and y, the forward pass or propagation calculates output z as a function of x and y i.e. f(x,y).

During backward pass or propagation, on receiving dL/dz (the derivative of the total loss, L with respect to the output, z), we can calculate the individual gradients of x and y on the loss function by applying the chain rule.

**Q2. What is the use of Artificial Neural Network?**

**Answer.**

Neural networks are a part of [deep learning,](https://www.analyticssteps.com/blogs/introduction-deep-learning-and-its-applications) which comes under the comprehensive term, artificial intelligence. Neural networks are a set of algorithms that are modelled after the human brain. These networks are also known as artificial neural networks (ANN).

Sensory neurons, motor neurons and interneurons form the human brain. Artificial neurons, form the replica of the human brain (i.e. a neural network).

Weights and biases are learning parameters of machine learning models, they are modified for training the neural networks.

Artificial Neural Network (ANN) is a collection of connected units (nodes). These connected units are known as artificial neurons. These units closely resemble the original neurons of a human brain.  Every node is built with a set of inputs, weights, and a bias value. Weights of the [neural network](https://www.analyticssteps.com/blogs/introduction-neural-networks-and-deep-learning) are held within the hidden layers.

## ****Applications of Neural Networks****

Neural Networks are regulating some key sectors including finance, healthcare, and automotive. As these artificial neurons function in a way similar to the human brain. They can be used for image recognition, character recognition and stock market predictions.

### **1. Facial Recognition**

Facial Recognition Systems are serving as robust systems of surveillance. Recognition Systems matches the human face and compares it with the digital images. They are used in offices for selective entries. The systems thus authenticate a human face and match it up with the list of IDs that are present in its database.

### **2. Stock Market Prediction**

Investments are subject to market risks. It is nearly impossible to predict the upcoming changes in the highly volatile stock market. The forever changing bullish and bearish phases were unpredictable before the advent of neural networks. But well, what changed it all? Neural Networks of course…

To make a successful stock prediction in real time a**Multilayer Perceptron MLP**(class of feedforward artificial intelligence algorithm) is employed.  MLP comprises multiple layers of nodes, each of these layers is fully connected to the succeeding nodes. Stock’s past performances, annual returns, and nonprofit ratios are considered for building the MLP model.

### **3. Social Media**

No matter how cliche it may sound, social media has altered the normal boring course of life. Artificial Neural Networks are used to study the behaviours of social media users. Data shared everyday via virtual conversations is tacked up and analyzed for competitive analysis.

 Neural networks duplicate the behaviours of social media users. Post analysis of individuals' behaviours via social media networks the data can be linked to people’s spending habits. **Multilayer Perceptron ANN**is used to mine data from social media applications.

MLP forecasts social media trends, it uses different training methods like **Mean Absolute Error (MAE),**[**Root Mean Squared Error (RMSE),**](https://www.researchgate.net/publication/284169605_Application_of_Artificial_Neural_Network_in_Social_Media_Data_Analysis_A_Case_of_Lodging_Business_in_Philadelphia)**and Mean Squared Error (MSE).** MLP takes into consideration several factors like user’s favourite instagram pages, bookmarked choices etc. These factors are considered as inputs for training the MLP model.

In the ever-changing dynamics of social media applications, artificial neural networks can definitely work as the best fit model for user data analysis.

### **4. Aerospace**

Aerospace Engineering is an expansive term that covers developments in spacecraft and aircraft. Fault diagnosis, high performance auto piloting, securing the aircraft control systems, and modeling key dynamic simulations are some of the key areas that neural networks have taken over. Time delay Neural networks can be employed for modelling [non linear time dynamic systems.](https://www.hindawi.com/journals/ijae/2011/247294/)

**Time Delay Neural Networks** are used for **position independent feature recognition.**  The algorithm thus built based on time delay neural networks can recognize patterns. (Recognizing patterns are automatically built by neural networks by copying the original data from feature units).

Other than this TNN are also used to provide stronger dynamics to the NN models. As passenger safety is of utmost importance inside an aircraft, algorithms built using the neural network systems ensures the accuracy in the autopilot system. As most of the autopilot functions are automated, it is important to ensure a way that maximizes the security.

### **5. Defence**

Defence is the backbone of every country. Every country’s state in the international domain is assessed by its military operations. Neural Networks also shape the defence operations of technologically advanced countries. The United States of America, Britain, and Japan are some countries that use artificial neural networks for developing an active defence strategy.

Neural networks are used in logistics, armed attack analysis, and for object location. They are also used in air patrols, maritime patrol, and for controlling automated drones. The defence sector is getting the much-needed kick of artificial intelligence to scale up its technologies.

### **6.  Healthcare**

The age old saying goes like “Health is Wealth”. Modern day individuals are leveraging the advantages of technology in the healthcare sector. **Convolutional Neural Networks**are actively employed in the healthcare industry for**X ray detection,** **CT Scan** and **ultrasound.**

As CNN is used in image processing, the medical imaging data retrieved from aforementioned tests is analyzed and assessed based on neural network models. **Recurrent Neural Network (RNN)** is also being employed for the development of voice recognition systems.

### **7. Signature Verification and Handwriting Analysis**

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Signature Verification, as the self-explanatory term goes, is used for verifying an individual’s signature. Banks, and other financial institutions use signature verification to cross check the identity of an individual.

Usually, a signature verification software is used to examine the signatures. As cases of forgery are pretty common in financial institutions, signature verification is an important factor that seeks to closely examine the authenticity of signed documents.

**Artificial Neural Networks** are used for **verifying the signatures.** ANN are trained to recognize the difference between real and forged signatures. ANNs can be used for the verification of both offline and online signatures.

For training an ANN model, varied datasets are fed in the database. The data thus fed help the ANN model to differentiate. **ANN model employs image processing**for [extraction of features.](http://www.iosrjournals.org/iosr-jce/papers/Conf.16051/Volume-1/7.%2028-35.pdf)

Handwriting analysis plays an integral role in forensics. The analysis is further used to evaluate the variations in two handwritten documents. The process of spilling words on a blank sheet is also used for behavioural analysis. **Convolutional Neural Networks (CNN)** are used for handwriting analysis and handwriting verification.

### **8. Weather Forecasting**

The forecasts done by the meteorological department were never accurate before artificial intelligence came into force. Weather Forecasting is primarily undertaken to anticipate the upcoming weather conditions beforehand. In the modern era, weather forecasts are even used to predict the possibilities of natural disasters.

**Multilayer Perceptron (MLP), Convolutional Neural Network (CNN) and Recurrent Neural Networks (RNN)** are used for weather forecasting. Traditional ANN multilayer models can also be used to predict climatic conditions 15 days in advance. A combination of different types of neural network architecture can be used to predict air temperatures.