

Lesson 1: Artificial Neural Networks**Table of Contents**

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1.1 Introduction

An artificial neural network is an attempt to simulate the network of neurons that make up a human brain so that the computer will be able to learn things and make decisions in a humanlike manner. ANNs are created by programming regular computers to behave as though they are interconnected brain cells.

1.2 Definition of terms

There are a number of terms used in this unit which we need to familiarize ourselves with and some of which are described below:

1.2.1 Algorithms

A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer

1.2.2 Neural Science

Neuroscience, also known as Neural Science, is the study of how the nervous system develops, its structure, and what it does. Neuroscientists focus on the brain and its impact on behavior and cognitive functions.

1.2.3 Neural Networks

It is a type of machine learning process, called deep learning that uses interconnected nodes or neurons in a layered structure that resembles the human brain.

1.2.4 Artificial Intelligence

The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages

1.2.5 Artificial Neural Networks

Artificial neural network (ANN) is a computational model that consists of several processing elements that receive inputs and deliver outputs based on their predefined activation functions.

1.2.6 Machine Learning

Machine Learning (ML) is that field of computer science with the help of which computer systems can provide sense to data in much the same way as human beings do. In simple words, ML is a type of artificial intelligence that extract patterns out of raw data by using an algorithm or method. The main focus of ML is to allow computer systems learn from experience without being explicitly programmed or human intervention.

1.3 Characteristics of Neural Networks

- i. It is neurally implemented mathematical model
- ii. It contains huge number of interconnected processing elements called neurons to do all operations
- iii. Information stored in the neurons are basically the weighted linkage of neurons
- iv. The input signals arrive at the processing elements through connections and connecting weights.
- v. It has the ability to learn, recall and generalize from the given data by suitable assignment and adjustment of weights.
- vi. The collective behavior of the neurons describes its computational power, and no single neuron carries specific information.

1.4 Types of Neural Networks

There are three types of Neural Networks:

1.4.1 Multi-Layer Perceptron (MLP)

A multilayer perceptron (MLP) is a class of a feed forward artificial neural network (ANN). MLPs models are the most basic deep neural network, which is composed of a series of fully connected layers. Today, MLP machine learning methods can be used to overcome the requirement of high computing power required by modern deep learning architectures. Each new layer is a set of nonlinear functions of a weighted sum of all outputs (fully connected) from the prior one.

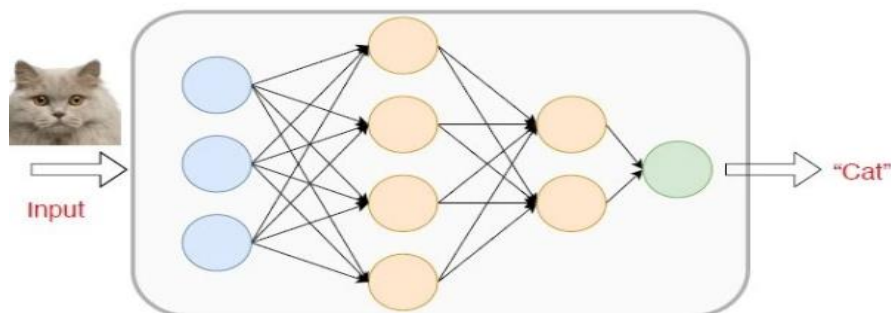


Figure 1: Concept of a Multi-Layer perceptron

1.4.2 Convolutional Neural Networks (CNN)

A convolutional neural network (CNN, or ConvNet) is another class of deep neural networks. CNNs are most commonly employed in computer vision. Given a series of images or videos from the real world, with the utilization of CNN, the AI system learns to automatically extract the features of these inputs to

complete a specific task, e.g., image classification, face authentication, and image semantic segmentation. Different from fully connected layers in MLPs, in CNN models, one or multiple convolution layers extract the simple features from input by executing convolution operations. Each layer is a set of nonlinear functions of weighted sums at different coordinates of spatially nearby subsets of outputs from the prior layer, which allows the weights to be reused.

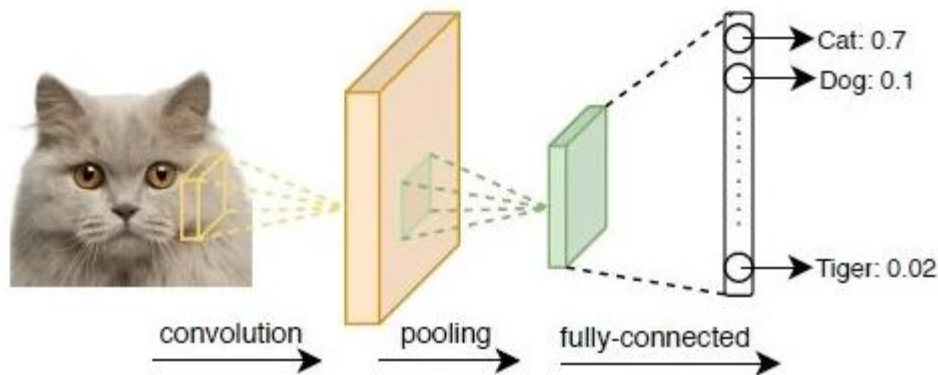


Figure 2: Concept of a CNN

1.4.3 Recurrent Neural Networks (RNN)

A recurrent neural network (RNN) is another class of artificial neural networks that use sequential data feeding. RNNs have been developed to address the time-series problem of sequential input data. The input of RNN consists of the current input and the previous samples. Therefore, the connections between nodes form a directed graph along a temporal sequence. Furthermore, each neuron in an RNN owns an internal memory that keeps the information of the computation from the previous samples.

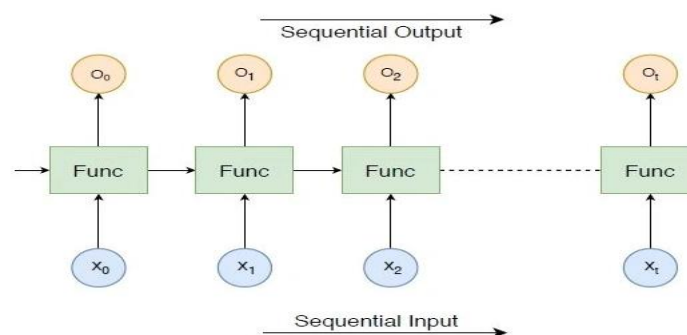


Figure 3: Concept of a Recurrent Neural Network

1.5 Application of Artificial Neural Networks (ANN)

- i. Classification: NNs organize patterns or datasets into predefined classes.
- ii. Prediction: They produce the expected output from given input.

- iii. Clustering: They identify a unique feature of the data and classify it without any knowledge of prior data.

1.6 Comparison of classical AI and ANN

AI verses ANN

Artificial intelligence	Neural Network
It is a branch of computer science that emphasizes on the creation of smart machines that embody a sort of intelligence, as opposed to the natural intelligence demonstrated by humans	It refers to a network of artificial neurons or nodes vaguely inspired by the biological neural network that constitute animal brain.
It is an idea of creating intelligent machines, ones that are as smart as or smarter than humans	It is a network of interconnected nodes whose functionality is loosely based on animal neurons
Applications of AI include machine learning, knowledge reasoning, natural language, processing, data processing, clinical diagnosis, pattern recognition, machine vision among others.	Applications include text classification and categorization, named entity recognition

1.7 Opportunities for experts in ANN

- i. Test engineer
- ii. Research Scientist
- iii. Applied scientists
- iv. Business intelligence developer
- v. Full-stack developer
- vi. Data engineer
- vii. Software engineer
- viii. Machine learning engineer
- ix. Deep learning engineer

1.8 Lesson Questions

In which field of your career path with ANN help you as a professional?