

Chapter 2

Comprehensive Introduction to Neural Networks: Advent, Evolution, Applications, and Challenges


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ABSTRACT

Unknowingly, artificial intelligence (AI) has become an inevitable part of our lives. In this chapter, the authors discuss how the neural networks, a sub-part of AI, changed the way we analyse things. In this chapter, the advent of neural networks, inspiration from the human brain, simplification models of biological neuron models are discussed. Later, a detailed overview of various neural network models, their strengths, limitations, applications, and challenges are presented in detail.

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INTRODUCTION

Neural Networks (NNs) are widely being used in many Artificial Intelligence (AI) applications such as Robotics Computer Vision, and Natural Language Processing (Y. LeCun, Y. Bengio, and G. Hinton, 2015). They deliver cutting edge accuracy on various AI tasks. This comes at the cost of high computational complexity. There are system architectures and hardware platforms that support Neural networks. In this chapter, we go in-depth understanding of how neural networks work and how they are implemented and embedded in our lives.

Brain-inspired computation is often discussed in the fields of AI and Machine Learning. Since the human brain is currently the best “computing machine” known to mankind that performs many undefined cognitive operations such as observe, analyze and solve problems referred to as learning. it is a natural place to look for inspiration for the Machine Learning approach (J. Madrenas and J. M. Moreno, 2009).

Therefore, from the way the brain works, taking some basic aspects of its form or functionality, programs or algorithms on brain-inspired computation are developed. This is in contrast with the attempts being made to create an artificial brain. But rather the program aims at emulating some of the key features of how humans understand the brain’s operation. Although research is still being carried out on exploring the details of the human brain. The neuron is widely believed to be the main computational element of the brain.

NEURON

there are an estimated eighty-six billion neurons in an average human brain. as shown in figure 1, These neurons are themselves connected to each other with a number of structural elements entering them called **dendrites**, an element leaving them called **axons** and the central unit called **soma**, where the information is processed. A typical neuron has a random number of dendrites and axons depending upon the role it plays in a particular function. Figure 1 depicts the basic structure of a neuron (Leterrier, Christophe, 2016).

Neurons channel the incoming signals entering it over the dendrites, carryout computation on those signals at the soma and provoke an output signal on the axon. These input signals are purported to as **activations**. The axon of one neuron branches out and is connected to the dendrites of many other neurons. The site where a dendrite and a branch of the axon a meet is called a **synapse** that’s where a neuron transmits signals from one to another. There are estimated to Hundred billion synapses in an average human brain and new synapses are made and broken every second.

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