CHAPTER 27

What Is Deep Learning?

Deep learning is a class of machine learning algorithms called neural networks. Neural networks are mathematical models inspired by the structure of the brain. Deep learning enables the neural network algorithm to perform very well in building prediction models around complex problems such as computer vision and language modeling. Self-driving cars and automatic speech translation, to mention just a few, are examples of technologies that have resulted from advances in deep learning.

The Representation Challenge

Learning is a non-trivial task. The brain's ability to learn complex tasks is not yet fully understood by research communities in neurological science, psychology, and other brain-related fields. What we consider trivial, and to some others natural, are a system of complex and intricate processes that have set us apart from other life forms as intelligent beings.

Examples of complex tasks performed by the human brain include the ability to recognize faces at a millionth of a second (probably much faster), the uncanny aptitude for learning and understanding deep linguistic representations, and forming symbols for intelligent communications. Also, the adept skills to compose and perform masterful musical pieces are examples of the marvel of natural intelligence.

The challenge of AI research and engineering is to build machines that can understand and decompose the structural patterns inherent in complex problems in order to mimic natural intelligence. Deep learning as an AI technique approaches the representation problem by learning the underlying fundamental structure inherent in the dataset. Deep learning is also called representation learning.

E. Bisong, *Building Machine Learning and Deep Learning Models on Google Cloud Platform*,
https://doi.org/10.1007/978-1-4842-4470-8_27

Inspiration from the Brain

Scientists often look to nature for inspiration when performing incredible feats. Notably, the birds inspired the airplane. In that vein, there is no better type to study as an antitype of intelligence as the human brain.

We can view the brain as a society of intelligent agents that are networked together and communicate by passing information via electrical signals from one agent to another. These agents are known as neurons. Our principal interest here is to have a glimpse of what neurons are, what their components are, and how they pass information around to create intelligence.

A neuron is an autonomous agent in the brain and is a central part of the nervous system. Neurons are responsible for receiving and transmitting information to other cells within the body based on external or internal stimuli. Neurons react by firing electrical impulses generated at the stimuli source to the brain and other cells for the appropriate response. The intricate and coordinated workings of neurons are central to human intelligence.

The following are the three most essential components of neurons that are of primary interest to us:

- The axon
- The dendrite
- The synapse

The axon is a long tail connected to the nucleus of the neuron as seen in Figure 27-1. The axon is responsible for transmitting electrical signals from the nucleus to other neuron cells through the axon terminals. The dendrite, on the other hand, receives information as electrical impulses from other neuron cells through the synapses to the nucleus of a neuron cell.