Chapter 2
Artificial Intelligence: Exploring Machine Learning, Deep Learning, and Neural Networks

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ABSTRACT

Artificial Intelligence (AI) has rapidly advanced with key contributions from Machine Learning (ML), Deep Learning (DL), and Neural Networks (NN). These technologies form the foundation for numerous applications across diverse domains such as healthcare, finance, and autonomous systems. This chapter explores the fundamental concepts, techniques, and architectures of ML, DL, and NN, delving into the evolution of these fields and their current state. The chapter also highlights the challenges, such as data quality, interpretability, and computational efficiency, while discussing emerging trends like Explainable AI, Federated Learning, and energy-efficient AI. As AI continues to evolve, it holds the potential to transform industries and society, underscoring the importance of responsible and sustainable development.

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1. INTRODUCTION

1.1 Brief Overview of Artificial Intelligence (AI)

AI is one of the most innovative and developing fields of the present-day technology. In its broadest sense, artificial intelligence may be described as the attempt to create machines that are able to mimic human intelligence (Zhang & Lu, 2021). They include acquiring knowledge, making inferences, solving problems, perceiving, comprehending language and making decisions. The idea of artificial intelligence can be dated back to the 1950s whereby thinkers such as Alan Turing came up with an idea of a machine that was capable of thinking like a human being. Since then, AI has gone through many phases of advancement, experience great progress and downfalls as well. In the modern world, due to the development of computing technology, the availability of data, and the use of complex algorithms, artificial intelligence is used in almost all spheres of our life, including medicine, finance, entertainment, and automobile industry. AI is still in its development stage but its impacts on industries and day to day life are promising to be enormous, hence AI is an area of research and development in the twenty first century(Yüksel et al., 2023).

1.2 Importance of Machine Learning (ML), Deep Learning (DL), and Neural Networks (NN) in AI

Concerning the wide field of AI, subfields of ML, DL and NN have become significant complements with a significant amount of recent progress occurring in these areas. Machine Learning is a branch of AI in which the computer is trained to make its decision based on the data it is fed with, without being programmed for this particular task. Artificial learning algorithms are seen to be quite successful in a few areas including, spam detection, image classification and recommendation (Janiesch et al., 2021). ML is further divided into Deep Learning wherein the layered structures called NN are used to model the patterns in huge data sets. These deep architectures create a branch of learning that is loosely mimicking the structure of the human brain and which require feature extraction from the input data at different layers, and fine and coarse gradients of learning, making them very effective, and best suited for applications such as speech recognition, NLP or autonomous vehicles. Neural Networks(NN), being the building block of DL, give the architecture by which the machines can emulate a structure of neurons and layers that allow the machines to learn complex patterns of the data. In fact, ML, DL, and NN are not just the subfields of AI, rather, they are the keys to most of the current advancements in AI. This cannot be overemphasized as they have successfully applied abstract ideas into real life solutions that are revolutionizing sectors, and even cultures(Sarker, 2021).