Chapter 10

Deep Learning for Next-Generation Inventive Wireless Networks: Issues, Challenges, and Future Directions

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ABSTRACT

Recent years have witnessed an exponential rise in the number of connected wireless devices. This number is expected to rise at an unprecedented rate leading to severe challenges in user demands and network infrastructure. With the fusion of artificial intelligence (AI) technologies, these devices have become more smart and intelligent. Using machine learning, efforts are being carried out to artificially train these networks to determine the optimum system requirements automatically. With these intelligent networks generating an enormous volume of data along with the demand for high data rate, machine learning has found its few limitations. Deep learning techniques have emerged as one of the most impressive tools to solve many of these problems. The primary objective of this chapter is to provide insights into deep learning and the applications of deep learning in next-generation inventive wireless networks. The chapter also presents the issues, challenges, and future directions in this research area.

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INTRODUCTION

Over these years, tremendous increase has been seen in the number of connected wireless devices. With the introduction of technologies like Internet of Things (IoT) (Ahlgren et al., 2016; Philip et al., 2016; Deshkar et al., 2017; Jacob et al., 2019; Menon et al., 2019; Rajesh et al., 2019) fog computing (Nayyar 2018; Menon & Prathap, 2017, 2018), flying ad hoc networks(Rosati et al., 2016; Cruz 2018), 5G networks, dynamic ad hoc networks(Menon & Prathap 2016, 2017, 2019; Nayyar et al., 2018), cognitive radios etc. this number is rising exponentially. With Artificial Intelligence (AI) (O’Leary, 2013; Murphy, 2018; Jain, 2019; Vinoj, 2019) incorporating adaptive learning and decision-making capabilities, these devices have become smarter and more intelligent. Modern applications thus face a huge task of providing high data rates and better Quality of Service. Handling the huge amount of generated data is yet another challenge in these networks (Yazti & Krishnaswamy, 2014; He at al., 2016; Mengke et al., 2016; Londhe & Rao, 2017; Vijay et al., 2018).

Many technologies have been tried to optimize the performance of the modern wireless networks and to provide better service to users. Machine learning (Xue & Zhu, 2009; Ross et al., 2013; Louridas and C. Ebert, 2016; Alzubi et al., 2018) has been one of the successful methods. Machine learning techniques and approaches have helped the modern applications using intelligent wireless devices to provide better QoS to users. Optimization of network resources, traffic management, routing of data packets, congestion management etc. has been effectively dealt using machine learning approaches. Using various machine learning approaches, most of the devices in the network have been trained with the collected data and knowledge to perform better in future. But with the number of devices increasing at an unprecedented rate, machine learning has found its limitations. This has given way to the rise of deep learning technology (Wang, 2016 2017; Nishani & Çiço 2017, Kauer et al., 2018).

With the use of deep learning computational models composed of several processing layers which are capable of learning data representations with multiple levels of abstraction. Deep learning has been a revolution and has effectively managed various problems faced by modern applications. Many deep learning techniques are being used to improve the performance of the intelligent wireless networks. The research article provides insights into fundamental deep learning concepts with some of its applications in next-generation inventive wireless networks

The organization of the research paper is as follows. The transition from machine learning to deep learning is discussed in section 2. This section presents the advantages of deep learning compared to machine learning approaches. Next section gives a detailed explanation on the various concepts in deep learning. Section 4 presents a summary of the next generation wireless network technologies. The application of deep learning in these inventive wireless networks is discussed in Section 5. Issues and challenges existing in this research area are discussed in Section 6 and we conclude the paper in section 7.

MOVING FROM MACHINE LEARNING TO DEEP LEARNING

This section describes the transition from machine learning to deep learning approaches. As a subset of artificial intelligence, machine learning is widely used for a variety of applications. Machine learning is the art of gaining knowledge from experience and using it for future decisions. The primary objective of Machine learning is the development of computer programs which can access data from the dataset and learn by themselves. The overview of machine learning process is illustrated in Figure 1.