Chapter 3
Artificial Intelligence in Mobile and Modern Wireless Networks

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ABSTRACT

Wireless communication systems have become fundamental to the information centric infrastructure of today. Due to their high demand, accessibility, and ease of use, they have undergone rapid development to support the ever-growing needs of wireless communication. Machine learning and artificial intelligence-enabled algorithms have provided unique solutions to many of the modern challenges in wireless communication systems. This chapter provides an overview of many of the communication sub-systems where intelligent algorithms are actively playing an important role. It starts by providing a brief introduction to the history and development of wireless communication systems, followed by an overview of their types, their applications, and properties. It then describes the main components of a basic wireless communication system, followed by the role of AI, based on the type of sub-system in the wireless communication chain. It also provides a comprehensive overview of the work being done in the areas currently targeted by AI in the wireless communication domain.

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INTRODUCTION TO WIRELESS NETWORKS

The development of communication in human civilization enabled humans to realize the full potential of their intellectual faculties not only greatly empowering cooperation but also sharing and understanding. Man has always relied on other members of their species for survival, because what they lacked in terms of teeth and claws, they made up for in intellect and cooperation. The communication of information within and across generations made it possible for the people to preserve the work done by their neighbors and ancestors, while also exploring further horizons of development.

Considering the current landscape of technological development, the personal computer and radio were two of the most important inventions that paved the way for further technologies on which many of our important systems rely today. Every sector, from healthcare to finance to construction, relies on computer systems and advanced radio operated equipment for their operation necessities. The recent COVID-19 pandemic pushed the limits of the current network infrastructure and proved that the services available through decades of development have the potential to enable offsite operation in a variety of areas. This situation however also further highlighted the necessity of the developments planned for the future generation of wireless networks.

In addition to the above-mentioned scenario, the mainstream adoption of IoT based home automation and security systems, the widespread use of IoT devices, and availability of assistants and smart gadgets has created a new application domain where traditional networks fail to meet the necessary functional requirements. These types of use cases necessitate very different network constraints to be placed on the performance of the communication system. They do require high bandwidth connectivity but rather low-energy, sparse, control oriented and highly available communication. These requirements, along with many others, form the basis of machine-to-machine (M2M) communications. M2M type communication has been given considerable importance in the fifth-generation wireless networks, however, it still provides limited support for the formation of proper M2M networks. Next generation wireless networks aim to not only provide full support for the formation, functioning and maintenance of M2M networks but to also integrate AI and machine learning for network performance optimization.

The application scenarios required to be supported by the next generation of wireless networks place strict multi-dimensional performance requirements on these networks. These requirements are expected to be enabled and supported by a set of key technologies that enable next generation communication networks to form feasible and effective communication architectures. These architectures aim to make effective use of a multitude of technologies to enable ubiquitous coverage and consistent performance while meeting the quality of service (QoS) requirements

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