Chapter 11
AI in Cognitive Radio Networks: Its Role and Applications

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ABSTRACT

This chapter provides a-state-of-art of artificial intelligence (AI) techniques applied to cognitive radio networks. Cognitive radio (CR) is an empowering innovation for various new opportunities, for example, spectrum sensing, access, markets, and self-organizing networks. Its target is to enable the system to exploit the available resources through self-learning and to adapt itself accordingly to the sensed environment. To understand this plethora of applications, CR researchers often make use of several types of AI techniques. By utilizing AI, the network system can immediately complete self-awareness learning, structure association, and scheduling several tasks. To help researchers obtain a healthier knowledge of AI techniques along with CR, this chapter presents several such implementations that have already been applied. Finally, the literature review of the best accomplishments in applying AI techniques to CRs is presented and classified according to the major techniques of artificial intelligence.

INTRODUCTION

Cognitive radio (CR) is an empowering innovation for various new opportunities, for example, spectrum sensing, spectrum access, self-organizing networks, and spectrum markets. A wireless communication system marks its future in its aptness to intelligently utilize the resources to meet the needs of services with growing diversity. Its target is to enable the system to perceive and exploit the available resources through self-learning and to adapt itself accordingly to the sensed wireless network environment. It then reconfigures itself so as to maximize the exploitation of available resources. Re-configurability and

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perceptibility are the imperative features of cognitive radio. To understand this plethora of applications, CR researchers often make use of several types of artificial intelligence (AI) techniques. As the world around is progressing in various forms of networking, the data generated by us is increasing at par. Such patterns significantly alter our way of working with computers. Therefore, we need the machines to be more brilliant and increasingly accommodating.

In order to forge useful partnerships with AI, we need effective means such as technology that can be both a master and a slave. Drawing on multi-disciplinary work in this field, this chapter investigates the scientific support of such techniques and the applications that they have been exploited. CRs have been considered as favorable technology for exploiting the spectrum in ad-hoc networks. This work will expose some of the latest challenges in the networking field, especially cognitive radios. Three words most commonly used in this work are Cognition (observing and analyzing before making decisions), Observation (to gather surrounding information) and Re-configurability (altering radio parameters).

In recent decades, the demands of wireless type applications have been increasing. Therefore, Cognitive Radios are being used to deal with the problem of spectrum scarcity. A large number of novel wireless techniques have been built. Some of those include AI algorithms along with MIMO, millimeter waves, IoT, energy-efficient techniques, d2d frameworks, etc. more research needs to be done in this case. Many Cognitive radio issues such as spectrum sensing, spectrum decision, spectrum mobility, resource allocation, etc. have been resolved using AI techniques such as Game Theory, Decision Trees, Fuzzy logics, Reinforcement Learning, Clustered networks and Support Vector Machines.

Cognitive radio networks (CRNs) are networks of those nodes that are furnished with radios that can streamline their performance by restyling themselves according to the environment's network conditions. Several routing protocols with different degrees of adaptability and perception (or cognition) have been propounded for CRNs. Such sort of works is mostly constrained due to system-level focus (i.e., which highlights the degree of optimization of the user cognitive radio framework). Nonetheless, the intuition of CRNs needs that the focus should advance from its prevailing system obsession to a wide network-based optimization's interest. It propels the growth of routing protocols for cognitive radios and such type of protocols, which completely and flawlessly include AI-based techniques into the structure of their design. In this chapter, we provide a self-sustaining elucidation of several decision-theoretic and learning algorithms from AI that are pertinent to the challenges faced by cognitive routing in CRNs. Besides providing important background details along with every technique discussed in this chapter, their usage in general and for the routing problem, in particular, are also mentioned. Likewise, challenges associated with these algorithms and the common traps are also divulged.

Motivation

The motivation behind this chapter is to understand Networks, especially Cognitive Radio Networks, and how has Artificial Intelligence resolved several issues related to this. To understand this, four research questions have been proposed and this chapter does justice to the research questions:

RQ1: What are the different types of wireless network systems, and what are their strengths and shortcomings?

RQ2: What are Cellular Networks, and how did they grow over time in terms of bandwidth, battery, power consumption, etc.?

RQ3: What are Cognitive Radio Networks and the issues being faced by them in terms of communication?