Recent Advances on Artificial Intelligence in Cognitive Radio Networks

Badr Benmammar, University of Tlemcen, Tlemcen, Algeria

ABSTRACT

Cognitive radio is a form of wireless communication that makes decisions about allocating and managing radio resources after detecting its environment and analyzing the parameters of its radio frequency environment. Decision making in cognitive radio can be based on optimization techniques. In this context, machine learning and artificial intelligence are to be used in cognitive radio networks in order to reduce complexity, obtain resource allocation in a reasonable time and improve the user's quality of service. This article presents recent advances on artificial intelligence in cognitive radio networks. The article also categorizes the techniques presented according to the type of learning— supervised or unsupervised—and presents their applications and challenges according to the tasks of the cognitive radio.

KEYWORDS

1. INTRODUCTION

The main motivation for the development of cognitive radio is to overcome the conflicts between spectrum demand growth and spectrum underutilization arising from legacy static spectrum allocation policies (López-Benítez, 2018).

A CR must be intelligent and able to learn from its experience by interacting with its radio frequency (RF) environment. As a result, learning is an indispensable part of the CR that can be provided using artificial intelligence and machine learning techniques. Indeed, the application of artificial intelligence and especially machine learning in cognitive radio networks (CRNs) has recently aroused great interest in the literature.

Learning aims to make machines perform tasks similar to those of an expert. The intelligent machine will perceive its environment and make decisions to maximize its own utility. According to Woods (1986), artificial intelligence focuses on deduction, reasoning, problem solving, knowledge representation and learning.

According to Abbas et al. (2015), the learning process in CRNs is illustrated in Figure 1 and can be presented as follows:

- Sensing of radio frequency parameters
- Observation of the environment and analysis of its reactions

Figure 1. Learning process in CRNs (Abbas et al. (2015))
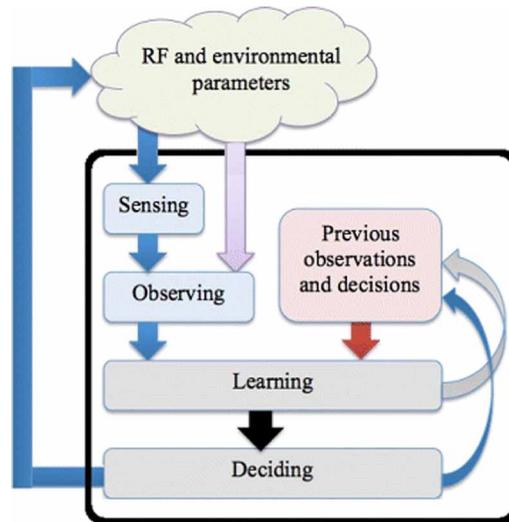
- Learning
- Retention of decisions and observations for updating the model and finally
- Decide on resource management issues and adjustment of transmission errors accordingly (Bkassiny et al., 2013; Russel et al., 2016)

In the literature, there is some work that has focused on the application of artificial intelligence techniques in CRNs. In Zhao et al. (2012), the authors introduced the use of artificial intelligence and machine learning techniques in the CR. They also presented the possible applications and fundamental ideas around the CR.

A survey on different techniques of artificial intelligence has been presented in Bkassiny et al. (2013).

The difficulties encountered in the application of these techniques in CR, their advantages and disadvantages were also discussed in the paper.

In Gavrilovska et al. (2013), the authors studied game theory, reinforcement learning, and reasoning approaches such as Bayesian networks, fuzzy logic, and case-based reasoning in CRNs.

In 2015, the survey presented in Abbas et al. (2015) was devoted to fuzzy logic, genetic algorithms, neural networks, game theory, reinforcement learning, support vector machines, case-based reasoning, Bayesian networks, Markov models, multi agent systems and artificial bee colony algorithms.

However, we noticed that the paper previously mentioned, did not discuss the application of the particle swarm optimization (PSO), a metaheuristic widely used in CRNs. Other metaheuristics, more recent and used in CRNs, are not mentioned in Abbas et al. (2015), like firefly algorithm (FA), cuckoo search (CS), gravitational search algorithm (GSA), invasive weed optimization (IWO) and flower pollination algorithm (FPA).

As, the state of the art of a part of techniques has been presented in the paper published in 2015. In this paper, we are interested in most artificial intelligence techniques that have been used only in the last three years in CRNs (between 2016 and 2019).

The main objectives of this survey are as follows:

- Presents a comprehensive study on artificial intelligence techniques, their definitions, their applications in CRNs, their evaluations, their strengths and their challenges. Some techniques were never discussed before in the previous survey.
- Presents the main tasks of CR and their corresponding challenges.

14 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/article/recent-advances-on-artificial-intelligence-in-cognitive-radio-networks/249152

Related Content

Wireless Power Transfer to Implantable Medical Devices With Multi-Layer Planar Spiral Coils
N. Sertac Artan and Reza K. Amineh (2019). *Emerging Capabilities and Applications of Wireless Power Transfer (pp. 203-227).*
www.irma-international.org/chapter/wireless-power-transfer-to-implantable-medical-devices-with-multi-layer-planar-spiral-coils/212522

Introduction to Cognitive Radio Networks: Communication Protocols and Security Issues
Natarajan Meghanathan (2013). *Cognitive Radio Technology Applications for Wireless and Mobile Ad Hoc Networks (pp. 1-30).*
www.irma-international.org/chapter/introduction-cognitive-radio-networks/78228

An RFID Best Effort Mechanism for in Motion Tracking Applications
Rafael Perazzo Barbosa Mota and Daniel Macedo Batista (2018). *International Journal of Wireless Networks and Broadband Technologies (pp. 39-52).*
www.irma-international.org/article/an-rfid-best-effort-mechanism-for-in-motion-tracking-applications/209434

Security Issues in Mobile Ad Hoc Networks: A Survey
Sunil Kumar and Kamlesh Dutta (2016). *Mobile Computing and Wireless Networks: Concepts, Methodologies, Tools, and Applications (pp. 1940-1985).*
www.irma-international.org/chapter/security-issues-in-mobile-ad-hoc-networks/138364

Recent Advances on Artificial Intelligence in Cognitive Radio Networks
Badr Benmammar (2020). *International Journal of Wireless Networks and Broadband Technologies (pp. 27-42).*
www.irma-international.org/article/recent-advances-on-artificial-intelligence-in-cognitive-radio-networks/249152