

Chapter 14

Role of Artificial Intelligence in Cognitive Radio Networks

Shikha Singhal

Jaypee Institute of Information Technology, India

Shashank Gupta

Jaypee Institute of Information Technology, India

Adwitiya Sinha

Jaypee Institute of Information Technology, India

ABSTRACT

The role of artificial intelligence techniques and its impact in context of cognitive radio networks has become immeasurable. Artificial intelligence redefines and empowers the decision making and logical capability of computing machines through the evolutionary process of leaning, adapting, and upgrading its knowledge bank accordingly. Significant functionalities of artificial intelligence include sensing, collaborating, learning, evolving, training, dataset, and performing tasks. Cognitive radio enables learning and evolving through contextual data perceived from its immediate surrounding. Cognitive science aims at acquiring knowledge by observing and recording externalities of environment. It allows self-programming and self-learning with added intelligence and enhanced communicational capabilities over wireless medium. Equipped with cognitive technology, the vision of artificial intelligence gets broadened towards optimizing usage of radio spectrum by accessing spectrum availability, thereby reducing channel interferences while communication among licensed and non-licensed users.

INTRODUCTION

Artificial Intelligence (AI) refers to intellectual capability exhibited by computing systems through leaning, adapting and updating knowledge base. More essentially, a device that senses its environment and contextually performs actions based on the perceived information basically forms an artificial intelligence system. The main goals of AI include sensing, learning, training and performing tasks. In fact, an AI System is extended with enhancements in such a manner that allows it to perform tasks with human-like

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intelligence. Recently, the role of AI in Cognitive Radio Networks (CRNs) has become impeccable & inevitable in executing basic processes, involving sensing, learning, training, and performing overall functions dynamically and intelligently, similar to operations of a human brain (He, Bae, Newman, Gaeddert, Kim, Menon... & Tranter, 2010).

Cognitive Radio (CR) is a technology capable of learning and adapting the surrounding environment with help of sensed environmental parameters. The term cognition means gaining of knowledge by experiencing the externalities of the environment. CR exhibits a self-programming ability that allows learning intelligently and autonomously over the wireless domain. Main objective of CR device is to optimize the use of radio frequency spectrum by sensing free spectrum availability and minimize interference between the primary and secondary users, i.e. managing permanent reliable communication dynamically. CR has an ability to access spectrum and allot available spectrum to secondary user animatedly. In order to equip spectrum management with power of dynamism, CR must rely on artificial intelligence. The learning problems in CRN mostly include decision making and feature classification problems. Feature classification problem occur at the time of spectrum sensing while decision making problem is to determine the spectrum sensing rules along with policies. To overcome these challenges, different types of learning paradigms are available, such as supervised learning and unsupervised learning for classification problem and reinforcement learning for decision making problem. In addition, AI technique extends learning paradigms over Artificial Neural Network (ANN), K-means, Support Vector Machine (SVM), Hidden Markov, and Game Theory. The main factors that need to be focused when designing algorithms involve learning in partially perceivable environments, multi-agent learning and autonomous learning in unknown radio frequency environments. The cognitive technology aims to perform its task optimally with increased robustness in CR-based applications. Normally, in case when no prior information of the radio parameters (i.e. signal to noise ratio, bandwidth and bit error rate, vulnerable rate), AI-based techniques tend to behave more optimally over Very High Frequency (VHF) and Ultra High Frequency (UHF) FM and TV bands.

ARTIFICIAL INTELLIGENCE

Artificial Intelligence is fundamentally a computer, software or computer controlled machine which thinks intelligently same as like human brain works. These computers do not use a fixed programmed to solve real-world problems. They are based on learning, training, reasoning, planning, and decision making aspects. The foundation of AI is based on how human brain works intelligently towards solving the problem i.e., how human brain thinks, sense, learn, decide, take actions to try to address any issue. On the basis of these studies, researchers developed some intelligent software so as to reduce manual efforts. The engineering science makes intelligent machine possible which behaves like as human brain (Russell, Norvig, Canny, Malik, & Edwards, 1995; He, Bae, Newman, Gaeddert, Kim, Menon, Morales-Tirado, Neel, Zhao, Reed, & Tranter, 2010).

AI assimilates science and engineering concepts through which we can develop a machine which treats any situation similar to the way human brain would respond, and produces the result intelligently with help of sensed and learned information (database). Technically, artificial intelligence refers to the ability of a system to calculate, evaluate a correct reason, perceive the current environment, analyse all possible relationships, learnt from experience, store and retrieve information from database, provide solution, problem solving, comprehend new ideas, use natural language, classify, generalize, and able

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