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A SURVEY ON FUZZY SET FOR MULTIPLE DECISION IN COGNITIVE RADIO NETWORKS

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Abstract

The channel sensing problem has gained new aspects with cognitive radio access concepts. It is one of the most challenging issues in cognitive radio systems. A survey of channel sensing methodologies for cognitive radio is presented. Various aspects of spectrum sensing problem are studied from a cognitive radio perspective and multi-dimensional spectrum sensing concept is introduced. Challenges associated with channel sensing are given and enabling spectrum sensing methods are reviewed. The paper explains the cooperative sensing concept and its various forms. External sensing algorithms and other alternative sensing methods are discussed. Furthermore, statistical modeling of utilizating these models for prediction of primary user behavior is studied. In this paper, we review sensing algorithms and approaches of channel detection and detection performance relevance to CR systems.

Index terms: Dynamic channel access, Co operative access, Multiple criteria decision making, N-auction, ELECTRE.

1.Introduction

Wireless devices and applications, the spectrum demand poses a great challenge on current spectrum allocation schemes. Cognitive radio[1] which utilizes spectrum holes by permitting access, serves as a promising technology to alleviate the scarcity of spectrum resource. Spectrum access Primary Users (PUs), who own the licensed spectrum bands, to temporarily release their spectrum resource to Secondary Users (SUs), who desire the spectrum for transmission. A main challenge lying here is to provide incentives for PUs to share their spectrum resource. Many popular economic tools such as price [2], game theory [3], contract theory [4], and auction [5], have been widely applied. Among all the economic tools for spectrum allocation, auction is the preeminent due to its fairness and efficiency. Various forms of auction have been brought to the research, such as VCG auction [6], McAfee auction

[7], and Walrasian auction [8]. A critical issue in studies on auction is economic robustness, since it is necessary to keep the auction invulnerable and avoid market manipulation.

Auction based spectrum allocation have been proposed, two important aspects in spectrum trading have been overlooked. First is the heterogeneity on spectrum supply and demand. In a realistic network, spectrum bands offered by PUs are often heterogeneous on bandwidth and available duration, due to, for example, the diversity of PUs' activities. Meanwhile, the demands of SUs on bandwidth and using time also show the heterogeneity since SUs may have different kinds of applications. However, previous works either ignore this aspect by assuming all the channels are identical and SUs only care about how many channels they obtain [9–11], or only focus on a single attribute which cannot fully reflect the heterogeneity of supply and demand [12–16]. Second, in traditional auction, buyers are only allowed to bid for an individual item, which greatly restricts the flexibility of requirement and compromises the efficiency of allocation result.

Cooperative sensing is a way of getting spatial diversity gain by receiving signal from different cognitive users in the vicinity of a fusion center (central node). In practice, most of the current schemes assume that secondary/cognitive users send the correct measurement/decision to the fusion center (FC) to make the global decision [17-22]. Each fusion method has its own pros and cons.

The elimination and choice translating reality (ELECTRE) methods ELECTRE I, II, III, IV, IS, and TRI were developed, which are extensions of ELECTRE. To date, ELECTRE methods have been successfully used in a wide variety of fields including biological engineering, energy sources, environmental studies, economics, value engineering, communication and transportation, personnel selection, and location selection problems.

2.Spectrum Sensing techniques

In this section, we summarize some of the relevant works on spectrum auction and MCDM.

2.1 Co operative spectrum access

A centralized radix-2multistage decision fusion strategy comprising simple AND and OR rules for cooperative spectrum sensing in cognitive sensor networks. This co-operative spectrum sensing (CSS) may be distributed or central-ized. In the centralized scheme, a fusion center (FC) collects the information from the CR nodes and takes a final decision about the spectrum availability. If the information sent by the CR nodes are their 1-bit decisions, it is called decision fusion (DF), otherwise it is known as data fusion[16]. We follow the DF schemes for their spectral and energy efficiency, and comparable performance with the data fusion. CR nodes have identical DP and FAP pair, and that the FC is aware of these values. We further assume that the CR nodes transmit their 1-bit decisions to the FC on the occupancy or the availability of the spectrum. A CR node with additional processing power may act as a FC or there may be a dedicated FC. Since most of the processing is done at the FC, it consumes more energy, and therefore, the role of FC may dynamically change across the nodes to preserve energy. However, the exact architec-ture of the FC is not looked into in this work[23]. a criterion to make a choice between the AND and OR rules and compute the optimum number of nodes participating in cooperative spectrum sensing for these rules to maximize the correct decision probability.

2.2 Combinatorial auction

The combinatorial auction scheme to solve the spectrum allocation problem under heterogeneous supply and demand in cognitive radio networks. The heterogeneity of spectrum is embodied via exploiting multiple attributes, based on which a valuation function is devised to evaluate the preference of an SU over a spectrum band. First an auction scheme consisting of a greedy-like winner determination algorithm and a critical value based discriminatory pricing policy. Auction scheme to a more challenging scenario by considering spectrum sharing among SUs. Theoretical analysis demonstrates that our auction schemes achieve individual rational, budget balance, value-truthfulness of SUs, and weak value-truthfulness of PUs. Our simulation results verify the advantage of combinatorial auction, the functionality of spectrum sharing and the economic robustness of our auction schemes[24].

2.3 Elimination technique

Cooperative spectrum sensing is a process of achieving spatial diversity gain to make global decision for cognitive radio networks. However, accuracy of global decision effects owing to the presence of malicious users/nodes during cooperative sensing. In this work, an extended generalized extreme studentized deviate (EGESD) method is to eliminate malicious nodes such as random nodes and selfish nodes in the network. The random nodes are carried off based on sample covariance of each node decisions on different frames. Then, the algorithm checks the normality of updated soft data using Shapiro–Wilk test and estimates the expected number of malicious users in cooperative sensing. These are the two essential input parameters required for classical GESD test to eliminate significant selfish nodes accurately. Simulation results reveal that the algorithm can eliminate both random and frequent spectrum sensing data falsification (SSDF) attacks in cooperative sensing and outperforms the existing algorithms.

2.4 ELECTRE technique

In hesitant fuzzy sets (HFSs), which are generalized from fuzzy sets, the membership degree of an element to a set, for which decision-makers hesitate while considering several values before expressing their preferences concerning weights and data, can be assigned one or more possible precise values between zero and one. If two or more decision-makers assign an equivalent value, that value is only counted once. However, situations in which the same value is repeatedly assigned substantially differ from those in which the value appears only once. Therefore, multi-hesitant fuzzy sets (MHFSs) can be used to manage cases in which values are repeated in a single HFS. In this paper, a method for comparing multi-hesitant fuzzy numbers (MHFNs) is presented. Some outranking relations for MHFNs, which are based on traditional ELECTRE methods, are introduced, and several properties are analyzed. For ranking alternatives, we propose an outranking approach to multi-criteria decision-making (MCDM) problems similar to ELECTRE III, where weights and data are in the form of MHFNs. Finally, an example is given to illustrate the developed approach, and its validity and feasibility are demonstrated by a comparison analysis with other existing methods.

The remainder of this paper is as follows. In Section 2, we briefly discuss related works in the area of spectrum sensing and fusion rules. In section 3 we present the system model for the proposed fuzzy fusion rule and the channel sensing through elimination method. Finally Section4 concludes.

3. Channel sensing

In this work we have considered a CR network consisting of one PU and more number of CR terminals for mutiple decision fusion. We assume that the PU is operating only on a particular channel and the CR terminals are trying to sense the spectrum hole in that channel. Firstly, we have proposed to access best channel using a new technique N-auctions. Fusion center which eliminates the channel through thershold. When the channel has energy efficency, time and without interfence the fusion center allocate channel to SU. Secondly, Muti Criteria Decision Making (MCDM), it bacisally applied in decision making. MCDM which ranks the channel according to their priorities. Here we use ELECTRE which is mathematical tool such as fuzzy set, assigns the channel to SU without interference to PU. Whereas spectrum exploitation refers to how efficiently a secondary user can access and utilize a channel or a set of channels. In this work, we focus on the latter and investigate a simple channel sensing order so as to efficiently yet effectively exploit the temporarily unoccupied spectrum.This integrated method improve performance and correct decision.

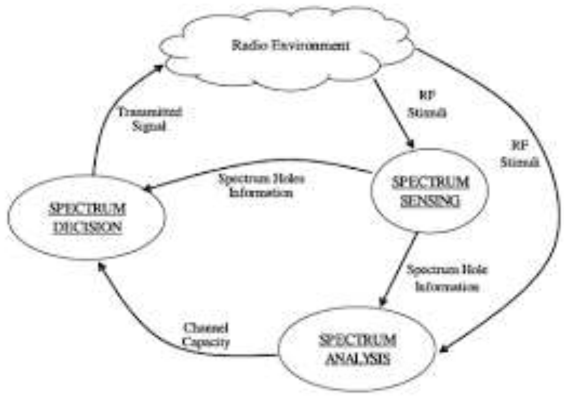

Figure:3 Channel sensing

In general, many of those references discuss performance of Boolean rules such as AND, OR, Majority Logic and Likelihood Ratio Tests at the

FC. A detailed study of these methods is beyond the scope of this survey paper.

4.Conclusion

In this review, we have argued that cooperative spectrum sensing, when implemented appropriately, would yield better sensing performance and better throughput in CR networks. We have also indicated the distributed detection algorithms in wireless networks form the basis for cooperative sensing in CR networks. Once we have an appropriate model for observations that sense the presence or absence of a PU in a channel, the results surveyed in this paper are directly applicable to cooperative spectrum sensing. Some of those methods discussed in the literature involve energy detection. Other discussions consider type PU signals and employ autocorrelation based spectrum sensing.

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