SUJET DE POST-DOC 2013

<u>LABORATOIRE</u> : IETR
<u>EQUIPE DE RECHERCHE</u> : SCEE – SUPELEC
<u>THEMATIQUE</u> : COMMUNICATIONS NUMERIQUES

Decision Making Techniques in Green Cognitive Radio context.

Within the Framework of an International Chair of the Université Européenne de Bretagne for its Excellence Center (Laboratoire d'Excellence) CominLabs the **GREAT** project (**G**reen Cognitive **R**adio for **E**nergy-**A**ware wireless communication **T**echnologies evolution) has ben selected. Signal Communication and Embeeded Electronics (SCEE) Lab (a research team of the IETR Lab and engineer school SUPELEC) is looking for a Postdoc on Decision Making for Green Cognitive Radio Topic, starting **January 2013** for **18 months** duration,.

When designing Cognitive Radio equipments the main challenge is to find an appropriate way to correctly arrange its cognitive abilities according to its communication environment as well as to its purpose [1]. Several methods are available in literature based on the "a priori" information on the environment. The degree of dependence between the various learning/decision making strategies and a priori knowledge is indicated in Figure 1. First attempt of cognitive radio decision making and learning techniques classification is proposed in [3] in the particular context of cognitive equipments for OSA, based on this *a priori* knowledge concept.
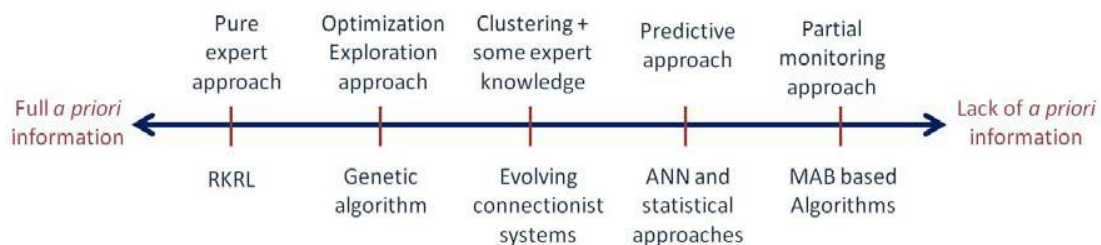

Figure 1: Decision making techniques.

Starting from previous studies performed in our laboratory [3,4,5,6,7] the objective of this research Postdoc is to extend some theoretical results and to apply these results to the Green Cognitive Radio concept, (i.e) to take into account the additional green constraint in the decision making algorithms.

Three directions will be investigated :

1. In a context of high uncertainty and unknown environment, as often expected in a Cognitive Radio context, reinforcement learning (including transfer learning) is a promising solution for intelligent decision making, including the learning and reasoning capabilities. Cognitive Radio may be, in some cases such as dynamic spectrum access (DSA) or dynamic configuration adaptation (DCA), modeled as a multi-armed bandit (MAB) issue. Machine learning community has proposed low complexity solutions to solve the heavy computation problems, namely upper confidence bound (UCB) algorithms. UCB enables a Cognitive Radio to choose a trade-off between exploration (learning) and exploitation (make the optimal choice).

2. Here we will be interested in statistical decision making built on statistical data modeling to optimize the equipment power consumption while still keeping the quality-of-service. For example, by analyzing jointly the signal-to-noise ratio and the inter-symbols interference, we can decide to maintain or not the operation of receiving equalizer and so on, and if its utilization is not necessary, to decrease equipment power consumption. In this way, from the data sensors, a dynamical configuration can be done to control the terminal

3. In this task, we will investigate multiple distributed nodes collaboration mechanisms based on Swarm Intelligence approach. By the distributed optimization approach that relies on the cooperation of agents to achieve the common optimization goal with a collective complexity out of individual simplicity, Swarm Intelligence enabled solution can greatly increase the target balance of energy efficiency and spectral efficiency

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[3] W. Jouini and C. Moy and J. Palicot. Upper Confidence Bound Algorithm for Opportunistic Spectrum Access with Sensing Errors. 6th International ICST Conference on Cognitive Radio Oriented Wireless Networks and Communications, Osaka, Japan, 2011.

[4] W. Jouini and C. Moy. Channel Selection with Rayleigh Fading: A multi-Armed Bandit Framework. The 13th IEEE International Workshp on Signal Processing Advances in Wireless Communications (SPAWC, 2012)

[5] W. Jouini, Contribution to Learning and Decision Making under Uncertainty for Cognitive Radio. PhD dissertation, SUPELEC, 2012.

[6] Bourbia S, Le Guennec D, Grati K, Gazel A, *Statistical Decision Making Method for Cognitive Radio*, ICT 2012, 19th International Conference on Telecommunications, Jounieh, Lebanon, 23-25 April 2012

[7] Bourbia S, Le Guennec D, Grati K, Gazel A, *Computational Complexity Reduction in a Cognitive Radio Receiver for Green Communications*, WSR 2012, 7th Karlsruhe Workshop on Software Radios, 7-8 March 2012

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