Analysis and Design of Cognitive Radio Networks and Distributed Radio Resource Management Algorithms

Overall Length: The talk is targeted to 12 hours.

Objective: This talk is intended to provide attendees with an appreciation of the challenges presented when cognitive radios are deployed in a network, techniques for modeling this problem, techniques for analyzing the behavior of cognitive radios in a network, and techniques and general principles for designing cognitive radio algorithms for deployment in a cognitive radio network.

Outline:

1. Models of Cognitive Radio Networks (2.5 hrs)
    - 1.1 Introduction to Cognitive Radio
        - 1.1.1 Implementation Classes of Cognitive Radio
        - 1.1.2 Modeling Cognitive Radio Network Behavior
    - 1.2 Dynamical Systems Models of Cognitive Radio Networks
        - 1.2.1 Dynamical Systems Model as Applied to Cognitive Radio Networks
        - 1.2.2 Variances Between Dynamical Systems Model and CRN Model
    - 1.3 Games and Cognitive Radio Networks
        - 1.3.1 Basic Modeling Elements of Game Theory
        - 1.3.2 A Game Theoretic Model of a CRN
        - 1.3.3 Variances Between Game Theoretic and CRN Model
    - 1.4 Modeling Summary
2. General Analysis Methods for Cognitive Radio Networks (3 hrs)
    - 2.1 Analysis Objectives for Challenges Posed by Cognitive Radio Networks
    - 2.2 Analysis based on dynamical systems
        - 2.2.1 Steady-states
        - 2.2.2 Optimality
        - 2.2.3 Convergence
        - 2.2.4 Noise/Stability
    - 2.3 Analysis based on game theory
        - 2.3.1 Steady-states
        - 2.3.2 Optimality
        - 2.3.3 Convergence
        - 2.3.4 Noise/Stability
    - 2.4 Summary of General Analysis Techniques
3. Model-Based Analysis of Cognitive Radio Networks (3 hr)
    - 3.1 Supermodular Games
        - 3.1.1 Concept
        - 3.1.2 Steady-state properties
        - 3.1.3 Convergence Properties
        - 3.1.4 Stability Properties
        - 3.1.5 Example Supermodular Games in Wireless Networks
    - 3.2 Potential Games
        - 3.2.1 Concepts and Forms

- 3.2.2 Steady-state properties
- 3.2.3 Convergence Properties
- 3.2.4 Stability Properties
- 3.2.5 Example Potential Games in Wireless Networks

3.3 Repeated Games and the Nash Folk Theorem

- 3.3.1 Concept
- 3.3.2 Properties
- 3.3.3 Example Applications of the Nash Folk Theorem in in Wireless Networks

4. Model-Based Design of Cognitive Radio Networks (3 hr)
   - 4.1 A Sensor Network Formation Algorithm with weak FIP
   - 4.2 Interference Reducing Network (IRN) Design Framework
   - 4.3 Algorithms based on the IRN Framework
   - 4.4 General Design Principles from Game Theory
5. Summary and Conclusions (0.5 hr)