Abstract
This project chiefly concerns the improvement of social efficiency of cognitive radio (CR) community in power control games. The economical concept of pricing is introduced as an incentive to motivate users to reach more socially efficient Nash Equilibrium (NE) points, which results in the Pricing Iterative Water-Filling (PIWF) algorithm. To reach a optimal pricing function, a distributed Reinforcement Learning (RL) algorithm, the Probabilistic Pricing Iterative Water-Filling (PPIWF), is also proposed. The simulation results of the algorithms are presented for comparison.

Objective
The objective of this project is to propose distributed algorithms with machine learning schemes and pricing mechanism to improve the social efficiency of power control game in CRN.

Features
This project utilizes the following concepts to achieve the objective:
- Cognitive Radio Networks
- Game Theory
- Convex Optimization
- Pricing Mechanism
- Machine Learning

System Model
- Multiple Chanel Network
- Power Constraints
- Game Theoretical Model

Problem Formulation
The problem can be formulated into a coupled convex optimization problems:
\[
\begin{align*}
\text{maximize} & \quad r(T) \\
\text{subject to} & \quad \sum_{k \in K} p_k(T_k) \leq P_{\text{max}}, \forall T \in M \\
& \quad p_k(T_k) \leq P_{\text{max}}(h_k), \forall T, k \in K \\
& \quad p_k(T_k) \geq 0, \forall T, k \in K
\end{align*}
\]

Algorithm 1
1. Initialize \( P = 0 \), \( T = 0 \). Set counter \( i = 0 \).
2. for all channels do
3. for all strategies do
4. Compute optimal action \( a_k \) for this iteration
5. Compute optimal action \( a_k \) for this iteration
6. end for
7. end for
8. for all channels do
9. Compute optimal action \( a_k \) for this iteration
10. Compute optimal action \( a_k \) for this iteration
11. end for
12. end for
13. for all channels do
14. Compute optimal action \( a_k \) for this iteration
15. Compute optimal action \( a_k \) for this iteration
16. end for
17. for all channels do
18. Compute optimal action \( a_k \) for this iteration
19. Compute optimal action \( a_k \) for this iteration
20. end for
21. for all channels do
22. Compute optimal action \( a_k \) for this iteration
23. Compute optimal action \( a_k \) for this iteration
24. end for
25. end for
26. end for