French Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes one of the PhD subjects proposed by the French Polytech network. The network is composed of 15 engineering schools/universities. The document also provides information about the supervisor. Please contact the PhD supervisor by email for further information regarding your application.

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PhD information	
Title	**Stochastic control and chance constrained differential games with applications to renewable energy markets**
Main topics regards to CSC list (3 topics at maximum)	Control theory and Technique, Energy

Required skills in science and engineering	Master in Applied Mathematics or Master in Computer science with a strong background in mathematics; good programming skills; notions in renewables energies

Subject description (two pages maximum including biblio)

Game theory is a formal discipline which studies situations of competition and cooperation between several involved players. Game theory has a large number of applications ranging from strategic questions in warfare to understanding economic competition, from robotics to social networks, from cloud/distributed computing to network security; and this list is certainly not exhaustive.

A milestone in the history of game theory is the paper of John von Neumann [6] where he proved the famous minimax theorem for zero-sum games. He showed that there exists a mixed strategy saddle point equilibrium for a two player zero sum matrix game. Later, John Nash [5] showed that there always exists a mixed strategy Nash equilibrium for an n-player general sum game with finite number of actions for each player. There two seminal results in game theory considered that the players' payoffs are deterministic and static.

However, in many real-world applications, there are random perturbations in the games, and the deterministic formulations may no longer be appropriate. In this case, stochastic control problems, stochastic games [3,8-13], differential games and stochastic chance constrained dynamic programming (CCDP) capture this new situation. The wholesale electricity markets are the good examples that capture this situation, especially renewable energies. The randomness in an electricity market is present due to various external factors, e.g., wind integration [4], and consumers' random demand [2].

The basic model in dynamic programming has two main features: an underlying discrete dynamic system, and an additive over time cost function. The dynamic system describes the evolution of some variables, namely the state of the system, subject to the influence of discrete instances of time decisions. The system is composed by the state variables which summarizes past information relevant for future optimization, the control variables, and a random parameter.

Chance constrained dynamic optimization was initially studied in the 1970s in the context of water management, and for solving some optimization problems with reliability constraints. Over the last decades, chance-constrained optimization [1,7] has been widely studied within model predictive control area and extended to optimal control methods.

The research topic of this thesis is in the framework of stochastic control theory with probabilistic constraints together with applications to differential games.

The project aims at developing new fast methods to find exact or approximate equilibrium in the framework of differential games. This research project could also focus on algorithmic and computational developments on practical applications including planning and equilibrium problems in renewable energies markets.

References:

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