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A FUZZY MODEL FOR BIDDING BEHAVIOR OF GENERATORS IN ELECTRICITY MARKETS

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Abstract. *In a deregulated electricity market, participants have to decide their bids under various uncertainties. We proposed a model of decision-making under uncertainty using a fuzzy inference procedure where fuzzy rules map environmental information to bid actions. The tuning of the fuzzy database is based on a reinforcement learning method called symbiotic evolution learning method where fuzzy sets and fuzzy rules are learned based on reward/punishment signals. Such a learning ability enables our agents to adapt to different situations without being taught beforehand. Experiments show that our model agrees with Cournot game and Bertrand game solutions in game theory methods if generators' strategies are restricted to quantity competition or price competition.*
Keywords: Multi-agent system, Fuzzy inference, Symbiotic evolution, Reinforcement learning, Electricity market

1. **Introduction.** With the restructuring in electricity industries around the world, electricity markets have been and are being introduced in many countries. Generation companies (gencos) and consumers are exposed to markets to meet their own needs, i.e. gencos sell power to earn a profit and consumers buy power for consumption. Although electricity markets are expected to promote competition and efficiency and then to bring in lower prices and better service for consumers, gencos' strategic bidding behavior is often observed to influence market price significantly.

Much research work is devoted to the bidding strategies of market participants. From the perspective of profit optimization, the optimal strategies are formulated as a two-level optimization problem which is solved by mathematical programming or evolutionary computation methods [1], [2]. Market equilibrium points are then found by iteratively solving individual profit maximization problem for each market participant until all the bids become constant. From the viewpoint of directly focusing on the equilibrium itself, Cournot oligopoly model [3] and supply function equilibrium models [4] are widely used for analyzing electricity markets. However, due to the difficulty in obtaining solutions, these analytical models are usually oversimplified so that important practical issues can not be considered.

Agent-based simulation is widely applied in social science and economics [5], [6]. Especially in electricity markets analysis, a participant is modeled as a rational and adaptive agent which learns to select bids that maximize its profit under various market conditions,