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Model-based and Data-driven Low-cost Fuzzy Controllers with Servo System Applications

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KEYNOTE SPEECH

***Abstract*—Reinforcement Learning (RL) is an attractive field of machine learning and artificial intelligence that involves solving control and decision-making problems in various fields, such as transportation. RL is closely related to optimization and neural networks. This plenary lecture presents research results from the Process Control Group at Politehnica University of Timisoara, Romania. The group's research focuses on RL-based control and combines it with metaheuristic algorithms to improve performance in four control structures. First, a Policy Iteration (PI) RL-based control structure is presented, where the weights and the biases of the control policy neural network (NN), i.e., the parameter vector, are searched using the metaheuristic GWO algorithm, aiming to overcome some known drawbacks of classical Gradient Descent (GD)-based implementations. Second, a Deep Q-Learning (DQL) control structure is described, where the NNs involved in the RL optimization process are initialized with the metaheuristic GSA, resulting in a more efficient initial version of the control policy neural network. Third, an efficient way is presented to to implement RL in the form of the Proximal Policy Optimization (PPO), where the metaheuristic SMA is used in the PPO algorithm to dynamically adjust the value of the learning rates involved in the RL process, resulting in an adaptive SMA-based PPO optimal control structure. Fourth, the safety issue of RL implementations is discussed using a Deep Deterministic Policy Gradient (DDPG) algorithm, where the NNs are initialized using the metaheuristic SMA. The safety constraints from the safe RL framework are introduced into the DDPG-based optimization process by computing a state safety penalty value that is added to the global cost function at each iteration. The safety penalty value is also introduced into the SMA-based initialization process, resulting in an initial version of the control policy NN that is able to safely explore the environment before the actual learning or control process starts. The experimental results of the servo system and tower crane system control systems are illustrated.**

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Keywords—control, neural networks, optimization, reinforcement learning, servo systems, tower crane systems

SHORT BIO

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