Umbrella Reinforcement Learning – A Tool for Hard Problems

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Abstract : We propose an approach for addressing Reinforcement Learning (RL) problems. It combines the ideas of umbrella sampling, borrowed from Monte Carlo technique of computational physics and chemistry, with optimal control methods, and is realized on the base of neural networks. This results in a powerful algorithm, designed to solve hard RL problems – the problems, with long-time delayed reward, state-traps sticking and a lack of terminal states. It outperforms the prominent algorithms, such as PPO, RND, iLQR and VI, which are among the most efficient for the hard problems. The new algorithm deals with a continuous ensemble of agents and expected return, that includes the ensemble entropy. This results in a quick and efficient search of the optimal policy in terms of "exploration-exploitation trade-off" in the state-action space.

Keywords : umbrella sampling, reinforcement learning, policy gradient, dynamic programming

Conference Title : ICMLCS 2025 : International Conference on Machine Learning and Computer Science

Conference Location : Dubai, United Arab Emirates

Conference Dates : January 30-31, 2025