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Comparing the Efficiency of Selected Reinforcement Learning Algorithms in Stability Control and Navigation Tasks

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This paper presents a comprehensive comparison of the efficiency of four key reinforcement learning algorithms (DQN, PPO, REINFORCE, and A2C) in stability control and navigation tasks. The study was conducted in two test environments: Cart Pole, representing a basic balance maintenance task, and Lunar Lander, constituting a complex navigational challenge requiring precise landing. As part of the research, the algorithms were implemented using various neural network architectures adapted to the specific requirements of each environment. For the Cart Pole environment, simpler architectures were applied, while for the more complex Lunar Lander environment, enhanced networks with additional learning process stabilization techniques were implemented, such as layer normalization and orthogonal initialization.

The research methodology focuses on a systematic analysis of key performance aspects, including convergence speed, sample efficiency, adaptability to different initial conditions, and learning process stability over time. For each algorithm and environment, standardized experiments were conducted with detailed performance metrics recorded throughout the training process. The experiments revealed significant differences in how algorithms perform under varying levels of environmental complexity.

The comparative analysis revealed significant differences between algorithms in terms of learning approach, training process stability, and ability to efficiently utilize accumulated experiences. These observations emphasize that selecting an appropriate algorithm strongly depends on the specifics of the particular task, environmental complexity, and available computational resources. This research provides practical insights into algorithm selection and configuration for reinforcement learning tasks of varying complexity in the domains of stability control and navigation.

Index Terms—reinforcement learning, deep Q-network, proximal policy optimization, REINFORCE, advantage actor-critic, stability control, navigation tasks, Cart Pole, Lunar Lander

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