Smart navigation through a rotating barrier via deep reinforcement learning with application to size-based sorting of active micro-agents

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Abstract

We have implemented Deep Reinforcement Learning (DRL) to optimize micro-agent pathfinding, referred to as smart Active Brownian Particles(sABPs), from an initial point to a target destination within a dynamic setting. Our investigation focuses on determining the shortest-time route by incorporating a rotating Gaussian potential within the environmental background. To train our agents, we adopted the Advantage Actor-Critic (A2C) method and found that it facilitates the development of a size-based sorting mechanism for sABPs in varying background environments. Furthermore, we explored how thermal noise influences the effectiveness of this sorting mechanism. We also demonstrated the benefits of noise-induced training in enhancing our approach, particularly in simulations where noisy conditions disrupt the environment. Applying reinforcement learning to autonomous ABP systems opens promising possibilities for discovering advanced navigation strategies in complex environments.

Keywords: Deep Reinforcement Learning, Autonomous Micro-agents, Optimal Pathfinding, Dynamic Environments, Active Brownian Particles, Size-based Sorting