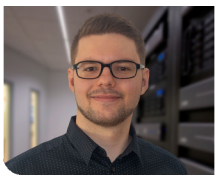
Enhancing Generalization of Autonomous Driving Agents in Complex Environments

Graduate



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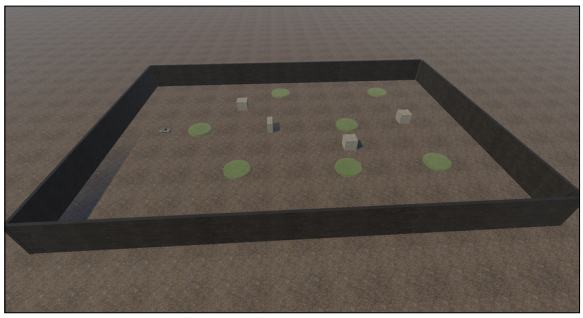
Introduction: This work seeks to evaluate the effectiveness of various reinforcement learning methods, including GAIL, Imitation Learning, and Curriculum Learning, to improve agent generalization and robustness in complex and dynamic environments. The focus lies on implementing an autonomous driving agent that navigates through an enclosed space with obstacles. The goal of the agent is to reach a set of control points as quickly as possible while avoiding collisions. This work aims to contribute to a better understanding of the application contexts of these advanced concepts in order to better handle reinforcement learning tasks in complex and dynamic environments.

Approach: The approach uses reinforcement learning, the Unity simulation environment, and Python-based tools. It makes use of the Unity ML-Agents framework. The experiment employs best-practice hyperparameters, a customized reward function, and curriculum learning to train agents more effectively. Imitation Learning approaches such as Behavioral Cloning and GAIL are also used. Performance is evaluated using cumulative rewards and success rates in test scenarios.

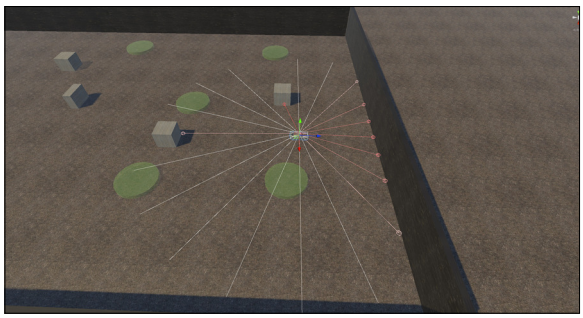
Result: The results showed that the use of extrinsic rewards alone was not sufficient for the agent to choose the best path to success. However, the agent's performance increased significantly when GAIL was used instead of extrinsic rewards. An even greater improvement was observed when these two strategies were used together, enabling the agent to rapidly improve on the demonstration data used.

Curriculum Learning was applied in two training runs. In the first run, the complexity of the environment was gradually increased to allow the agent to undergo a gradual training process. The second approach improved Curriculum Learning by modifying the hyperparameters, in particular by adjusting the balance between extrinsic rewards, GAIL, and Imitation Learning, resulting in a significant improvement in the agent's performance and generalization abilities. This combination allowed the agent to better adapt and learn to different levels of complexity in the environment.

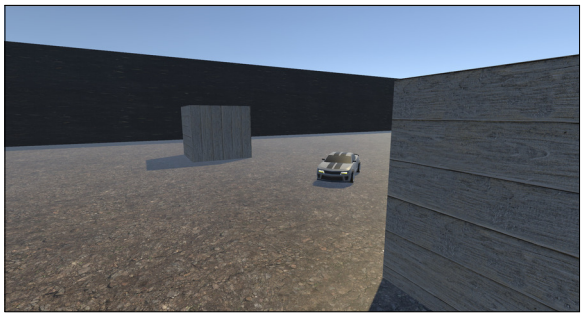
One of the learning environments for the agent
Own presentment



The ray casts used by the agent to navigate around the area
Own presentment



The car equipped with steering and braking capabilities that allow it to effectively avoid obstacles
Own presentment



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Subject Area
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