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Masters of Computer Science Thesis Progress Report

Please send a copy of your proposal to the MSc Coordinatorc via Canvas. Please email **MScCoordinator@cs.auckland.ac.nz** if you have any queries.

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Supervisor Name: …Gill Dobbie……………………………..............………………………….

Thesis Title:
How does the size of Replay Buffer influence training performance, model generalization in different racing track?

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Expected Submission date: …28/02/2026…………………..

How often are you in contact with your supervisor and means of contact?

…We meet once a week via Zoom.……………..…………..…………………………..……………

REQUIRED SIGNATURES

Student: ……………………………………………………………………………………………

Supervisor: ....

Date: …………………………………………………………………………………………

PLEASE TURN OVER

Please provide a summary of your progress to date.

So far, I have developed a deep reinforcement learning framework based on the Deep Q-Network (DQN) algorithm, which has been successfully applied to an autonomous driving simulation on an oval track. The model utilizes a two-layer fully connected neural network that learns to complete the track by controlling the vehicle's movement through interaction with the environment.

In the initial phase, to verify the algorithm's basic learning capability and ensure stable convergence, I employed a pre-defined path guidance approach, allowing the vehicle to follow a known route during early training. This setup helped confirm the feasibility of applying DQN to the track navigation task.

Currently, I am transitioning to a more challenging setting in which the vehicle must learn to complete the track entirely through trial and error, without any prior trajectory or external guidance. Progress in this phase has been relatively slow: while the model exhibits some early signs of learning, its training efficiency remains low, stability is inconsistent, and in some cases, it fails to converge altogether. Solving these issues is now my primary focus and a critical step toward achieving a fully autonomous learning agent.

Please also include a list of tasks that you still require to complete before submission.

1. **Simplify the Environment Design**
    - Construct a basic linear track to lower the initial learning complexity;
    - Gradually introduce curves and more complex track structures once the model performs well on the simpler track, to enhance its generalisation capabilities.
2. **Conduct In-Depth Experiments on the Replay Buffer**
    - Vary the size of the Replay Buffer and assess its impact on training convergence speed and stability;
    - Implement **Prioritised Experience Replay (PER)** to evaluate its effect on sample efficiency;
    - Compare different sampling strategies and analyse their influence on training performance.
3. **Hyperparameter Tuning**
    - Systematically explore combinations of learning rate, discount factor (γ), batch size, and other relevant parameters;
    - Optimise the balance between training efficiency and overall model performance.
4. **Performance Visualisation and Evaluation**
    - Integrate visual tools such as reward progression curves and vehicle trajectory plots during training;
    - Conduct comparative testing across different track configurations to assess robustness and adaptability.
5. **Report Writing and Analysis**
    - Summarise experimental results under various Replay Buffer configurations;
    - Compile a comprehensive final report detailing the experimental design, results analysis, and recommendations for future improvements.