

Development of Deep Q-Learning Agent for Playing the Game of Snake

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Abstract—This work presents the implementation of an agent for the game of Snake using Deep Q-Learning. We present the model, state space and reward engineering adopted, as well as the evolution of the agent’s performance across training episodes and during evaluation. In this context, the trained agent is consistently capable of scoring at least 10 times per game in 70% of its games. Lastly, we discuss the results and present conclusions regarding the employed methodology.

I. INTRODUCTION

First deep learning model to successfully learn control policies from high-dimensional sensory input using Reinforcement Learning (RL) was introduced by DeepMind in 2013. In that paper, they combined classical Deep Learning (DL) algorithms with RL to create a single, general-purpose learning agent that could learn directly from the screen input. The agent was able to learn to play seven Atari 2600 games by only observing the screen pixels and receiving a reward when the game score increased. This study was revolutionary since the agent was able to outperform all previous approaches on six of the games and surpassed a human expert on three of them.

Although Atari was high popular for Millennials and Gen X, the early Gen Z are more familiar with mobile games. One of them is the Snake game, usually played in a Nokia mobile. The game consists of a snake that moves around the screen and increases its score by eating apples and growing in length. The game ends when the snake collides with the borders of the screen or with its own body. The objective of the game is to obtain the highest score possible, which means survive and eat as many apples as possible, without eating its own body. The game of Snake is a good candidate for RL because it is a simple game with a clear reward function and a small state space. Figure 1 shows a illustration of the game.

In this work, we present the implementation of an agent for the game of Snake using the Deep Q-Learning framework adopted by DeepMind. The main goal is to set up an simulation of the game and train an agent to play it. We present two forms for a state representation and discuss the results obtained by the agent.

II. DEEP Q-LEARNING

The Deep Q-Learning algorithm is a combination of Q-Learning and Deep Neural Networks (DNN). Q-Learning is a model-free RL algorithm that learns a policy by directly

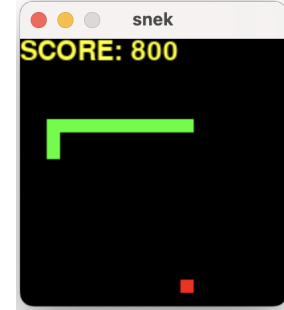


Fig. 1. Snake game from a 20×20 grid wall. The main goal for the snake is to eat the apples without eating itself.

approximating the optimal action-value function $Q^*(s, a)$, which is the expected return for taking action a in state s and following the optimal policy thereafter. This is necessary because the problem may have too much states, so it’s impossible (or really inefficient) to store the action-value function for all discrete state space.

III. METHODOLOGY

We developed the “Game of Snake” using PyGame in Python. The game architecture is based on three classes: the *Grid*, which corresponds to the space where the game occurs and also houses the apple (the target for the agent); the *Agent*, which represents the snake; and the *Game*, which orchestrates the interactions between the agent and the environment.

There are two game modes: one with closed walls, and the other without. In the first mode, the game-over event happens when the agent touches the borders of the window. However, this event does not occur in the second mode. Another way for the game to end is when the snake’s head collides with its body. The score increases every time the agent obtains the target (the apple), and a new target is randomly created afterward.

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Three	Four

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Fig. 2. Inductance of oscillation winding on amorphous magnetic core versus DC bias magnetic field

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VI. CONCLUSIONS

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APPENDIX

Appendixes should appear before the acknowledgment.

ACKNOWLEDGMENT

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REFERENCES

- [1] A. Sebastianelli, M. Tipaldi, S. L. Ullo and L. Glielmo, "A Deep Q-Learning based approach applied to the Snake game," 2021 29th Mediterranean Conference on Control and Automation (MED), PUGLIA, Italy, 2021, pp. 348-353, doi: 10.1109/MED51440.2021.9480232.