LET'S BEAT GEOMETRY DASH APS360 PROJECT PROPOSAL

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ABSTRACT

Our team's project proposal is to create a bot that can play geometry dash using machine learning. The bot will be trained with two architectures, a convoluted neural network so that it can identify obstacles in the game, and with deep reinforcement learning so that the bot can learn to make the right choices. —-Total Pages: 4

1 INTRODUCTION

Geometry Dash is a popular platformer video game where the player attempts to navigate through obstacles in order to reach the end of a level. The game features a variety of game modes and unique objects.

A video of the first level can be seen here: https://www.youtube.com/watch?v=bbVEbqU9wPo

The player is controlled by one input which determines whether or not the player jumps. Our aim is to build an agent that can beat many of the game's levels. This will involve training two models. We aim to analyze screen information using a CNN architecture to find the positions of structures and hazards, then use a deep learning reinforcement architecture to determine agent behavior.

Our project was inspired by similar work in other games such as Mario. However, most other games simply require you to jump over basic obstacles, and the proper decisions for progress are usually straightforward. Geometry Dash is unique and interesting because many levels feature "fakes" where jumping objects can trick the player into death. See Fig. 1 for an example.

Furthermore, many community-made levels often feature intricate designs that may confuse computer systems, as can be seen in Fig. 2 for example.

We believe that a deep-learning approach can enable a computer to tackle both these issues through object recognition and avoidance of fake objects and routes.

2 BACKGROUND AND RELATED WORK (4 MARKS)

CodeNoodles (2022) created a relatively simple Neural Network to play Geometry Dash that takes in some information (ie. intersection with "orb" objects, distance to blocks, overhead blocks) and outputs an action. See Fig 3. However, we believe that this solution is inadequate as it runs on a simplified version of Geometry Dash instead of the official game. The distance and position of the obstacles are readily available information to the model, which would not be the case in the real version. Furthermore, the simplistic neural network essentially functions as a decision tree, which could fail in some cases to the aforementioned misleading objects.

Figure 1: A screenshot from the 9th level "Cycles". Normally, interacting with the yellow orbs allows the players to jump higher and avoid obstacles. In this case, however, interacting with any of the yellow orbs will result in the player losing. (razing717, 2015)

Figure 2: A screenshot from the custom level "Edge of Destiny." Note the intricate details that make it harder to see the hazards. ("Fandom", 2024)

Yosh (2023) created a Youtube video that demonstrated that an AI can come to understand complex in-game physics systems and surpass human-level performance through training. See Fig 4. Trackmania shares a similar overarching gameplay system to Geometry Dash in which a player must consider various environmental features (ie. track shape, player position) in order to decide when and when not to activate various inputs. Thus, we believe this video helps demonstrate the potential for Deep Learning to work in geometry dash.

Chang et al. (2019) wrote a paper detailing how they split up an image for a robot into a bunch of different segments. This might be relevant for us as we could split up the images we attain from Geometry Dash into some array of squares, and try to sample at a specific framerate.

3 Data Processing (2 marks)

4 Architecture (2 marks)

5 Baseline Model (2 marks)

6 Ethical Considerations (2 marks)

Geometry Dash has online levels that users can play to earn rewards such as diamonds, orbs, and stars. These stars can be used to rank the player on the global leaderboard. Developing a bot that can

Figure 3: A screenshot of CodeNoodle's visualization of his neural network from his Youtube video. (CodeNoodles, 2022)

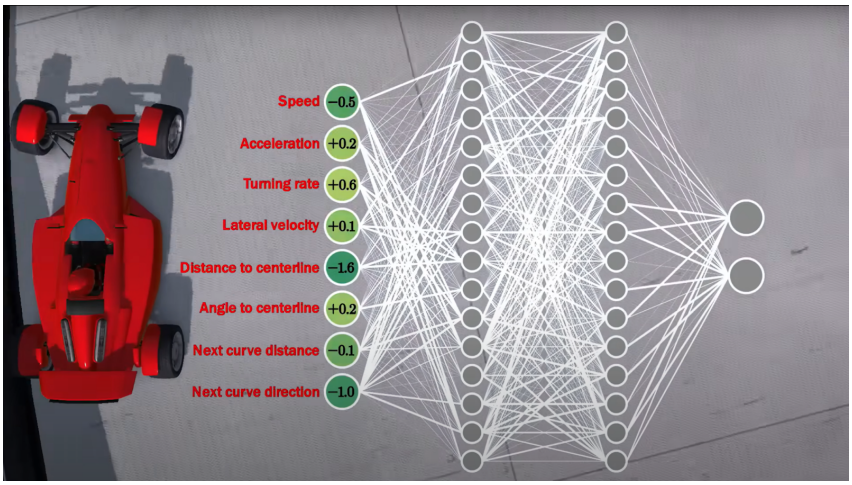

Figure 4: A screenshot of Yosh's visualization of his neural network for his trackmania bot. (Yosh, 2023)

complete Geometry Dash with machine learning can result in players gaining an unfair advantage over their peers as they climb the leaderboard, and result in people playing the game in a way the developers did not intend.

Another ethical consideration could be in the training of the models. It is unethical to use the work of others for profit without their permission. Levels that are created and published by Geometry Dash users online are their own creative works, and it may be unethical to use their work to train a model that can be used to generate an income without their consent. As a result, our group does not intend to commercialize this project.

7 Project Plan (4 marks)

8 Risk Registrar (4 marks)

The largest potential risk of this project is that we are unable to finish. We would like to train a bot that can complete Geometry Dash, but this would require that we finish training both the CNN model and the RL model in time. If we are unable to finish both, our group would just submit the CNN model for our final submission, as the CNN model would fulfill the requirements of this project, while the RL model is beyond the scope of this course. Although an RL model would be nice, we may have to sacrifice it if time does not permit.

There is also a risk that our group will not even finish the CNN model in time. There is a risk that our group will leave deliverables to the last minute, resulting in too little time to properly train our

model and embark on the iterative process of trial and failure that marks all successful projects. To combat this tendency, we have decided as a team to implement many internal deadlines so that our model will have plenty of time to train.

Another potential risk of this project could be that our code only works on one machine, as the course instructor made it clear that the TA grading our project should be able to run our code. We intend to make the bot able to play Geometry Dash, which could require that our bot access the keyboard on its host computer, which could involve different libraries and processes for different machines and operating systems. Although we could try to mitigate this as much as possible by testing on various computers and making sure it works on all of our different machines, time constraints may disallow us from solving this issue in time. If we are unable to guarantee that it can run on any machine, we may have to preface our final submission with a warning that it only runs on a certain operating system. As of right now, our team plans to develop our model for Geometry Dash on Linux.

Lastly, there is the risk that one of our team members is unable to finish their portion of the project due to an outside situation. Fortunately, we have clearly outlined the responsibilities and tasks of each teammate, so if a teammate is unable to complete their tasks on time, it will be easy for the other teammates to recognize what still needs to be done.

9 GITHUB LINK (1 MARK)

https://github.com/J-Vadakken/APS360-Project

AUTHOR CONTRIBUTIONS

If you'd like to, you may include a section for author contributions as is done in many journals. This is optional and at the discretion of the authors.

ACKNOWLEDGMENTS

Use unnumbered third level headings for the acknowledgments. All acknowledgments, including those to funding agencies, go at the end of the paper.

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