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7CCSMPRJ

Individual Project Submission 2023/24

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Project Title: ***Evaluating Generated Content in Videogames***

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Department of Informatics

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United Kingdom

7CCSMPRJ MSc Project

Evaluating Generated Content for videogames

Name: Harsha Kadur Yoganatha

Student Number: 23103996

Degree Programme: MSc in Artificial Intelligence

Supervisor’s Name: Michael Cook

This dissertation is submitted for the degree of MSc in Artificial Intelligence

Acknowledgement

First and foremost, I would like to thank my supervisor, Dr. Michael Cook, for his unwavering support throughout the duration of this project. His advice, feedback, and inputs during the many meetings we had were immensely helpful for the completion of this project. I am also grateful for my peers for allowing me to draw inspiration from their work.

Abstract

This report investigates the feasibility of using algorithmically generated content to replace or assist human efforts in the game development process, with a specific focus on level design for videogames. The project aims to answer whether generated content can maintain or improve the quality and playability of game levels traditionally created by human designers. The UC Berkeley Pac-Man project [1] serves as the experimental framework, utilizing “Shaun LeBron’s” Pac-Man maze generation [2] algorithm to create a set of levels for analysis.

To evaluate the generated levels, three different types of agents were employed: a Markov Decision Process (MDP) agent and a Reinforcement Learning (RL) agent to determine the winnability of the levels, and a corner-seeking agent to assess the traversability of the mazes. The data extracted by running these agents on the game provided a comprehensive assessment of the gameplay experience on algorithmically generated levels compared to human-designed ones.

The results reveal that while human-generated levels exhibit higher traversability, indicated by the corner-seeking agent’s data, the win rates achieved by the MDP and RL agents on both human and algorithmically generated levels were remarkably similar. This suggests that algorithmic generation can produce levels that are equally challenging and completable as those created by human designers. Detailed analysis supported by graphs, tables, and charts illustrates these findings, providing a nuanced understanding of the strengths and weaknesses of both human and algorithmically generated content.

The major conclusion drawn from this study is that algorithmically generated levels have significant potential to either replace or complement human efforts in game design. The algorithmically generated levels demonstrate a level of playability that supports their use as a viable tool in the game development pipeline. This can lead to increased efficiency and innovation, allowing designers to focus on more complex and creative aspects of game development while leveraging algorithmic generation for routine tasks.

Ultimately, this report provides compelling evidence that supports the integration of content generation algorithms into the game development process, potentially transforming the way games and created and experienced.

Nomenclature

*a* The number of angels per unit area

*A* The area of the needle point

*c* Speed of light in a vacuum inertial frame

*h* Planck constant

LMI Linear Matrix Inequalities

*N* The number of angels per needle point

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# Introduction

It provides the background and context of the work.

## Aims and Objectives

It provides the background of the work. The problems and project objectives should be stated comprehensively. The motivations of the project should be presented. The techniques and approaches used to deal with the problem should be stated with justifications, and the contributions and main results achieved should be stated clearly. The structure of the report can be described briefly at the end.

### Dissertation Length

The dissertation should be less than 15000 words.

#### Structure

1. Refer to KEATS for suggested structure

##### Insert More Subsections if Necessary

## Background and Literature Survey

It gives an overall picture about the work with a clear review of the relevant literature. The background of the project should be given. What have been done to deal with the problem should be stated clearly. The pros and cons of various existing algorithms and approaches should be stated as well. Differences between your proposed method and the existing ones should be briefly described. It is important to make sure that the discussion is structured and coherent; the key issues are summarised; key and relevant references are used critically analysed and the literature is covered comprehensively.

The following links may help on literature review:

* **IEEE Xplore digital library** (http://ieeexplore.ieee.org): a resource for accessing IEEE published scientific and technical publications (You must be with King's network to get access to the digital library)
* **ScienceDirect.com** (http://scienceDirect.com): an electronic database offering journal papers not published by IEEE (You must be with King's network to get access to the database)

## Insert More Sections if Necessary

# Background Theories

The background theories supporting the work should be given in this section. Provide references when someone’s work is recalled.

# Objectives, Specifications and Design

It recalls the objectives in a more detailed way to justify the development of a set of requirements and specifications, and identify a coherent set of issues to be addressed. It explains in detail the design and how the design can achieve the project aim (solve the problem).

# Methodology and Implementation

It presents and justifies the methodology used to deal with the problem and describes in detail the implementation procedures. The background theory presented in the previous chapter can be recalled to support the proposed implementation. The originality, novelty and contribution are to be demonstrated with the discussion of the strengths and limitations.

# Results, Analysis and Evaluation

It summarises the results obtained from the proposed design and methodology. The way to obtain the results should be described in detail. Analysis and evaluation have to be performed. Comparisons should be made. It should justify if the project aims, objectives, requirements and specifications have been achieved.

# Legal, Social, Ethical and Professional Issues

A chapter gives a reasoned discussion about legal, social ethical and professional issues within the context of your project problem. You should also demonstrate that you are aware of the Code of Conduct \& Code of Good Practice issued by the British Computer Society (BSC) (https://www.bcs.org/membership/become-a-member/bcs-code-of-conduct) for computer science project and Rule of Conduct issued by The Institution of Engineering and Technology (IET) (https://www.theiet.org/about/governance/rules-of-conduct) for engineering project. You should have applied their principles, where appropriate, as you carried out your project. You could consider aspects like: the effects of your project on the public well-being, security, software trustworthiness and risks, Intellectual Property and related issues, etc.

# Conclusion

It is a chapter to sum up the main points and findings of the work; how you achieve the project aims and address the research questions; the contributions and results you have achieved. Future plan and development can be mentioned in this section as well. It is normally in one or two pages.

# References

|  |  |
| --- | --- |
| [1] | D. K. P. A. John DeNero, “The Pac-Man Projects,” [Online]. Available: http://ai.berkeley.edu/project\_overview.html. |
| [2] | S. LeBron, “Pac-Man Maze Generation,” 2012. [Online]. Available: https://shaunlebron.github.io/pacman-mazegen/. |

# Appendices

## Appendix A: Heading

Supplementary materials (such as source code, user menu, etc) could be included. Each appendix must be labelled (for example, Appendix A, Appendix A.1, Appendix A.2, Appendix B, Appendix B.1, etc.) and with heading. All Appendices must be referred in the text.

## Appendix B: Points to Note

* Please note the following points when you write your report:
* Consider the outline of the report. It is a good idea to start with the table of contents, which gives you an overall structure of the report.
* Show understanding of the topic and demonstrate the contribution of the work. 70\% of the content of the report should be your own contributions and achievements.
* Always use your own words.
* The main report and any appendices must constitute one document.
* Pages must be numbered consecutively.
* Captions must be provided for all figures and tables.
* Equations (or important equations), figures and tables must be numbered.
* All figures and tables must be referred to in the text.
* Units of all variables must be provided.
* Numerical values (floating-point number) should be in 4 decimal places.
* Contractions should not be used.
* Check the punctuation of sentences. In particular, those sentences with equation. For example, if an equation is at the end of a sentence, a full stop should be used.
* All variables must be defined.
* Font face of variables throughout the report (in the text, equation, figures and table) must be consistent.
* Use proper headings for chapters, sections, subsections.
* Chapters, sections, subsections should be numbered and with the same numbering system throughout the report.
* It is suggested that vector and matrix variables should be in bold, scalar variables should be in italic.
* References must be used for materials used in the report that are not yours.
* A standard reference format must be adopted and be consistently applied through the report. General guidelines for reference format can be found on KEATS.
* Always backup your files.