CAPSTONE PROJECT 1
Planning Document

Evaluation of Nature-inspired Optimisation Algorithms in Solving Versus Tetris

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Abstract

Contents

1 Introduction

Tetris is a popular video game created in 1984 by computer programmer Alexey Pajitnov [1]. It is a puzzle game that requires players to strategically place sequences of pieces known as "Tetriminos" into a rectangular Matrix (refer to Figure 1.1). In the classic game, players attempt to clear as many lines as possible by completely filling horizontal rows of blocks, but if the Tetriminos surpass the top of the Matrix, the game ends.

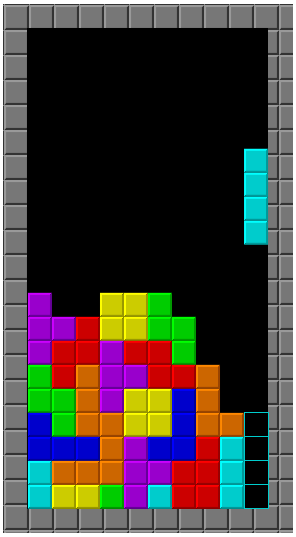

Figure 1.1: A Typical Tetris Game

Since its release, Tetris has captured the imagination of mathematicians and computer scientists alike, leading to a diverse array of research endeavours exploring the various facets of the game, including its complexity [2], and its possibility of being won [3] [4].

1.1 Motivation

While Tetris has been the subject of numerous research papers and academic studies, the majority of these have been focused on the classic single-player variant of the game. However, the emergence of multiplayer gaming introduces a novel dimension to Tetris gameplay that remains largely unexplored in academic research. Furthermore, the computational complexity of classic Tetris, proven to be NP-complete [2], underscores the necessity of innovative approaches, such as nature-inspired optimization algorithms, in tackling its challenges.

Figure 1.2: A Screenshot of a Game of Tetr.io, a Fan-made Versus Tetris Game

1.2 Problem Statement

Despite the extensive research on classic Tetris, there is a significant gap in the literature regarding its multiplayer versus variant (refer to Figure 1.2). This gap presents an intriguing problem within the field of computational gaming, as understanding the optimal strategies, challenges, and computational complexities unique to multiplayer versus Tetris remains largely uncharted territory.

1.3 Aim

The aim of this capstone project is to evaluate the viability of nature-inspired optimisation algorithms in solving the game of Versus Tetris. By leveraging insights from nature-inspired algorithms, the project seeks to create a robust and adaptable Tetris-playing software that compares different nature-inspired optimisation algorithms to determine their effectiveness in gameplay. The software will be designed to compete effectively against human players or other Tetris-playing programs, utilising insights gained from the comparative analysis of these algorithms.

1.4 Objectives

The objectives of this project are as follows:

1. Formulate the problem of Versus Tetris for game AI.

2. Research and implement a variety of nature-inspired optimisation algorithms to determine their suitability for optimising gameplay strategies in Versus Tetris.
3. Design a comprehensive framework for objectively evaluating and comparing the performance of the algorithms.
4. Develop a playable game of Tetris that simulates gameplay and training.
5. Using the game, do comparative analyses with the designed framework to assess the effectiveness and efficiency of each algorithms.
6. Summarize findings from the comparative analyses, highlighting the strengths and weaknesses of each nature-inspired optimisation algorithm.

1.5 Project Scope

This project will focus specifically on the evaluation of nature-inspired optimisation algorithms in the context of multiplayer versus Tetris. It will entail the development of a playable Tetris game capable of simulating gameplay and the training of algorithms. This simulation environment will facilitate in the analysis and evaluation of these algorithms' performances. The scope includes the exploring a range of nature-inspired algorithms to address the unique challenges inherent in Versus Tetris.

2 Literature Review

2.1 What is Versus Tetris?

3 Technical Plan

4 Work Plan

5 References

[1] Tetris Inc., *About Tetris*, https://tetris.com/about-us, [accessed Apr. 22, 2024].

[2] E. D. Demaine, S. Hohenberger, and D. Liben-Nowell, "Tetris is hard, even to approximate," in *Computing and Combinatorics*, T. Warnow and B. Zhu, Eds., Berlin, Heidelberg: Springer Berlin Heidelberg, 2003, pp. 351–363, ISBN: 978-3-540-45071-9.

[3] J. Brzustowski, "Can you win at tetris?" Ph.D. dissertation, University of Waterloo, 1988.

[4] H. Burgiel, "How to lose at tetris," *The Mathematical Gazette*, vol. 81, no. 491, pp. 194–200, 1997. DOI: 10.2307/3619195.