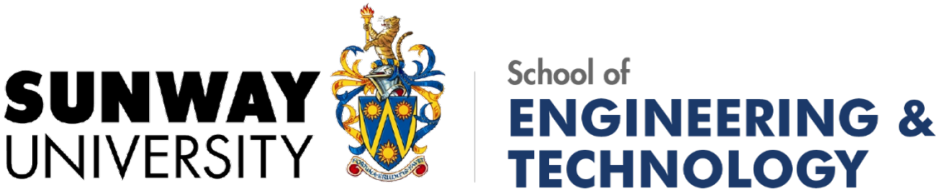

CAPSTONE PROJECT 1
Activity Log

Playing Versus Tetris with Nature-inspired Optimisation Algorithms

by

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Semester: April 2024
Date: 1 August 2024

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Contents

1 Timeline

In this chapter, the project's progression is meticulously documented. In these pages, the critical stages of the project are depicted in the form of tables. A Gantt chart of the timeline is also provided to give an overview of the project's temporal progression.

Table 1.1: Overall Work Activities

Phases	Work Activities	Work Product	Risk Factors	Time Allocated
Introduction	Write a comprehensive introduction, including the motivation, problem statement, aim, objectives and scope of the project.	A comprehensive introduction	Misunderstanding of concepts	1 Week
Literature Review	Find and read a wide variety of literature to write a comprehensive review that (1) justifies the use of non-traditional algorithms and (2) showcase past approaches to the game.	A comprehensive literature review that has a diverse set of sources	Lack of understanding of concepts, misunderstanding concepts	12 Weeks

Continued on next page

Table 1.1: Overall Work Activities (Continued)

Methodology	Come up with a methodology that covers all bases, it should include rule definition, algorithm selection, problem formulation and evaluation metrics	A well-defined methodology	Inadequate explanation of rules, trouble formulating problem formally	4 Weeks
Work Plan	Create a work plan that includes this table, a Gantt chart summarising what has been done in the planning phase of the project, as well as a similar table and Gantt chart for the implementation phase.	A well-defined work plan with goals to be met	Time constraints, formatting issues	1 Week

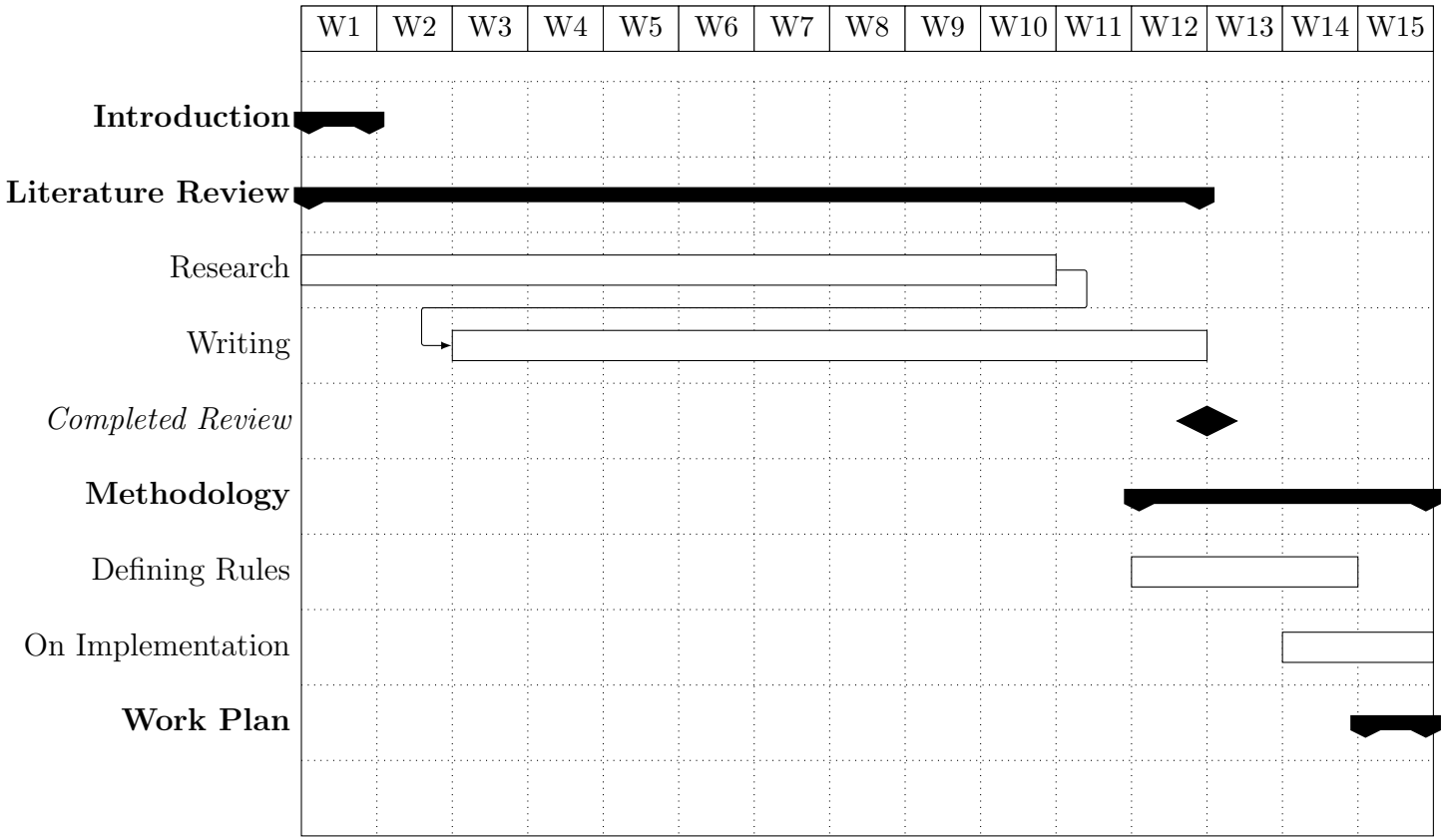


Figure 1.1: CP1 Timeline

1.1 Weekly Breakdown

In this section, a week-to-week overview that summarises work done that particular week will be shown in table form. Each subsection will contain a table that showcases work done for a particular chapter of the planning document.

1.1.1 Introduction

The introduction serves as the project's foundation, providing essential background information, introducing the topic, and articulating the project's objectives. Recognising its pivotal role, **one week** of time was allocated for its composition. This deliberate time-frame aimed to allow ample time for thoroughness, ensuring no essential elements were overlooked in writing a comprehensive and compelling introduction.

Table 1.2: Weekly breakdown of work done for Introduction Chapter.

Week	Work Done
1	• Researched existing literature on Tetris, NP-completeness and Nature-inspired algorithms. • Wrote the introduction chapter. • Learnt the tikz LaTeXpackage to draw better figures.

1.1.2 Literature Review

The literature review is one of the chapters that will take up a lot of space in the planning document. It is important to be thorough and correct about the information written on these pages. As such, a generous time of **twelve weeks** were allocated to research and write this section.

Table 1.3: Weekly breakdown of work done for Literature Review Chapter.

Week	Work Done
1	• Found and read literature on NP-completeness. • Tried to understand computational complexity as a whole.
2	• Continued researching NP-completeness. • Understood enough computational complexity for the project: complexity classes, reductions, P and NP, etc.

Continued on next page

Table 1.3: Weekly breakdown of work done for Literature Review Chapter. (Continued)

3	• Found and read literature on the difficulty of Tetris. • Began writing the first section of the literature review, dedicated to showing the intrinsic difficulty of the game of Tetris.
4	• Finished writing first section of literature review. • Created images for clarity.
5	• Found literature that utilise different approaches to playing Tetris with AI.
6	• Continued finding different approaches taken to play Tetris. • Specifically read and digested paper on imitation learning. • Began structuring second section of the literature review, dedicated to showcasing some of the approaches taken to play Tetris that aren't nature-inspired.
7	• Completed a subsection on the use of imitation learning for playing Tetris • Read up on Monte-Carlo Tree Search, UCB1, and how it is used as an approach to Tetris.
8	• Completed a subsection on the use of UCB1 for playing Tetris. • Read up on some deep reinforcement learning concepts because some papers were found that used Q-learning to play Tetris.
9	• Read literature that described the use of deep reinforcement learning for Tetris. • Completed a subsection on the use of deep reinforcement learning for playing Tetris. • Found and read papers that utilise non nature-inspired meta-heuristics like Harmony Search Algorithm and MVP Algorithm to play Tetris. • Found literature on using Genetic Algorithms and Particle Swarm Optimisation to play Tetris.
10	• Found and read literature on the use of Ant Colony Optimisation to play Tetris. • Completed a subsection on the use of different meta-heuristic algorithms for playing Tetris. • Started writing section dedicated to demonstrating the use of nature-inspired algorithms in playing Tetris.
11	• Completed a subsection on the use of genetic algorithms in playing Tetris.

Continued on next page

Table 1.3: Weekly breakdown of work done for Literature Review Chapter. (Continued)

12	• Completed a subsection on the use of Particle Swarm Optimisation in playing Tetris. • Completed a subsection on the use of Ant Colony Optimisation in playing Tetris.

1.1.3 Methodology

The methodology is arguably the most important chapter of the review as it sets up the entire project in the implementation phase (CP2). **Four weeks** were allocated to write up the methodology, which should define everything that will be done in a structured manner.

Table 1.4: Weekly breakdown of work done for Methodology Chapter.

Week	Work Done
12	• Structured the Methodology chapter • Began writing section on rules, defining the piece randomiser and matrix dimensions.
13	• Researched Tetris spin rules. • Continued writing rules section, defining spins, gravity and other features.
14	• Researched Tetris attack rules. • Completed writing rules section, adding attack rules to the rules. • Completed section on algorithm selection. • Began problem formulation section.
15	• Completed problem formulation section. • Completed section on evaluation metrics.

1.1.4 Work Plan

Careful consideration needs to be taken when coming up with a work plan. Risk factors need to be thought of and time needs to be allocated to each task. However, since the work plan takes up the least space in the document, only **one week** of time was allocated to it.

Table 1.5: Weekly breakdown of work done for Work Plan Chapter.

Week	Work Done

Continued on next page

Table 1.5: Weekly breakdown of work done for Work Plan Chapter. (Continued)

15	• Came up with tasks that need to be done. • Created table to showcase work activities, risk factors, and time allocated for all tasks. • Created Gantt chart to visualise the timeline.

2 Bibliography

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

In this webpage, the game of Tetris is described as an addictive puzzle game, there are references to some rules of the game, which includes the clearing of lines and the losing condition. There is also a section on the creator of Tetris. As this is the 'About Us' page of the official Tetris website, this is treated as a credible source. This source will be used to introduce the Tetris game. It gives readers a good amount of information without being too overwhelming.

[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.

In their paper, Demaine et al. mathematically proves that the natural objectives of Tetris - minimising the height of an occupied square, maximising the number of pieces placed, maximising the number of cleared rows and maximising the number of Tetrises (clearing four lines in a row) are NP-complete. This paper is credible because rigorous mathematical proof is used to come to its conclusions. This source will be used to introduce the NP-completeness of Tetris, a central motivation behind the project.

[3] J. Brzustowski, "Can you win at tetris?" Master's Thesis, University of Waterloo, 200 University Ave W, Waterloo, ON N2L 3G1, Canada, 1988.

In this thesis, Brzustowski proves that the classic game of Tetris is unwinnable if the computer is aware of and reacting to the player's moves. This is because certain pieces will lead to a loss given to the player in a sequence. This thesis is referenced in several different research papers relating to the game. This source will be used as an example for the research that is being done on Tetris.

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

In this article, Burgiel proved that any game of Tetris is unbeatable, regardless of whether the machine is aware of the player's move. Rigorous mathematical proof is provided to show that this is true. This article will be used as an example for the research that is being done on Tetris.

[5] M. Sipser, in *Introduction to the Theory of Computation*, Cengage Learning, 2013.

In a of theis textbook, Sipser describes NP-completeness and shares some characteristics of NP-complete problems. Sipser is an American theoretical computer scientist who made many contributions in the field of computational complexity. This source will be used to describe the properties of NP-complete problems.

[6] V. Lesch, M. König, S. Kounev, A. Stein, and C. Krupitzer, "A case study of vehicle route optimization," *CoRR*, vol. abs/2111.09087, 2021.

In their paper, Lesch et al. introduces vehicle route optimisation as an NP-complete problem. They then utilise nature-inspired algorithms including ant colony optimisation and genetic algorithms to tackle route optimisation. This source will be used to introduce route optimisation as a proven NP-complete problem.

[7] J. D. Ullman, "Np-complete scheduling problems," *Journal of Computer and System sciences*, vol. 10, no. 3, pp. 384–393, 1975.

In this article, Ullman demonstrates that several scheduling problems including single execution time scheduling and two processor scheduling are NP-complete. This source will be used to introduce job scheduling as a proven NP-complete problem.

[8] J. Arle and K. Carlson, "Medical diagnosis and treatment is np-complete," *Journal of Experimental & Theoretical Artificial Intelligence*, vol. 33, pp. 1–16, Mar. 2020. DOI: 10.1080/0952813X.2020.1737581.

In this article, Arle and Carlson show that medical diagnosis and treatment (MDT) is NP-complete. This is done by reducing the travelling salesman problem and set-cover problems to MDT. This source will be used to show that NP-complete problems also exist within the field of medicine.

[9] L. Davis, "Job shop scheduling with genetic algorithms," in *Proceedings of the First International Conference on Genetic Algorithms and Their Applications*, 1985, pp. 136–140.

In this paper, Davis highlights the limitations of deterministic scheduling algorithms and introduces genetic algorithms as a non-deterministic approach to solving the job shop scheduling problem. Through a series of experiments, he demonstrates the efficacy of genetic algorithms in generating schedules that optimize profit, even in the face of changing constraints and uncertainties typical of real-world job shops. This paper provides valuable insights into the application of a nature-inspired algorithm, genetic algorithms, in solving NP-complete problems.

[10] W. Korani and M. Mouhoub, "Review on nature-inspired algorithms," *Operations Research Forum*, vol. 2, Jul. 2021. DOI: 10.1007/s43069-021-00068-x.

This paper is a review of nature-inspired algorithms, focusing on their performance analysis, reporting of experimental evaluation results, and guidelines for proposing new nature-inspired techniques. This source will be used to demonstrate the effectiveness of using nature-inspired algorithms over traditional exact methods.

[11] J. Lewis, "Playing tetris with genetic algorithms," 2015. [Online]. Available: https://api.semanticscholar.org/CorpusID:17416568.

In this paper, Lewis explores the application of genetic algorithms to optimise Tetris gameplay. It delves into representing Tetris states using features such as game score and board configuration, with moves selected based on weighted feature sums. Through a genetic algorithm framework involving population-based selection, mutation, and crossover, the paper demonstrates the evolution of Tetris-playing strategies over 30 generations. Results indicate significant improvements in gameplay efficiency, with optimised players achieving an average game length of 179,531 moves and an average score efficiency of 2.5. This paper will be used as an example of using nature-inspired algorithms in tackling Tetris.

[12] L. Langenhoven, W. S. van Heerden, and A. P. Engelbrecht, "Swarm tetris: Applying particle swarm optimization to tetris," in *IEEE Congress on Evolutionary Computation*, 2010, pp. 1–8. DOI: 10.1109/CEC.2010.5586033.

This paper investigates the use of particle swarm optimization (PSO) to train neural network agents for playing the game of Tetris. The experimental results show the learning progress of the algorithm and compare it to a hand-optimized Tetris playing algorithm. The study concludes that a swarm-based approach is feasible for Tetris and suggests avenues for future work to further optimize the training algorithm parameters and improve the performance of the neural agents. The paper provides valuable insights into the application of computational intelligence techniques to game-playing agents. It will be cited as a nature-inspired approach to play Tetris.

[13] S. Asif, M. Coulombe, E. Demaine, *et al.*, "Tetris is np-hard even with o(1) rows or columns," *Journal of Information Processing*, vol. 28, pp. 942–958, Jan. 2020. DOI: 10.2197/ipsjjip.28.942.

In their paper, Asif et al. used Demaine et al.'s proof as a starting point to prove that Tetris is NP-hard in a general case. They proved that the game remains NP-complete even when restricted to 8 columns, or to 4 rows, showcasing the inherent difficulty of the problem. The paper utilise rigorous mathematical proofs to showcase their findings. This source will be used in addition to Demaine et al.'s paper to show the intrinsic difficulty of Tetris.

[14] M. R. Garey and D. S. Johnson, *Computers and Intractability: A Guide to the Theory of NP-Completeness*, First Edition. W. H. Freeman, 1979, ISBN: 0716710455.

This textbook is one of the most popular textbooks talking about NP things and intractability. The authors talk about numerous concepts in an intuitive way for readers of any level. It will be used when talking about the difficulty of the game and defining NP and NP-completeness.

[15] D. P. Bovet, P. Crescenzi, and R. Silvestri, "A uniform approach to define complexity classes," *Theoretical Computer Science*, vol. 104, no. 2, pp. 263–283, 1992.

This textbook talks about computational complexity as a whole. The authors give a more uniform explanation of complexities, including concepts like NP and NP-hard. It will be cited to explain NP-completeness.

[16] O. Goldreich, "Computational complexity: A conceptual perspective," *SIGACT News*, vol. 39, no. 3, Sep. 2008, ISSN: 0163-5700. DOI: 10.1145/1412700.1412710. [Online]. Available: https://doi.org/10.1145/1412700.1412710.

This book conceptually describes complexity theory as a whole, and give conceptually rich explanations to complexity in general. It will be cited in explaining NP-completeness.

[17] *The Millennium Prize Problems - Clay Mathematics Institute — claymath.org*, https://www.claymath.org/millennium-problems/, [Accessed 15-05-2024].

This website contains a list of the Millennium Prize Problems, which are the 7 most difficult problems in mathematics. Anyone who is capable of solving any of these problems are entitled to a million dollars. One of these problems is the problem of wheter P=NP. This will serve as general information of P, NP, and complexity classes.

[18] MIT OpenCourseWare. "Np-completeness." 6.046J: Design and Analysis on Algorithms, Massachusetts Institute of Technology. (2015), [Online]. Available: https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/resources/mit6_046js15_lec16/.

These lecture notes explain the theories of complexity in an intuitive way that would allow many different readers to understand these concepts. It gives intuitive explanations to nondeterminism, reductions, and the NP-completeness criteria. It is credible as these are the lecture notes given by professors at MIT. It will be used when explaining certain NP related concepts.

[19] S. Arora and B. Barak, *Computational Complexity: A Modern Approach*. Cambridge University Press, 2009, ISBN: 9780521424264.

This textbook attempts to explain complexity theory with a more modern approach. One of the key things mentioned in this book was that most researchers believe that P and NP are not equal sets. This will be used to justify why we need to use alternative approaches to approach NP-complete problems.

[20] D. Zhang, Z. Cai, and B. Nebel, "Playing tetris using learning by imitation," 2010. [Online]. Available: https://api.semanticscholar.org/CorpusID:10668262.

In their paper, Zhang et al. utilise an imitation learning approach to play Tetris. The machine learns patterns and features from a player or existing algorithm and tries to play like them. Experimental results show that a system imitating a human player will outperform one imitating an AI in a two-player game, but the opposite is true for a single-player game. This will be cited to demonstrate using imitation learning to tackle Tetris.

[21] A. Hussein, M. Gaber, E. Elyan, and C. Jayne, "Imitation learning: A survey of learning methods," English, *ACM Computing Surveys*, vol. 50, no. 2, Apr. 2017, ISSN: 0360-0300. DOI: 10.1145/3071073.

This article gives a brief overview of imitation learning, explaining the objectives of using the method, which is to mimic human behaviour by learning a mapping between observation and demonstrations. This article will be cited when defining imitation learning.

[22] C. Fahey, *Tetris AI*, [accessed Jun. 23, 2024], 2003. [Online]. Available: http://www.colinfahey.com/tetris/.

Fahey's AI is largely cited in a handful of the existing literature. In this webpage, Fahey explains his approach to developing a Tetris AI. It will be cited when a direct comparison is done between Fahey's AI and other works.

[23] G. Chaslot, "Monte-carlo tree search," English, Ph.D. dissertation, Maastricht University, 2010, ISBN: 9789085590996. DOI: 10.26481/dis.20100930gc.

In this thesis, Chaslot defines Monte-Carlo Tree Search as a best-first search method that is based on a randomised exploration of the search space. It will be used to further explain one of the approaches taken to play Tetris.

[24] Z. Cai, D. Zhang, and B. Nebel, "Playing tetris using bandit-based monte-carlo planning," Jan. 2011.

In their article, Cai et al. attempt to use a variation of Monte-Carlo Tree Search known as UCB1 to approach the game of Tetris. Under their implementation, they found that it was able to defeat Fahey's AI as well as their previous imitation learning algorithms. This will be used to demonstrate using a bandit-based Monte-Carlo approach to play Tetris with algorithms.

[25] L. Kocsis and C. Szepesvári, "Bandit based monte-carlo planning," in *Machine Learning: ECML 2006*, J. Fürnkranz, T. Scheffer, and M. Spiliopoulou, Eds., Berlin, Heidelberg: Springer Berlin Heidelberg, 2006, pp. 282–293, ISBN: 978-3-540-46056-5.

This paper formally defines the algorithm used by Cai et al. in their work on using UCB1 to approach Tetris. It will be cited to explain what UCB1 actually is.

[26] M. Stevens and S. Pradhan, "Playing tetris with deep reinforcement learning," *Convolutional Neural Networks for Visual Recognition CS23, Stanford Univ., Stanford, CA, USA, Tech. Rep*, 2016.

In their paper, Stevens and Pradhan take a deep reinforcement learning approach to learn the game of Tetris. They use Q-learning to train a convolutional neural network to make better piece placement decisions. This paper will be used to demonstrate using deep reinforcement learning to play Tetris.

[27] Y. Lee, *Tetris AI - The (Near) Perfect Bot*, `https://codemyroad.wordpress.com/2013/04/14/tetris-ai-the-near-perfect-player/`, [accessed Jul. 17, 2024].

In this webpage, Lee showcases their near perfect Tetris bot, and the methods they used to achieve the bot. The fitness function defined by Lee is used in Stevens and Pradhan's paper. This webpage will be cited when it is mentioned directly by other papers, and when comparing performance.

[28] Z. Chen, "Playing tetris with deep reinforcement learning," Master's Thesis, University of Illinois at Urbana-Champaign, 2021.

In this thesis, Chen uses Stevens and Pradhan's work as a starting point and approaches Tetris in a similar way. They also attempted different ways to train the agent, such as making them play a harder variant, allowing them to use the "hold" feature, and giving them a more predictible random piece generator. Experimental results showed that it significantly outperformed Stevens and Pradhan's agent. This paper will be used to demonstrate using deep reinforcement learning to play Tetris.

[29] X.-S. Yang, *Nature-inspired optimization algorithms*. Academic Press, 2020.

This book is a collection of information on nature-inspired optimisation algorithms. It also mentions that there are no widely accepted definitions of the term meta-heuristic. This book will be cited to show that meta-heuristic is a relatively loose term.

[30] S. Almufti, A. Shaban, R. Ali, and J. Fuente, "Overview of metaheuristic algorithms," *Polaris Global Journal of Scholarly Research and Trends*, vol. 2, pp. 10–32, Apr. 2023. DOI: `10.58429/pgjsrt.v2n2a144`.

In this article, Almufti et al. explain meta-heuristic and give a list of characteristics present in many meta-heuristics. It will be used to introduce meta-heuristics in the literature review.

[31] Z. W. Geem, J. H. Kim, and G. V. Loganathan, "A new heuristic optimization algorithm: Harmony search," *simulation*, vol. 76, no. 2, pp. 60–68, 2001.

In this article, Geem et al. propose a new algorithm inspired from the improvisation processes of musicians. The article will be used to introduce the Harmony Search algorithm before delving into how it has been used to approach Tetris.

[32] V. I. M. Romero, L. L. Tomes, and J. P. T. Yusiong, "Tetris agent optimization using harmony search algorithm," *International Journal of Computer Science Issues (IJCSI)*, vol. 8, no. 1, p. 22, 2011.

In this article, Romero et al. describes the use of Harmony Search Algorithm in optimising a Tetris agent. By using the weighted sum of features as an evaluation function, an agent can decide on which move to take. The weights for each feature are optimised using the harmony search algorithm. This article will be used to demonstrate how harmony search has been used to play Tetris.

[33] H. Bouchekara, "Most valuable player algorithm: A novel optimization algorithm inspired from sport," *Operational Research*, vol. 20, pp. 1–57, Mar. 2020. DOI: 10.1007/s12351-017-0320-y.

In this article, Bouchekara proposes a meta-heuristic algorithm that is inspired from sports, where teams compete against one another to win a championship and individuals compete against one another to win an MVP trophy. This article will be used to introduce the ideas of the MVP Algorithm before delving into how it is used to play Tetris.

[34] H. Armanto, R. D. Putra, and C. Pickerling, "Mvpa and ga comparison for state space optimization at classic tetris game agent problem," *Inform: Jurnal Ilmiah Bidang Teknologi Informasi dan Komunikasi*, vol. 7, no. 1, pp. 73–80, 2022.

In this article, Armanto et al. compare the use of an MVP algorithm and a Genetic Algorithm (GA) in optimising the state space of a classic Tetris agent. Results show that the MVP algorithm outperforms the GA, converging quicker and outscoring the GA. This article will be used to demonstrate how MVPA has been used to play Tetris. The results showing how MVPA outperforms GA will also be mentioned.

[35] R. Arya, S. Singh, M. Singh, B. Iyer, and V. Gudivada, *Nature-inspired Optimization Algorithms and Soft Computing: Methods, Technology and Applications for IoTs, Smart Cities, Healthcare and Industrial Automation* (Computing and Networks). Institution of Engineering and Technology, 2023, ISBN: 9781839535161. [Online]. Available: https://books.google.com.my/books?id=lTjhEAAAQBAJ.

In this book, certain concepts relating to nature-inspired algorithms are defined. Specifically, nature-inspired algorithms are themselves defined. The book will be cited when giving a short introduction to nature-inspired algorithms.

[36] L. Flom and C. Robinson, "Using a genetic algorithm to weight an evaluation function for tetris," 2005. [Online]. Available: https://api.semanticscholar.org/CorpusID:18453509.

In this article, Flom and Robinson utilise a variation of Genetic Algorithms to weight an evaluation function for a classic Tetris agent. It will be cited to demonstrate the use of genetic algorithms in playing Tetris.

[37] D. Whitley and T. Starkweather, "Genitor ii: A distributed genetic algorithm," *Journal of Experimental & Theoretical Artificial Intelligence*, vol. 2, no. 3, pp. 189–214, 1990.

In this article, Whitley and Starkweather propose a variation of Genetic Algorithms known as GENITOR. The algorithm is similar to that of vanilla GA, but instead of completely replacing a previous generation with a new one, GENITOR replaces poor performing individuals with children of high-performing individuals. This paper will be cited to define GENITOR, as this is the variation used by Flom and Robinson in their work.

[38] G. Syswerda, "Uniform crossover in genetic algorithms," Jan. 1989.

In this article, Syswerda formally defines what uniform crossover is and its differences between other types of crossover in a genetic algorithm. It is cited to better define uniform crossover, as this is the crossover function used by Flom and Robinson in their work.

[39] X. Chen, H. Wang, W. Wang, Y. Shi, and Y. Gao, "Apply ant colony optimization to tetris," Jul. 2009, pp. 1741–1742. DOI: 10.1145/1569901.1570136.

In this article, Chen et al. outlines their use of Ant Colony Optimisation (ACO) in playing Tetris. Similar to the other meta-heuristics mentioned, a list of features were used, and the algorithm was used to optimise the weights of each feature. This article will be cited to demonstrate the use of ACO in optimising an agent's Tetris gameplay.

[40] *Hard Drop - Tetris Community*, https://harddrop.com/, [accessed Jul. 27, 2024].

This website is home to the Tetris community. There are several wiki pages that explain the rules of Tetris in detail. The website will be used to help define the rules of Tetris more accurately.

3 Meeting Records

Throughout the semester, I had seven meetings with Dr Richard. Each time we discussed the work that had been done between the current and previous meeting. Dr Richard gave me plenty of pointers, as well as personal advice to produce a better planning document.

The following pages contain all meeting records, including the date and time of the meeting, the items discussed, and the expected work outcomes before the next meeting.

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

SUPERVISION MEETING RECORD

Meeting 1

Date: 22 April 2024
Time: 05:00 pm - 06:00 pm
Student: Yap Wei Xiang
Supervisor: Dr Richard Wong Teck Ken

Items Discussed this Meeting:

- The 'Introduction' chapter of the planning document was discussed.
  - ❖ Focus more on using academic language instead of using fancy words.
  - ❖ Try to find a better motivation for the project, find real world problems that are semi-parallel to the game or find a way to fit NP-completeness into the picture.

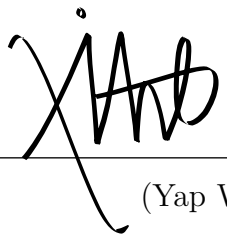
Work for the Coming Meeting:

- Make necessary adjustments to the Introduction.
- Start reading literature.

Supervisor Signature:

(Dr Richard Wong Teck Ken)

Student's Signature:



(Yap Wei Xiang)

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

SUPERVISION MEETING RECORD

Meeting 2

Date: 17 May 2024
Time: 10:30 am - 11:00 am
Student: Yap Wei Xiang
Supervisor: Dr Richard Wong Teck Ken

Items Discussed this Meeting:

- Revised motivation.
  - ❖ Motivation approved.
- Literature review structure
  - ❖ Confirmed that the literature review should include methods that are different from nature-inspired algorithms.
  - ❖ Ideas for further structure in certain sections of the review.
- Literature review
  - ❖ So far, everything has been approved. To continue on with the rest of the review.

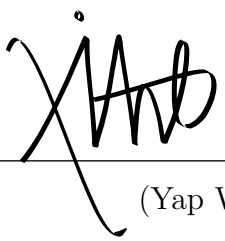
Work for the Coming Meeting:

- Continue writing Literature Review.

Supervisor Signature:

(Dr Richard Wong Teck Ken)

Student's Signature:



(Yap Wei Xiang)

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

SUPERVISION MEETING RECORD

Meeting 3

Date: 31 May 2024
Time: 10:30 am - 11:00 am
Student: Yap Wei Xiang
Supervisor: Dr Richard Wong Teck Ken

Items Discussed this Meeting:

- Revised section 2.1 of literature review.
  - ❖ Everything has been approved, to continue working on the review.
- Methodology
  - ❖ Since I have started on the literature review, Dr Richard suggested to start thinking of the structure of the methodology.

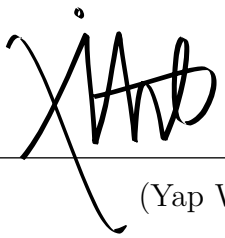
Work for the Coming Meeting:

- Continue writing Literature Review.
- Begin structuring Methodology

Supervisor Signature:

(Dr Richard Wong Teck Ken)

Student's Signature:



(Yap Wei Xiang)

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

SUPERVISION MEETING RECORD

Meeting 4

Date: 14 June 2024
Time: 10:00 am - 10:30 am
Student: Yap Wei Xiang
Supervisor: Dr Richard Wong Teck Ken

Items Discussed this Meeting:

- Completed Section 2.1 of Literature Review
  - ❖ Explain concepts more clearly (finite deterministic piece sequence).
  - ❖ Make minor edits.
  - ❖ Some points need citations.
- Mental Burnout
  - ❖ Stop giving myself expectations for perfect writing, just sit down and write.

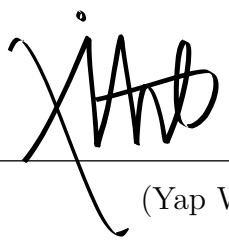
Work for the Coming Meeting:

- Complete Literature Review.
- Begin structuring Methodology

Supervisor Signature:

(Dr Richard Wong Teck Ken)

Student's Signature:



(Yap Wei Xiang)

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

SUPERVISION MEETING RECORD

Meeting 5

Date: 5 July 2024
Time: 10:00 am - 10:30 am
Student: Yap Wei Xiang
Supervisor: Dr Richard Wong Teck Ken

Items Discussed this Meeting:

- Section 2.2 of Literature Review.
    - ❖ Structure of explanation seems okay.

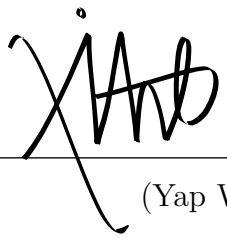
Work for the Coming Meeting:

- Continue Literature Review.

Supervisor Signature:

(Dr Richard Wong Teck Ken)

Student's Signature:



(Yap Wei Xiang)

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

SUPERVISION MEETING RECORD

Meeting 6

Date: 19 July 2024
Time: 10:00 am - 10:30 am
Student: Yap Wei Xiang
Supervisor: Dr Richard Wong Teck Ken

Items Discussed this Meeting:

- Methodology
    - ❖ Began coming up with ideas for the methodology section.

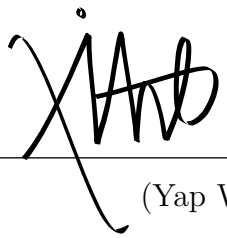
Work for the Coming Meeting:

- Complete Literature Review
- Complete Methodology

Supervisor Signature:

(Dr Richard Wong Teck Ken)

Student's Signature:



(Yap Wei Xiang)

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

SUPERVISION MEETING RECORD

Meeting 7

Date: 29 July 2024
Time: 10:00 am - 10:30 am
Student: Yap Wei Xiang
Supervisor: Dr Richard Wong Teck Ken

Items Discussed this Meeting:

- Literature Review
  - ❖ Approved Literature Review
- Methodology
  - ❖ Include introductory paragraph to methodology.

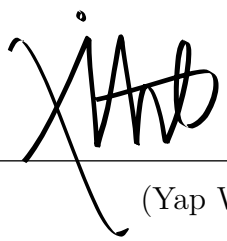
Work for the Coming Meeting:

- Complete Methodology

Supervisor Signature:

(Dr Richard Wong Teck Ken)

Student's Signature:



(Yap Wei Xiang)