HOW TO CREATE A CHESS ENGINE USING DEEP REINFORCEMENT LEARNING

A CRITICAL LOOK AT DEEPMIND'S ALPHAZERO

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Preface

This bachelor thesis is the conclusion to the bachelor programme Multimedia & Creative Technologies at Howest college West Flanders in Kortrijk, Belgium. The programme teaches students a wide range of skills in the field of computer science, with a focus on creativity and Internet of Things. From the second year on, students can choose between four different modules:

1. **AI Engineer**
2. **Smart XR Developer**
3. **Next Web Developer**
4. **IoT Infrastructure Engineer**

This bachelor thesis was made under the **AI Engineer** module. The subject of the thesis is a critical look at the result of my research project in the previous semester. The goal of the project was to create a chess engine in Python with deep reinforcement learning based on DeepMind's AlphaZero algorithm.

I will explain the research I needed to create it, the technical details on how to program the chess engine and I will reflect on the results of the project. To do this, I will contact multiple people familiar with the field of reinforcement learning to get a better understanding of the impact of this research on society. Based on this, I will give advice to people and companies who wish to implement similar algorithms.

I would like to show gratitude to Wouter Gevaert for his enthousiastic support in the creation of my research project and this thesis. I also want to thank the other teachers at Howest Kortrijk, who shared their knowledge and expertise in programming and AI in very interesting classes.

Furthermore, I would liike to thank my parents for giving me the chance to have a good education, and the motivation to get the best I can out of my studies.

Tuur Vanhoutte, 1$^{\text{st}}$ June 2022

Abstract

This bachelor thesis answers the question: "How to create a chess engine using deep reinforcement learning?". It explains the difference between normal chess engines and chess engines that use deep reinforcement learning, and specifically tries to recreate the results of AlphaZero, the chess engine by DeepMind, in Python on consumer hardware.

The technical research shows what is needed to create my implementation using Python and TensorFlow. It shows how to program the chess engine, how to build the neural network, and how to train and evaluate the network. During the creation of this chess engine, it was crucial to create a huge amount of data through self-play.

The thesis contains a reflection on the results of my research project, which proposes a solution to the problem of creating a high amount of games through self-play. It also reflects on the impact of this research on society, and the viability of this type of artificial intelligence in the future. With this comes a section on advice for companies that wish to implement similar algorithms.

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Glossary

1   Introduction

Chess is not only one of the most popular board games in the world, it is also a breeding ground for complex algorithms and more recently, machine learning. Chess is theoretically a deterministic game: no information is hidden from either player and every position has a calculable set of possible moves. Because the branching factor of chess is about 35-38 moves [1], calculating if a position is winning or losing requires an enormous amount of calculations.

Throughout the entire history of computer science, researchers have continously tried to find better ways to calculate if a position is winning or losing. The most famous example is the StockFish engine [2], which uses the minimax algorithm with alpha-beta pruning to calculate the best move.

More recently, researchers at Google DeepMind have developed a new algorithm called AlphaZero [3]. This thesis explores the concept of AlphaZero, how to create a chess engine based on it, and the impact of the algorithm on both the world of chess and the rest of society.

Research has been conducted by investigating what is needed to recreate the results of AlphaZero, by programming a simple implementation using Python and TensorFlow. This was done as part of a research project between November 2021 and January 2022. The code was written with lots of trial and error, as DeepMind released very little information about the detailed workings of the algorithm.

2 Research

2.1 Traditional chess engines

2.2 AlphaZero

3 Technical research

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7 Bibliography

[1] *Branching Factor - Chessprogramming wiki*, https://www.chessprogramming.org/Branching_Factor.

[2] "Stockfish (chess)," *Wikipedia*, Mar. 2022.

[3] "AlphaZero," *Wikipedia*, Jan. 2022.

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