University of Nottingham

Computer Science with Artificial Intelligence MSci

G54IRP/COMP4027 — Individual Research Project

AI for General Video Game Playing

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Contents

1 Introduction

1.1 Introduction

- Popularity of Video Games
- Variety of Video games being played
- Video Games as a testing ground for AI

1.2 Planning VS learning

- As the title says, just to get some definitions out of the way

1.3 Motivation

- Individual desire to get better at deep reinforcement learning
- Learning more Methods
- Applying Methods
- Learning to use more robust and real world frameworks for DRL
-
- Seeing the state of the art in DRL and AI game playing

1.4 Aims and Objectives

- Look at the project plan aims and objectives

2 Related Work

2.1 AI and Game Playing

- AI approaches have specialised heuristics or only been developed for a single game
-
- Go — previous interim report / PP
- Chess — previous interim report / PP
- OpenAIFive
- GET MORE THINGS FROM PP
-
- Dartmouth Workshop

2.1.1 Early Artificial Intelligence

The history of AI game playing begins near the start of artificial intelligence as a field, in the 1950s. Strachey created a draughts player for one of the first general computing machines (Manchester Ferranti Mark I) which by 1952 could "play a complete game of draughts at a reasonable speed"[2]. Prinz wrote a simplified chess player for the Manchester Machine as well which could solve the mate-in-two problem. This meant that if there was a checkmate solution in 2 turns it could successfully find it[2]. Prinz simply used an exhaustive search technique to find the correct moves, and even though computing power was limited at the time it was clear that this wouldn't scale to full games. This lead to Turning starting to program 'Turbochamp' a chess program that would be able to play a full game of chess using heuristics[2]

These simple games were made before the term artificial intelligence was being used even in an academic setting showing how natural AI and game playing go together.

2.1.2 Chess

Chess was an early and significant example in the history of AI game playing. In 1997 IBM managed to beat the reigning world champion, Garry Kasparov, using their custom developed machine, Deep Blue[1]. This was significant as, at the time, creating a winning chess AI was seen to be the next big milestone at the time in AI.

To achieve this Deep Blue used a combination of techniques with the main underlying AI technique being a search method. As Chess is a deterministic game and both players have complete information of the board state it was possible for Deep Blue to generate future board states. With this forward model its possible to generate a search tree of possible moves and their resulting game states The tree was efficiently generated by a combination of a massively parallel architecture over 30 nodes and the fact that each node has special purpose chess chips, generating around 6–8 moves ahead on average. Alpha-beta pruning was used in a MinMax algorithm to help efficiently search the tree while using the custom hardware to evaluate each node quickly.

IBM had proven that search methods could achieve strong results against human opponents but this was mostly due to brute force computing power and a heavy reliance on expert knowledge. The expert knowledge came from other grandmasters and was used in the form of an opening/closing move database and the special purpose hardware to evaluate board states. While higher computing power will always benefit AI techniques, later techniques have been developed to reduce the need of expert knowledge and to make more efficient use of hardware available.

2.1.3 Go

2.2 GVGAI and VGDL

- TODO Make some notes up here

2.3 OPEN AI GYM and GVGAI GYM

- What is OPEN AI GYM
- Why is OPEN AI GYM helpful for RL
- GVGAI GYM
- Initial results from GVG AI GYM paper
- Maybe some more here

[3]

2.4 Subsection to end all subsections

- Maybe something about the open AI baselines
- Depends what technique I would be using but I should look into that
- Where does reinforcement learning come into this bad buoy

3 Appendix

3.1 Meeting Minutes

3.2 Work Plan

3.3 References

References

[1] Murray Campbell, A Joseph Hoane, and Feng-hsiung Hsu. Deep blue. *Artificial intelligence*, 134(1-2):57–83, 2002.

[2] Jake Copeland. A brief history of computing. `http://www.alanturing.net/turing_archive/pages/Reference%20Articles/BriefHistofComp.html#MUC`, June 2000.

[3] Ruben Rodriguez Torrado, Philip Bontrager, Julian Togelius, Jialin Liu, and Diego Perez-Liebana. Deep reinforcement learning for general video game ai. *arXiv preprint arXiv:1806.02448*, 2018.