AI Concepts & How Deep Learning in Texas Hold'em Poker Can Affect Gameplay

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Research Methods

Contents

1. Introduction

1.1. Artificial Intelligence

"AI is the study of how to make computers do things which, at the moment, people do better" (Kulkarni and Joshi, 2015).

Artificial intelligence (AI) is the concept of developing machines that act intelligently, attempting to mimic the responses that humans have. It is a science, which has been continually developed on since its birth in 1955 when John McCarthy became one of the founding fathers of AI. (Kulkarni and Joshi, 2015).

5 years prior to this, Alan Turing wrote an article centred around the question "Can machines think". This led to the Turing test or rather the imitation game where a third party would attempt to identify which of two unidentified entities is human and the other a machine, simply by asking it/them questions whilst unable to see and hear them. It was this idea that would determine how intelligent a machine is by being undistinguishable from a human (Turing 1950).

Over the years, researches have continuously sought after making advancements in the field of AI motivated by the idea of understanding the nature of intelligence and/or understanding the human brain. Game developers tend to stride in a different direction, drawing from the research of others to build algorithms that allow them to create AI that appears to make intelligent decisions in a 3-dimensional environment with the aid of some flashy graphics. One of the earliest video games developed that entailed AI was Pac-Man, with 4 AI entities, each having a different chance of chasing the player or heading of in a different direction all together incorporating semi-randomness into their decision-making process (Millington and Funge, 2009).

1.2. Minimax Algorithms

Minimax algorithms, a simple and effective recursive search tree function allows the best action to take in games consisting of multiple AI agents (2) using an evaluation function. These search functions only search a specified depth for instance in a game of chess where there are a possible 10^{40} moves to consider so for a search function such as this to performance optimally, it can search a depth of 3 reducing the amount of node to check dramatically. Alpha-beta pruning, an optimized version of the minimax algorithm allows the best action while disregarding large portions of the search trees dramatically improving performance. Search functions such as minimax have been used in a variety of games for example tic-tac-toe, chess and even go (Russell, Norvig and Davis., 2016).

1.3. Deep Learning

Deep learning or what is sometimes referred to as Machine Learning is the concept of computers gathering knowledge from experience which has been used in many situations to date whether it's to defeat chess champion Garry Kaspararov in 1997 using IMB's Deep Blue system (Hsu, 2002) or the filter the content displayed on your favourite social media website. It has made many advancements in areas such as image and speech recognition, analysing

data from particle accelerators but typically solving issues that many in the AI community have struggled to resolve (LeCun, Bengio and Hinton, 2015).

Neural networks, a machine learning algorithm was brought to life by some of the earliest work in the field of AI influence by neuroscience and the workings of the human brain more specifically neurons. Because of this and their effectiveness as a learning system, have become more popular of late as they can be used in many diverse applications with varying conditions (Russell, Norvig and Davis., 2016). One example of the uses of a neural network is in Audio-visual speech recognition (AVSR). The aim of AVSR is to improve speech recognition by using visual information such as the motion of the speaker's lips to assist when a piece of audio is corrupted by background noise (Node, et al., 2015).

Neural networks are only one of many machine learning algorithms. Decision tree learning, the simplest form of machine learning can also be thought of as the most successful form of learning algorithm (Russell, Norvig and Davis., 2016). This form of machine learning has been used to solve a variety of problems one of which is the prediction of whether a treatment will cure patients with variety of illnesses i.e. chronic hepatitis C. After testing 142 Japanese patients, it is possible to predict with a high probability of 93% whether can be cured or not (Kawamura, Takasaki and Mizokami, 2012).

1.4. Literature Review

Texas Hold'em poker (THP) makes for a very interesting game to implement such an algorithm into due to its unpredictable nature and unique scenarios. Learning algorithms cope well in these types of environments because of their ability to learn from experience and make decisions based on that information rather than relying on predicting the possible outcomes and making the best decision from that information (Kulkarni and Joshi, 2015).

DeepStack's AI which the research for was released on the 2 March 2017 managed to defeat ten out of eleven pro poker players whilst running on a GPU you can pick up at your local tech store. Their AI runs a neural network using randomly generated poker scenarios instead of referring to stored strategies prior to play to create what is referred to as "DeepStack's gut feeling" when deciding on actions to take (Moravčík, M, et al., 2017). As well as fixing the number of possible moves to calculate down to just 107 at any given point giving the average time of 5 seconds to figure out a move which allows for a fast response time for any given action (Hsu, 2017).

For the last two decades, video games such as chess, checkers, go and now poker have allowed the development of AI systems to reach new milestones such as DeepStack's AI and while this is great for the advancement of AI, it doesn't bode well for the general player. Having an AI as advanced as DeepStacks in any video game would severally impact gameplay and replace the challenge and reward that many players seek from a video game (Fabricatore, C, 2007) with a near impossible to beat AI, in this case DeepStacks where only 1 in 11 pro players have managed to conquer it.

1.5. Aims & Objectives

The main aim of this research project is to determine if an AI utilizing a complex algorithm such as a deep learning neural network will benefit gameplay more than a less complex algorithm such as a minimax algorithm. Both have their pros and cons and in this research, both will be explored. To come to such a conclusion, two AI entities will be implemented into a game of heads-up THP, a non-perfect information game. From this, the following information will be recorded from pitting both AI against each other in various poker matches:

- Win/Lose ratios
- Response time for each action
- Performance

Secondary aims and objectives include the optimisation of both AI to gain the best possible performance and to investigate other methods of machine learning for example decision tree learning.

2. Methodology

With the aims and objectives of this project in mind, the research and development process will be broken down into 3 stages over roughly 16 weeks. The first stage will be the development of the THP game and the careful implementation of its rules as if implemented incorrectly would taint any results gathered. It will be developed using the Visual Studio software in the C++ programming language as a console application. The reason it will be developed as a console application is that the graphical user interface of the game will be of little importance to the overall goal if the appropriate information can be displayed to the user.

The second stage will be the implementation of a minimax algorithm. Minimax algorithms have been used in many video games to provide a challenging AI such as chess, and are far less complex to implement then your typical deep learning algorithms (Russell, Norvig and Davis., 2016). A simple yet effective AI such as this will not only make testing the games functionality far easier but will also offer up as an opponent against the AI running the neural network and any user running this application. When considering the optimisation of think minimax algorithm, Alpha-Beta would dramatically improve the performance of the search function and will most likely be the optimal choice.

Finally, the third stage will be focused on the implementation of the deep learning algorithm more specifically a feedforward neural network. Feedforward neural networks take in information as inputs, passing that information through multiple layers that will eventually reach an output layer. As the name suggests, this is feedforward algorithm so no information will be sent back through the network so the weight or strength of each node will not be manipulated based on that information. Instead, the weight or strength of each node is based on the nodes that are linked to it and eventually, the output with the highest value would represent the best of all the outputs (Anon, 2017). How this will apply to a THP game is still unknown and requires further research in order to design an appropriate model for but as of

now, every time the AI will be required to take some form of action will go through a process similar to this.

3. Project Management

3.1. Milestones & Gantt Chart

As stated before this project will last around 16 weeks and in those 16 weeks are key milestones aimed at breaking down each part of development into achievable goals. As well as this is a Gantt chart breaking down each milestone into individual tasks that are ordered by priority will allow for a steady development process.

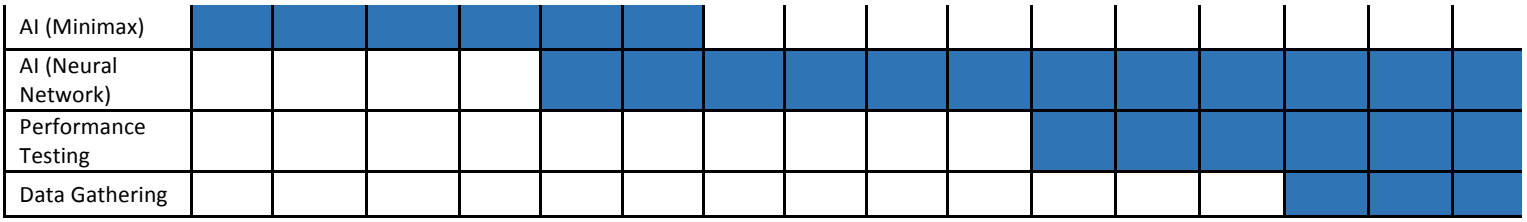
3.1.1. Milestone 1: Week 3

The THP console application, developed in Visual Studios. Testing of the games rule set will take place alongside its development to ensure that the results won't be tainted by an incorrect implementation.

3.1.2. Milestone 2: Week 6

Continuation of the testing carried out from previous weeks whilst implementing the minimax algorithm along with any optimizations to allow for better performance.

	Week															
Tasks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Research																
First Draft	■	■	■	■	■	■	■	■	■	■						
Second Draft											■	■	■			
Final Draft														■	■	■
Programming																
Milestone 1	■	■	■													
Milestone 2				■	■	■										
Implementation (Minimax)				■	■	■										
Optimization (Alpha-Beta Pruning)					■	■										
Milestone 3 & 4							■	■	■	■						
Implementation (Neural Network)							■	■	■	■						
Optimization									■	■	■	■	■			
Testing																
Game Functionality & Rules	■	■	■	■	■	■										



3.1.3. Milestone 3: Week 10

First draft of research paper as well as a basic implementation of the neural network which can play a full game of THP from start to finish.

3.1.4. Milestone 4: Week 13

Second draft of research paper along with a more optimized version of the neural network. Testing and data gathering will begin and both AI will be monitored by various outputs to the console window.

3.1.5. Milestone 5: Week 16

Final draft of research paper with a clear conclusion as to whether the desired outcome has been achieved based on the data gathered through testing.

3.2. Risk Assessment

Some of the risks involved in the development of this project that could potentially affect the overall outcome of this research have been carefully thought about, the main issue lying with the implementation of a neural network for an AI to learn and play a game of THP appropriately. What would directly influence a poor implementation is the engineer's skillset, as this is something new and complex to take on, if implemented in correctly would either taint the results or produce no results overall. If this was the case, research that is freely available from outside sources such as the DeepStacks AI research would allow for the data produced via the AI running a minimax algorithm to be compared to as well as other sources. As well as this, there are various other types of machine learning algorithms that would be considered that could also benefit this research.

Secondary risks include the implementation of the THP games ruleset, though there are many implementations of the game freely available on the internet which will be considered as reference points. The same outcome as the incorrect implementation of a neural network can be applied here is that the overall data collected from any testing completed would be un-usable.

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