Learning to Play no limit Texas Hold'em Using Reinforcement Learning

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Abstract

In recent years the area of machine learning has gained a lot of ground in a broad range of areas. A particularly interesting problem pertaining to machine learning is how we can develop useful AIs in a more hands off fashion. This problem is addressed by a machine learning paradigm named reinforcement learning. Reinforcement learning allows us to set up an agent in an environment after which the agent can explore the environment and begin to learn the more which actions that it should take in the different scenarios it can find itself in. This avenue of machine learning is suited to a broad range of problems but one interesting area is that of imperfect information games such as texas holdem.

Contents

Chapter 1

Introduction (10)

In this section I will introduce the subject area of this Final year Project (FYP). I will then go on to establish some of the objectives for the project, give an overview of the report along with some of the motivations for choosing this subject area.

1.1 Overview (3) w5

1.2 Objectives (2) w4

1.2.1 Primary Objectives

Leverage Deep Reinforcement Learning to Develop a Poker Playing Agent

In the past, methods such as counterfactual regret minimization (CFR) have been used to develop agents that can play no-limit texas holdem to a superhuman level. There have also been attempts to solve the limit version of the game using reinforcement learning (RL). In this report we will explore the possibility of using reinforcement learning to tackle the larger problem of no-limit texas holdem.

Experiment with Different Reinforcement Learning Methodologies

Although all RL algorithms share certain core properties, there are a number of distinct approaches that we can take. In this project we will attempt

to determine, through statistical analysis, which approach yields the most favourable results.

Develop a Web Interface For Users to Play Against the Agent

The focus of this report will largely be research. However it is also my goal to create a product that will be fun and useful for the general public. As such another objective will be to create a website that will allow users to play heads-up against the final product.

Utilise Statistical Techniques to Prove the Efficacy of the AI Agent Produced

1.2.2 Secondary Objectives

Understanding Reinforcement Learning

As this project is very specific and academic, one of the larger challenges will be to gain a strong knowledge of the domain. This means learning the history of RL, the types of problems that it has been used to solve and the specific details of different RL algorithms.

Understand the Existing Literature on Artificial Intelligence and Imperfect Information Games

A successful project will require a high degree of knowledge from the broader domain of RL. However, it is also the case that I must become closely familiar with the existing academic literature in the area of RL with respect to imperfect information games. This will allow me to avoid taking approaches that have previously shown to fail and also allow me to contribute to the existing literature without simply replicating what has already been done.

Learn about Different Approaches to Implementing Poker Agents

1.3 Contribution (1) w5

1.4 Project Plan (1) w5

1.5 Motivation (2) w5

Chapter 2

Background (18)

The aim of this chapter is to give the reader background information on the problem domain in order for them to understand the rest of the report. This will consist first of an introduction to machine learning. Then we will go into more detail on the areas of reinforcement learning and texas hold'em. Finally we will take a deeper dive on the literature surrounding how we can utilise reinforcement learning to tackle the problem of texas hold'em.

2.1 Introduction to Machine Learning (1) w5

Machine learning is an area of computer science that tackles how we construct computer programs that improve with experience[1]. The term was coined by Arthur Samuel in his 1959 paper where he discussed machine learning methods using checkers as his problem area. Since then there has been a great deal of advancement in the field. Some of the notable early contributions being the discovery of recurrent neural networks in 1982 and the advancement of reinforcement learning by the introduction of Q-Learning in 1989. Recently we have seen some of this early academic work culminate in more practical achievements such as Facebook's DeepFace system which, in 2014, was shown to be able to recognise faces at a rate of 97.35% accuracy, a rate that is comparable to that of humans. Another example of recent achievement is Google's AlphaGo program which, in 2016, became the first program to beat a professional human player.

It should be becoming clear that machine learning can be a solution to a wide scope of problems and as both hardware and software continue to

improve this scope will only continue to widen. We are starting to see machine learning systems become a key component of many companies business model. Since certain machine learning techniques are great at prediction, machine learning has been widely used for content discovery by companies such as Google and Pinterest. Other business applications include the use of chatbots as a part of customer service, self-driving cars and even in the field of medical diagnostics.

Since there is such a large range of actual and potential applications for machine learning it would be good for us to understand how different methodologies can be applied to solve different types of problems. In the next we will discuss just that.

2.2 Machine Learning Categories (3)

Supervised Learning

Supervised learning involves example input-output pairs and the goal of the agent is to use these to develop a function that maps from input to output[2].

Unsupervised Learning

Reinforcement Learning

2.3 History of Reinforcement Learning (1) w5

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[2] S. J. Russell and P. Norvig, *Artificial intelligence: a modern approach*. Malaysia; Pearson Education Limited,, 2016.