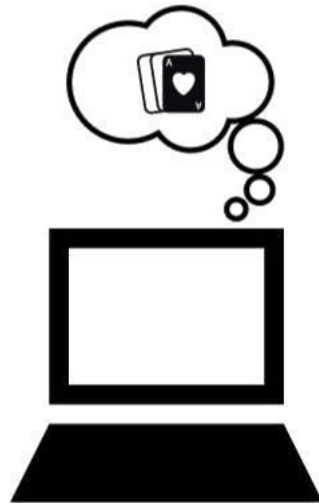


Texas Hold'Em AI Program

Report 1 on work of Week 1

Joseph E. Carrick

August 2015



Application Development Section

1 Project Concept Proposal

1.1 Purpose

The purpose of this project is to tackle some of the challenges involved in the field of A.I. programming of incomplete information games by creating a Texas Hold'em playing A.I. program.

A.I. programming in games has been around since the 50's. Since then it has proved to match and even rival human players in various games, especially those where brute force search tree algorithms can be utilized (chess, checkers, othello). Texas Hold'em Poker however, is a game of imperfect information, meaning there are elements of the game that are not knowable to the players. This minimizes the computing advantage of A.I. programs. The lack of knowledge in a Hold'em game makes the moves of the players seemingly intuitive, as they have to guess what cards the other players have. This presents an interesting coding challenge.

Typical implementations of A.I. in Texas Hold'em focus on areas of the game where the A.I.'s computational strengths can be utilized. Statistical analysis of one's own hand and calculating pot odds are particularly suited for A.I. processing. Implementations such as these give an advantage to the A.I. in so far as analysis is involved, but outside of this realm the A.I. is lacking.

The most successful Texas Hold'em-playing A.I. today is Claudico from Carnegie Mellon. Claudico is programmed to devise a winning strategy based on rules given to it, which in this case are the rules of Texas Hold'em. The algorithms Claudico uses are not built exclusively for playing Texas Hold'em. This type of A.I. computing requires a lot of processing power and can produce unexpected results.

On April 24th, 2015 Carnegie Mellon pitted Claudico against four of the top professional heads-up Texas Hold'em players in a game of No Limit Texas Hold'em Poker at the Rivers Casino. The match consisted of 80,000 one-on-one games against the computer, with the winner determined by final bankroll. The result: humans still prevail in the world of Texas Hold'em- but only by a small margin.

From this match one can see the potential room for improvement in this particular field of artificial intelligence. Although the time and resources required to program an A.I. like Claudico are unattainable in the scope of this project, there is perhaps a small contribution this project can make through a different approach to this problem.

Professional Hold'em strategy was intentionally excluded from Claudico's al-

gorithms making Claudico a very 'pure' type of A.I.. Since the aim of this project is just to make an A.I. that is good at Hold'em, the algorithms will include Hold'em strategy. The challenge in this approach is that there are an endless number of puzzling scenarios the A.I. can find itself in, and the best possible version of this program would hypothetically need to solve all of them.

The first goal of this project is to design an A.I. that can play heads-up tournament style Texas Hold'em Poker and be able to take into account the statistical analysis of it's own hand. This is fairly straight forward as formulas for determining hand strength and corresponding bet sizes are given in numerous Hold'em strategy books and online. Time permitting, the next step of this project will be to design an A.I. that can also take into account certain game mechanics such as table position and number of players, make guesses as to the strength of opponents' hands, and have the ability pull off bluffing. Implementing any number of these abilities in a Hold'em A.I. should theoretically make it better at playing the game.

The second goal of this project is to create an interface on which to play the A.I.. A preliminary interface will be needed in order to test the A.I. throughout it's development. The two current candidates for this interface are one, a simple text output display, and two, 'theaigames.com'(a website were Texas Hold'em A.I. programs face off against each other). The end interface goal of this project is implementation on a web server.

If a web server interface is achievable, the audience for this project would hypothetically be any Texas Hold'em enthusiast, specifically those interested in A.I. programming.

1.2 Challenges

There are certain axioms in Texas Hold'em strategy that are generally excepted in the professional poker community. Beyond these, however, high-level Texas Hold'em strategy is not singularly formulated. Many professional Hold'em players have their own methodology that works for them. This presents a challenge in programming Hold'em strategy to the A.I.. That challenge is deciding which strategy is optimal for a machine player to use.

Once it has been selected, implementing the strategy is the next challenge. Any strategy beyond statistical analysis of one's own hand requires observation of how their opponents play. This might require a detailed game log with analysis and, or, personality profiles (aggressive, conservative, analytical, etc).

Another challenge with implementing a strategy is weighting the decisions of the A.I.. When a human player faces a decision on the poker table most high-level strategy books recommend the player go through a list of questions about the scenario at hand using the answers to those questions as pros and cons in his

decision. Humans have the ability to get very good at assigning importance to pros and cons without a numerical system of measurement; and on account of Texas Hold'em being a game played primarily by humans, the system of assigning importance to pros and cons as given in most Hold'em strategy books is not based on numerical measurements. In fact, a lot of high-level poker strategy is fuzzy.

Here is an example of this system applied by Phil Gordon in his book, *Phil Gordon's Little Green Book*. To deal with the scenario 'Playing Great Hands When They Raise' (p 46) Gordon suggests asking these questions:

- (How good is my) position?
- How good is my opponent?
- How strong is their hand?
- How do they like to play?
- How strong is my hand?
- How many chips do I have?

Gordan's follow up advice is great for a human player trying to get a feel for how to play in this particular situation, but his advice is such that would make programming it difficult. For example, most of his advice for these questions are worded like, "If ... then I am more likely to ...". Figuring out how to quantify a statement like this and weighing the importance of each question versus the others will take some thought.

1.3 Measures

The completeness of this project is measured by two outcomes: a successful Hold'em-playing A.I., and a playable interface for the game. Success in Texas Hold'em is difficult to define. Texas Hold'em players that are generally considered successful could be those with a high win-to-loss ratio or those with the highest accumulated chip stack. Since the game type for this project is Heads-up tournament style Texas Hold'em poker, a good approximation for success is a win-to-loss ratio higher than 1 to 1. The skill level of the A.I.'s opponents may throw a kink in this approximation however, so another method of approximating success may be to simply run a play-by-play analysis of the A.I.'s decisions to determine if they are consistent with high-level poker strategy.

1.4 Future Extensions

If basic statistical analysis of one's own hand is as advanced as this program gets, an obvious future extension is the incorporation of 'intuitive' plays as described in the goals section. However, since there are endless scenarios in Texas Hold'em and many various strategies to deal with these scenarios, there will always be room for improvement.

1.5 Resources

- Platform: Wordpress for preliminary local server, GitHub web server from student developer package for final web server.
- Languages: Python for A.I. programming; HTML, Javascript, and PHP for interface.
- Libraries: 'Tkinter' for testing-GUI, 'Flask' to construct python server, 'random' and 'math' for A.I. algorithms.
- Tools: WAMP for database and local hosting a server, PyScripter, GitHub and Atom for code editing, Orchestra for web server database API, Namecheap for domain name registration and SSL certificates, ShareLaTeX for documentation and reports.

2 Inspiration

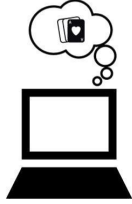
2.1 Motivation

Texas Hold'em Poker has been a hobby of mine for about two years now. I love the game and I play it frequently online and with friends. The idea to make an A.I. Hold'em program came to me last semester (Spring 2015) when I started reading Gus Hansen's book *Every Hand Revealed*. In the book, Hansen goes through almost every hand he played at the Aussie Millions describing the process of his deliberation for each play he made. While reading this book I couldn't help but think of how interesting and challenging the task of creating a Texas Hold'em A.I. would be. I decided to consider it for my senior project. Over the summer the idea became more and more appealing to me, and I decided to go with it.

2.2 Profession

A.I. programming in gaming is a big industry with lots of opportunity. Since the goal of this project is to emulate professional poker strategy in a program, the type of A.I. programming used in games falls right in line with the type of A.I. programming I hope to achieve in this project. That is to say, the A.I. mimics intelligence rather than trying to reinvent the wheel. Statistical analysis of systems with incomplete information is applicable to more fields than just games. This kind of analysis is used fields such as medicine, auctions, negotiation and cybersecurity. This project could point me in the direction of this kind of research, which also interests me.

Executive Section



To: Dr. Matt Jadud

From: Joseph Carrick

Subject: Texas Hold'Em AI Program

Date: September 4, 2015

Accomplishments

Researched history and fundamentals of A.I. programming in games, including Texas Hold'em. Re-read *Every Hand Revealed*. Began reading *Phil Gordon's Little Green Book*. Brainstormed foreseeable challenges along with solutions to those challenges. Found tools for implementing the project on a website (GitHub student developer package). Narrowed the game-play scope down to one-on-one tournament matches. Made logo icon for project. Learned how to use ShareLaTeX.

Challenges

There was some difficulty in learning how to use ShareLaTeX, but solutions were easily accessible via Tex forums.

Time Spent

Approximately 10 to 12 hours were spent on research. About 1 hour was spent learning ShareLaTeX and formatting report. 3 hours were spent on brainstorming solutions to the challenges mentioned in section 1.1.2.

Goals

Create a 'Table' class and basic game loop for testing. Finish *Phil Gordon's Little Green Book*. Find and study open sourced Hold'em A.I. programs. Decide on, and implement, program architecture for A.I.. Begin setting up website using Flask or Wordpress.