**Halite, Not for the Faint of Minerals**

**Abstract:**

The purpose of this project is to analyze a given environment which is constantly changing. Teams each with the same goal are trying to outsmart the other and take over the environment. They initially start with the exact same resources, but as one team begins to overtake the other, it becomes apparent which overall strategy is going to be best. By programming several different strategies and testing them against all of the other existing strategies, it will be easy to find which one has the best approach.

**Introduction:**

Life is full of competition. Giving an even playing field there are all sorts of variables that go into who will win, and by how much they are going to win. It is estimated in 2013 that the top 1% of the citizens in America owned 36.7% of the wealth. The following 19% of the wealthy owned 52.2% of the wealth, and the remaining 80% of the population here in America accounted for only 11.1% of the wealth [1]. These are staggering numbers given the American dream, where anyone can become wealthy. Life is competitive. It pays to have a better strategy than those around you.

While doing research into neural networks I came across an online programming challenge where the participants programmed the logic for their team. A team consists initially of a single fleet. On the map are planets on which the fleet can colonize and begin mining the resources on that individual planet. Once gathering resources, more fleets will be created that can head back into the map in search of other planets to colonize. The whole purpose of the game is to take over the entire map using strategy and logic that would be able to outsmart your opponents.

This is an interesting and unique problem because initially the playing field is even. Every team member starts with the same number of fleets, but quickly the team with the best logic behind it is able to overrun the entire map. A multi-agent approach would be much more effective than a central agent, because if each fleet is able to act as an agent and take the best decision based on what it is able to see, the overall strategy would be much more effective than if a central agent were to give tasks that had to be carried out regardless of constantly changing variables in the environment.

**Background Information and Related Work:**

The programming challenge, called Halite, is an “open source artificial intelligence programming challenge.” [2] Players from around the world create their own bots to compete in the annual competitions. The space takeover challenge, deemed Halite II, that will be investigated for this project ended in January 2018. The challenge duration was approximately three months. In this time, almost 6000 participants from 110 countries entered bots. These participants range in skill level from high school students to professional programmers. Both factors: the recent competition and the skill of the programmers, will give us modern approaches of all types with which to test our own strategies.

Artificial intelligence aims to allow computer systems to act in a way that may be deemed intelligent by human standards [3]. Humans are able to perceive their always-changing surroundings and react in an appropriate manner. A goal of artificial intelligence is to understand the way humans are able to accomplish such a complex task and implement that into machines [4].

A mobile game is available that is very similar to the Halite II challenge. The same objectives exist in that there are multiple players attempting to overrun planets and mine their resources. The winner is the player that eliminates all others by taking over their resources and obtaining a monopoly of the playing field. In this game, of course, a human controls the actions of one of the players. The human can assess the current situation of the playing field and react accordingly. They act as a central controller. Human strategies can be very difficult to quantify because they often act in an unpredictable manner. Our goal is to find a quantifiable multi-agent strategy that could beat other programmed strategies using artificial intelligence, as presented in the challenge’s description.

**Proposed Work:**

Our idea for the project is to play the game. Initially, players download the provided starter code which has a few built in functions to assist in programming your logic. From there you begin to think up your strategy on how to win the game. Once you have programmed to your liking, you will be able to review the games that have taken place to find potential flaws in your strategies and tweak them to get better results. By programming a few different strategies and playing them against all the other bots, we should be able to analyze the best strategies, and possibly develop better ones than those listed below. The results should be very telling of a program’s quality because of the large number of participants, including bots created by Open AI and Ubisoft. A few of the strategies that we are planning to test on the system include:

* Central-agent: Program multiple central agent approaches to see how they compare with the multi-agent approaches.
* Multi-agent, go for the strongest other bot: By going after the strongest other bot, it is possible to weaken him, while still staying stronger than the other bots within the playing field.
* Multi-agent, go for the weakest other bot: By going for the weakest bot first, it should be easier to take control of his resources at which point you will be better prepared to take on the stronger enemies.
* Multi-agent, fortify owned planets, then colonize: By having multiple fleets on individual planets, you should be able to fortify it, and mine its resources faster in order to be making more fleets.
* Multi-agent, take over the center of the map: By trying to take over the center of the map first, you could potentially have a better striking position to the other planets.

It will be interesting to see how each of these strategies perform relative to all of the other bots in the playing field. By getting the ranking of each different strategy, we will know which one performed the best. This will allow us to conclude whether or not a multi-agent approach is, indeed, better for this application as well as which multi-agent approach is most efficient.

**References:**

[1] G. William Domhoff (April, 2017) “Wealth, Income, and Power” retreived from: <https://www2.ucsc.edu/whorulesamerica/power/wealth.html>

[2] Two Sigma. (2017). Halite AI Programming Challenge. Retrieved March 02, 2018, from <https://halite.io/>

[3] Berkeley, I. S., Ph.D. (1997). What is Artificial Intelligence? Retrieved March 02, 2018, from <http://www.ucs.louisiana.edu/~isb9112/dept/phil341/wisai/WhatisAI.html>

[4] Artificial Intelligence. (2018). Retrieved March 02, 2018, from <https://cpsc.yale.edu/research/artificial-intelligence>