# COSC 322 - 001 Introduction to Artificial Intelligence

# 2020 Winter Term 2

# Progress Report

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## Current Accomplishments.

We have reached several milestones as of writing this report. Firstly, we set up a Github team account and added every team member to it. Allowing the group to work on the project together in a convenient manner through a version control platform.

Next, we were able to get both of the warmup tasks done and get the project to run on everyone’s machines. Completing these warm-up tasks enabled us to have two players participate in a game that contains no rules. Also, the players can enter any of the available rooms they want. To add further, a spectator can also join the room and watch the gameplay unfold.

Of course, having this run on every team member’s machine is beneficial. To allow everyone to familiarize themselves with the code on their own before attending group meetings and working on the project. In addition, everyone in the group familiarized themselves with the API.

Once we finished the warmup tasks, we took time to understand the rules of the game. We wanted to ensure that everyone can understand how the game is meant to be played before implementing a working algorithm. Currently, the group can play the game following the proper rules.

Next, we finished the research on what algorithm we want to use. Based on the research we collectively decided as a group we want to implement the Monte Carlo Search Tree algorithm.

Lastly, we were able to create a new class called randomPlayer. This player can make a random move each time. This is going to serve as our starting point for implementing the Monte Carlo Search Tree algorithm.

## Task Seperation and Responsabilties.

We have split up several tasks among five people to reach the first project milestone. Firstly, Logan and Jean-Philippe started by completing both of the warmup tasks. This was a crucial point as it allowed the group to make sure we can run the program. Next, Jaden led peer programming sessions as we started to make modifications to the player class. After getting more familiar with the program, JP and Rylan started to compile research and compare which algorithm to use. Lastly, Guy took all the information and put it together in the form of a report.

## Algorithm Analysis.

### About Monte Carlo Tree Search

#### Monte Carlo Tree Search, in general

Monte Carlo Tree Search is a technique based on “the analysis of the most promising moves, expanding the search tree based on random sampling of the search space” (https://en.wikipedia.org/wiki/Monte\_Carlo\_tree\_search). This technique seems promising because it “has been used successfully to play games such as Go, Tantrix, Battleship, Havannah, and Arimaa." (https://en.wikipedia.org/wiki/Monte\_Carlo\_method). All these games are strategy board game which resemble, to a varying extent, the game of Amazons.

The “Principle of Operation” section of the page https://en.wikipedia.org/wiki/Monte\_Carlo\_tree\_search gives a good overview of how this technique works. The basic idea is to traverse the current search tree until we reach a node from which no simulated game (called playout) has been run yet. This means that node has no child, making it a leaf. Then, the leaf is expanded. The process of expansion is the following: many times (each time being one playout), the outcome of the game is simulated by picking random legal moves for each opponent starting at the node being expanded, until the game ends. Then, depending on the outcome, a step of backpropagation is run, where the value of each node is updated. The value of the nodes is increased if the simulation resulted in a win for that player, and decreased if it was a loss.

The diagram below helps understand the mechanics of that technique.

Chart

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#### Monte Carlo Tree Search, as applied to the Game of Amazons

We found [a paper] which seems to be especially well-suited to our needs (https://dspace.jaist.ac.jp/dspace/bitstream/10119/8867/7/paper.pdf). In it, the author, Julien Kloetzer, dedicates a whole section to applying the MCTS method to the game of Amazons. In that section, before detailing his algorithm, he states that: "[I]t is possible to apply Monte-Carlo with a good confidence to compute a broad number of values" (Kloetzer, 20). This gives us hope as to the potential of using the MCTS method for our project.

The author then explains his algorithm. While the details of it are beyond the scope of this report, we expect to inspire our final algorithm off of the pseudocode he provides on page 21, which we have copied below.Text

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What the algorithm above does is the following. It starts at a given position, which is a game state. Then, it iterates over all possible moves m from that position. For each move, which results in a position P, it then plays N number of games, where N is an input to the algorithm. For each playout, it picks random moves starting from the same position P. Every time it reaches the end of a playout, it increments the value of the move m. The amount by which the value of the move m is incremented depends on whether the playout resulted in a win, a loss, or a draw. Finally, it divides the value of the move m by the number of simulated games, so that the value of the move m becomes a probability of winning. Finally, it plays the move with the highest probability of winning.

#### Other techniques we considered using, and why we decided to go with MCTS

Another technique we have considered using is the min-distance evaluation function detailed in [Dr. Martin Muller's paper](http://library.msri.org/books/Book42/files/muller.pdf). This technique is interesting and, according to the author, effective: "A similar pattern became apparent in the Second Computer-Amazons championship in which [our program] participated and took third place". As the author explains, however, this algorithm also has disadvantages: "However, against aggressive human players and programs, such as Jens Lieberum’s Amazong, Arrow gets into trouble quickly". For this reason, we thought it would be interesting to explore using Monte Carlo Tree Search.

Additionally, there does not seem to be a very large amount of information to be found online when searching for uses of the Monte Carlo Tree Search method to play the Game of Amazons. We managed to find two papers in addition to the aforementioned one: [Amazons Discover Monte-Carlo](https://link.springer.com/chapter/10.1007/978-3-540-87608-3_2) and [Analysis of a Monte Carlo Tree Search in Knight-Amazons](https://www.sciencedirect.com/science/article/pii/S1877050915025417), and that second one actually applies the MCTS method to a variant of the game called Knight-Amazons. Therefore, we thought it would be interesting to give this technique a try.

### Unexpected Cases/Difficulties.

At this current stage, we encountered a major difficulty when implementing a random player class into the project. When we all got together to start working on the project, the server was down. Nevertheless, we continued to attempt to make as many changes to the code as we could. We got to a certain point where we needed a debugger to continue developing our AI. To alleviate this issue, we contacted the professor right away. Luckily, he responded quickly and made the server go back up. This gave us enough time to finish implementing the random player class before the progress report deadline.

### Plans Going Forward.

Overall the plan going forward is to build on the current progress we have. We are going to be meeting one to two times a week and continuing using peer programming techniques. The reason for peer programming is before we start splitting tasks we want to make sure we all have the same amount of knowledge about what is going on.