• Title of Project: Nine Mens Morris Solver
• Type of Project: Game Tree Search
• Number of Team Members: 2

• Project Description:
In our project, we will use game search to play Nine Mens Morris Solver (http://www.mathplayground.com/logic_nine_mens_morris.html). In Nine Mens Morris Solver, you are given a board with 24 intersections, where some positions are connected. Each person will have nine pieces, and player is expected to form 'mills' -- three pieces in a line horizontally or vertically, which will allow the player to remove an opponent's piece from board. The goal state to achieve is to reduce opponent to two pieces, or leave him unable to move. We will try to use uninformed and heuristic search to solve this puzzle. During the game, there are three phases in total, where users can place pieces, then move them and finally "flying". An heuristic to use is to recognize most favorable scenario from the board and make full use of it. For example, try place the pieces into more versatile positions instead exploit the early advantage too much; And try to form two mills side by side and have one piece to move back and forth between them so that each turn we can eliminate an opponent's piece. This puzzle is suited for heuristic search as better heuristic can reach beneficial states more quickly. And goal state can be recognized when the number of opponent's pieces is lower than 2 or their pieces is immobilized.

• Evaluation Plan:
We will keep track of the states of the 7*7 board. There are four possible values of each cell: black, white, empty or impossible. "Black"/"white" means the cell is occupied by the black/white player. "Empty" indicates the cell is not occupied by any player, but is a possible cell for any player to occupy. "Impossible" means the cell is impossible to be occupied by any player. When any row or column (except the 4th row and the 4th column) is occupied by 3 pieces by the same player, it enters a "remove mode" that can remove any piece of the opponent. For the 4th row or and the 4th column, only when the first or the last 3 pieces are occupied by the same player, it will enter the "remove mode". If any player has <= n pieces, it enters the "fly mode". If any player has 2 pieces or it is immobilized, then the player loses and we reach the goal state. We will run the same searches by different search strategies, including DFS, BFS, A* search, greedy search, etc. Then compare the time and the space they need. We will identify situations and examples where our heuristic searches perform either very well or very poorly and provide explanations of these examples in our discussion.

• Roles for Team Members:
One team member will be responsible for encoding the puzzle into matrix and finish the code for final goal evaluation; Also to implement a simple search algorithm with beginner-mode heuristics. The other will try to come up with more heuristic functions and evaluations for medium and hard mode. Both team members will contribute to the final write-up: one will write the puzzle description and methods, while the other focus on the heuristic function discussion and result evaluation.