Isolation Game Project Report

The additional techniques implemented for all experiments include alpha-beta pruning and iterative deepening.

1.Evaluation heuristic

In addition to the #my_move - #opponent_move introduced in the lecture, another heuristic was investigated:

$$Heuristic\ score = N_{my,5*5} - N_{oppo,5*5}$$

Where N_{5*5} denotes the number of open cells in a 5 * 5 square around the player's current position. The intuition is that in addition to the available next moves, the number of open cells in the neighboring region is also important since more spaces can allow the player more opportunity to move back and forth. To compare the performance of the two heuristics, the improved agent played matches against three components, which were denoted as MiniMax-simple (minimax algorithm without alpha-beta pruning), Random, and Greedy. For all matches, 200 games were played, and the win rate and the mean search depth of the improved agent were calculated and shown in the following table:

Heuristic	Mean Search Depth	Win rate(%) vs opponent		
		MiniMax	Random	Greedy
# moves diff	3.74	80.0	96.5	93.0
# 5*5 open cell diff	3.55	90.0	99.5	98.0

According to the table, the # 5*5 open cell diff heuristic outperforms the # moves diff heuristic in all three opponents. Despite its better performance, its mean search depth is smaller than the # moves diff heuristic, which indicates that this heuristic is more time consuming to calculate. However, the experiment clearly shows that the improvement in the evaluation accuracy outweighs the search speed so that the win rate was improved by a large margin.

2.Opening book

To develop an opening book, 30,000 games were played between the custom agent and itself. A dictionary was created where the keys are the board states and the values are available moves for the board states and their corresponding scores. The games were played until the end and the winning player's first two moves were given a reward of +1 while the losing player's first two moves were given a reward of -1, and the score for each move was calculated as the average reward of the action. Each game was played as the following: for the first two moves of each player, if the board state was in the dictionary, the move was chosen from the dictionary according to the ε-greedy algorithm (with probability ε a random move was chosen, with probability 1 - ε the move with the maximum score was chosen, where ε was set to 0.1 in this report). If the board state is not in the dictionary, the move was chosen by using MiniMax algorithm (described in section 1). To evaluate the performance of the opening book, 200 games were played with each opponent including MiniMax-simple, Random, and Greedy agent with and without the opening book. The results are summarized in the following table:

Win rate (%)	MiniMax	Random	Greedy
No opening book	82.0	98.0	98.5
Opening book	83.0	99.0	100.0

As we can see from the table, the win rate of the custom agent improves slightly with the help of the opening book. The opening book suggests that for an empty board the player 1 should play at the grid #67 and the player 2 should respond at the grid # 60. (two positions are shown in the graph below)