

Artificial Intelligence – Spring 2022 – Assignment 3

Objective: this

- Becoming proficient with game representation
- Get familiar with the different strategies for optimal playing
- Being able to create programs playing games optimally

Two people (A and B) play a multi-round and turn taking game as follows.

- A starts the game; B plays next; then A, B, etc.
- In each round, the agent can select one of the numbers between 1 and 9 (inclusive) if the number has not been selected in the previous rounds, by either player (e.g., if A plays 1 in the first round, then the number 1 is no longer available for selection by any player this action of A).
- The selection of the number by either player must obey the following rules:
 - If the number selected in the previous round is less than 5 then the next number must be at least 5 (e.g., if A/B plays 4 then B/A must play a number ≥ 5);
 - If the number selected in the previous round is an odd number, then the next number must be an even number (e.g., if A/B plays 5 then B/A must play an even number, perhaps 2, 4, 6, or 8); this rule must be obeyed together with the previous rule (e.g., if A/B plays 1 then B/A must play an even number ≥ 5)

Note: A/B stands for A or B. B/A stands for B or A.

- The game terminates if a player cannot select a number to continue (e.g., if at some round, A plays 3 and B cannot select another number, because all valid numbers have been selected, then the game ends and A wins!).
- The utility at each state x is x for the winning player and $-x$ for the losing one (if B cannot select a number to continue after A select the number 3 then the utility for A is 3 and B is -3).

You are asked to do the following.

- a) Develop a formal representation of the game by specifying the components of the game following the definition of a game.
- b) Draw the game tree after the first two moves, one from A and another from B, using the following conventions:
 - Write each state at the node as a set consisting of the set of numbers that the players can select from; this means that the initial state is $\{1, 2, \dots, 9\}$.
 - Use the number that is selected by the player.
- b) Implement the game and provide a test program that demonstrates that your implementation is correct such as
 - i. The initial state of the game corresponds to the state at the root of your game tree;
 - ii. The actions that the player can take at some of the nodes obey the rules of the game;

- iii. Compute the optimal first move for A using the minimax algorithm;
- iv. Compute the optimal first move for B using the alpha-beta algorithm after the first optimal move of A;
- v. Provide a trace of the game when an optimal player plays against another optimal player;
- vi. Provide a trace of the game when an optimal player plays against a random player;
- vii. Provide a trace of the game when a random player plays against an optimal player;

Submit your written homework and codes on Canvas by 11:59 pm, March 1, 2022. The written portion of the assignment should be given in a PDF file. Do include a README file that explains how your code should be compiled and ran.

Grading:

- Part a) 70 points [each element of the definition correct: 10 points]
- Part b) 30 points [the first level correct: 10 points; the second level correct: 20 points]
- Part c) README file for the implementation: 5 points
- Part c) 100 points [correct implementation of the class: 70 points, illustration: 25 points]