Build an Adversarial Game Playing Agent

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Introduction:

The objective of this report is to study and performance of a custom heuristic on a modified version of Isolation board game. An iterative deepening search technique is used in both the baseline agent and the custom agent. The only difference was the heuristic being used.

Baseline Heuristic:

The baseline heuristic used is the same as the one used in the lecture.

$$H_{baseline} = \#\ of\ Agent's\ moves - \#\ of\ opponent's\ moves$$

Custom Heuristic

It is a combination of three types of heuristics:

- Center heuristics
- Boundary heuristics
- Baseline heuristics

Center Heuristic

Center heuristic is the measurement of how far the player's location is from the center. The closer the player is, the larger the evaluation value. For this reason, I have subtracted the opponent's distance from the agent's distance.

$$H_{Center} = Agent's\ distance\ from\ the\ center - Opponent's\ distance\ from\ the\ center$$

Boundary Heuristic

Boundary heuristic measures how far the player's location is from the 4 walls and takes the minimum one.

$$B(Player\ Name) = \min \begin{pmatrix} Distance\ of\ Player\ from\ left\ wall,\ Distance\ of\ player\ from\ right\ wall \\ Distance\ of\ Player\ from\ top\ wall,\ Distance\ of\ player\ from\ down\ wall \end{pmatrix}$$

$$H_{Boundary} = B(agent) - B(opponent)$$

Combined Heuristic

This heuristic used in the custom agent is a linear combination of the above heuristics. The weights added in the below equation is a result of trial and error.

$$H_{Custom} = H_{Baseline} + 1.5\ H_{Center} + 2.25\ H_{Boundary}$$

Results

Both custom and baseline agents played against Random, Greedy, Minimax and Self 200 games each (fair matches).

Opponent	Baseline (%win)	Custom (%win)
Random	97.00	96.00
Greedy	46.50	95.50
Minimax	73.50	77.00
Self	52.00	51.50

As the table shows, the custom agent outperformed the baseline agent when it played against Greedy and MINIMAX Agent. The win ratio is almost the same against the Random and Self Agent.

Questions:

- What features of the game does your heuristic incorporate, and why do you think those features matter in evaluating states during search?

When the agent at the center of the board and getting away from the wall boundaries, it focuses on giving high values. This is why the features do matter in evaluating states because as long as we stay close to center, it has more choices to move and lower the probability of getting stuck. Similarly, if you get closer to the boundaries, it has fewer moves and the opponent may have higher chance to win. Nevertheless, the heuristic gives a higher value if the opponent stays from the center and gets closer to boundaries so he will have a higher probability to lose.

- Analyze the search depth your agent achieves using your custom heuristic. Does search speed matter more or less than accuracy to the performance of your heuristic?

Average maximum depth in a game was calculated for both agents and shown in the provided table.

Agent	Average maximum depth in a game calculated over 40 games
Custom	1113
Baseline	1900

The custom agent has a fewer average maximum depth. This means that in custom agent, the heuristics focus more on the accuracy rather speed while in baseline agent prunes more parts of the tree and hence reaching a higher depth.