CS 4341 Project 3

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**Feature Extraction:**

**Feature 1:** Lower Left Corner

* Description: The player with a piece in the lower left hand corner of the board. A result of 1 represents player 1, a result of 2 represents player 2, a result of 0 represents no piece in that space.
* Justification: This will ideally serve as a baseline for all subsequent features. We do not expect this specific feature to be able to accurately predict the winner from any given board state.

**Feature 2**: Central Columns

* Description: The player with the most pieces in the central 3 columns of a board. A result of 1 represents player 1 having more pieces in the central columns than player 2, a result of 2 represents player 2 having more pieces in the central columns than player 1, a result of 0 represents both players having the same number of pieces in the central columns.
* Justification: Pieces towards the center of the board have more flexibility in the directions that strings of pieces can form (left and right). This means that each central piece can be beneficial in more board states than a piece closer to the edges. As such, we feel that having more pieces in the center of the board than the opponent will be more likely to lead to a win

**Feature 3:** Number of Columns Contesting

* Description: The number of columns that player 1 has at least one-piece in. A result of 0 represents a board with no player 1 pieces, a result of 1 represents a board where all of player 1s pieces are in exactly one column, a result of 2 represents a board where player 1s pieces are split between exactly two columns, and so on. Results can range from 0 to 7.
* Justification: Having pieces in more columns makes it more likely that there are horizontal strings of pieces in a row and diagonal strings of pieces in a row. This means that pieces spread out between multiple columns can be part of more winning moves than those in a single column. We feel that having the pieces more spread out between columns than one’s opponent can lead to more potential victory paths and thus a higher likelihood to win.

**Feature 4:** Number of Surrounding Openings

* Description: The total number of openings adjacent to player 1s pieces. **Openings** are spaces with no pieces (i.e. a 0 in the current game board representation). Openings that have multiple pieces adjacent to them are counted once for each adjacent piece. A result of 1 means that there is a total of one opening adjacent to player 1’s pieces. A result of 2 means that there are either two distinct openings adjacent to a single player 1 piece, two distinct openings adjacent to two player 1 pieces, or one opening adjacent to two of player 1s pieces.
* Justification: Having more openings next to one’s pieces means that they have more moves that make strings of multiple pieces in a row. Having more potential options generally means that there are more “good” options a player can take than if there were less options. The same openings are counted multiple times because if said openings are filled, they create a large string of pieces in a row than if only one piece had an opening. We believe that more openings will lead to a higher win rate than not.

**Feature 5:** Number of Edge Pieces

* Description: The number of player 1s pieces that are on the edge of the board. An **edge** is a portion of the board that pieces can never be pieces can never be placed above, below, to the left of, or to the right of. It is worth noting that corners of the board are included in this definition. A result of 1 represents that exactly one of player 1s pieces is on an edge of the board, a result of 2 represents that two of player 1s pieces are on an edge of the board (the edges they are on can be different).
* Justification: Pieces in edges of the board are inherently limited in the directions in which they can create strings of pieces in a row. They are blocked of in one (two in the case of corners) direction regardless of the rest of the game board. We fell that the more pieces a player has along the edge, the less likely they are to win.

**Feature 6:** Player 1 Horizontal 2-in-a-rows

* Description: The number of two-in-a-rows that player 1 has in the horizontal orientation. A **two-in-a-row** is a sequence of two adjacent pieces in a given orientation. If a piece is part of a horizontal two-in-a-row, that means that there is a piece directly to the left and/or to the right of the given piece. A sequence of three adjacent pieces in a horizontal direction constitutes two horizontal two-in-a-rows; one for the left most piece and the middle piece, one for the middle piece and right most piece. A result of 1 means there is exactly one horizontal two-in-a-row for players 1, a result of 2 means there are exactly two horizontal two-in-a-rows for player 1.
* Justification: A string of two-in-a-row is halfway to a string of four-in-a-row, a game winning state. A player with multiple two-in-a-rows will generally have more options that create three-in-a-rows, moving them closer and closer to a winning board state. Horizontal two-in-a-rows are just one type of two-in-a-row. We expect, in general, the more horizontal two-in-a-rows player 1 has, the more likely they are to win.

**Feature 7:** Player 2 Horizontal 2-in-a-rows

* Description: The number of two-in-a-rows that player 2 has in the horizontal orientation. A **two-in-a-row** is a sequence of two adjacent pieces in a given orientation. If a piece is part of a horizontal two-in-a-row, that means that there is a piece directly to the left and/or to the right of the given piece. A sequence of three adjacent pieces in a horizontal direction constitutes two horizontal two-in-a-rows; one for the left most piece and the middle piece, one for the middle piece and right most piece. A result of 1 means there is exactly one horizontal two-in-a-row for players 2, a result of 2 means there are exactly two horizontal two-in-a-rows for player 2.
* Justification: A string of two-in-a-row is halfway to a string of four-in-a-row, a game winning state. A player with multiple two-in-a-rows will generally have more options that create three-in-a-rows, moving them closer and closer to a winning board state. Horizontal two-in-a-rows are just one type of two-in-a-row. We expect, in general, the more horizontal two-in-a-rows player 2 has, the less likely player 1 is to win.

**Feature 8:** Player 1 Vertical 2-in-a-rows

* Description: The number of two-in-a-rows that player 1 has in the vertical orientation. A **two-in-a-row** is a sequence of two adjacent pieces in a given orientation. If a piece is part of a vertical two-in-a-row, that means that there is a piece directly above and/or below the given piece. A sequence of three adjacent pieces in a vertical direction constitutes two vertical two-in-a-rows; one for the bottom most piece and the middle piece, one for the middle piece and top most piece. A result of 1 means there is exactly one vertical two-in-a-row for players 1, a result of 2 means there are exactly two vertical two-in-a-rows for player 1.
* Justification: A string of two-in-a-row is halfway to a string of four-in-a-row, a game winning state. A player with multiple two-in-a-rows will generally have more options that create three-in-a-rows, moving them closer and closer to a winning board state. Vertical two-in-a-rows are just one type of two-in-a-row. We expect, in general, the more vertical two-in-a-rows player 1 has, the more likely they are to win.