

Project Specification: Rules of the Game of Squatter

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Board

Our game of Squatter is played on an $N \times N$ square board, which comprises N^2 squares known as *cells* or *positions*. Your game playing agent will need to be able to cope with different values of $N > 5$, i.e., boards of different sizes. It should be optimised to work on a 6x6 board.

We number board positions using the notation (row, column), where (0,0) corresponds to the top-left position, and ($N-1$, $N-1$) corresponds to the bottom-right position, i.e., row indices increase as we move down the board, while column indices increase as we move to the right.

Each cell can have up to 8 *adjacent* cells that are either vertically, horizontally or diagonally adjacent (e.g., (1,1) has the adjacent cells (0,0), (0,1), (0,2), (1,0), (1,2), (2,0), (2,1) and (2,2), whereas (0,0) has only 3 adjacent cells).

Initially, all cells on the board are empty.

Players

There are two players named *Black* and *White*. Each player has their own set of pieces that they can place on the board. We will denote a piece for player Black as *B* (or a black disk), and a piece for player White as *W* (or a white disk).

Example of piece positions

Below is an example of a 6x6 board. It has three white pieces at cells (0,3), (1,2) and (2,2), and two black pieces at (1,3) and (5,0).

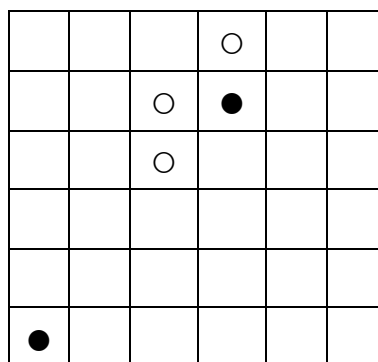


Figure 1

Objective of the game

The objective of each player is to capture as much territory as possible by encircling cells using their pieces, which we define as follows.

A region of territory is encircled by a player when that player has formed a continuous loop using

his/her pieces. A loop is defined as a sequence of adjacent pieces that belong to the same player, which do not lie in captured territory. In the board state below, Black has a loop encircling two cells (one empty – marked with an X, and one containing a white piece). We consider that this loop has captured 2 cells of territory. In contrast, none of the white pieces form a loop. Note that the white pieces in the top left do not form a closed loop, because the edges of the board do not count as part of a loop. Moreover, if White placed a piece at the cell marked Y, it would not count as a loop. This is because the leftmost white piece is inside territory that has been captured by the black loop, and hence it cannot be used to form a loop for White. Note that it is possible for a player to form more than one loop with one move.

| | | | | | |
|---|---|---|---|---|--|
| | | | ○ | | |
| | | ○ | ● | | |
| ○ | ○ | ○ | | | |
| ● | ● | ● | ○ | | |
| ● | X | ○ | ● | Y | |
| ● | ● | ● | ○ | | |

Players cannot place one of their pieces into captured territory. We refer to a cell that has not yet been captured or occupied as a “free” cell. The game ends when there are no free cells left. The winner of the game is the player who has captured the most territory. Note that a draw is a possible outcome.

Consider that the game continues from the board state above, and we reach the following board state. Captured cells are denoted with a horizontal dash. At this point in the game, Black has formed two loops and has captured $2 + 4 = 6$ cells, while White has formed one loop and captured 1 cell.

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|---|---|---|---|---|---|
| | ○ | ○ | ○ | ○ | |
| ○ | - | ○ | ● | ● | |
| ○ | ○ | ○ | ● | ⊖ | ● |
| ● | ● | ● | ⊖ | - | ● |
| ● | - | ⊖ | ● | ⊖ | ● |
| ● | ● | ● | ○ | ● | ○ |

We continue the game until the final board state below, where there are no free cells left. No new loops have been formed. So Black is the winner with 6 captured cells, while White has only captured 1 cell.


| | | | | | |
|---|---|---|---|---|---|
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| ○ | | ○ | ● | ● | ○ |
| ○ | ○ | ○ | ● | ○ | ● |
| ● | ● | ● | ○ | | ● |
| ● | | ○ | ● | ○ | ● |
| ● | ● | ● | ○ | ● | ○ |

Rules

- A player is chosen arbitrarily to make the first move.
- Each player takes a turn at placing one of their pieces at any free cell on the board.
- Players cannot move or remove a piece once it has been placed on the board.
- Territory is captured once the cells in that territory have been surrounded by a loop of adjacent pieces belonging to a player, and the enclosed territory contains at least one cell that was free or occupied by the other player.
- A cell is free if it is empty, and it has not been captured.
- Captured cells can change hands if a loop by one player is later encircled by a loop of the other player. Note that regions of captured territory belonging to different players cannot overlap.
- The game finishes when there are no free cells left on the board.
- The winner of the game is the player with the most captured cells. Note that if captured cells have changed hands, then they only count towards the player who captured them last. When a player captures some territory, it may contain pieces of either player, and the player only counts cells that were free or occupied by the opponent towards their total.

In the following board configuration (where \ominus denotes a captured white piece), black has captured 6 cells and white has captured 1 cell.

| | | | | | |
|---|---|-----------|-----------|-----------|---|
| | ○ | ○ | ○ | ○ | |
| ○ | - | ○ | ● | ● | |
| ○ | ○ | ○ | ● | \ominus | ● |
| ● | ● | ● | \ominus | - | ● |
| ● | - | \ominus | ● | \ominus | ● |
| ● | ● | ● | ○ | ● | ○ |

In the following board configuration (where  denotes a captured black piece), black has captured 7 cells of which 6 count towards its final total, and white has captured 0 cells. Note that White has not captured any territory in the top left corner because it *has not encircled any* free or opponent pieces. Note that the territory captured by Black has formed one big region, which includes one of its own pieces, rather than two smaller regions. The black cell in Black's captured territory does not count towards its total.

| | | | | | |
|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | |
| ○ | ○ | ○ | ● | ● | |
| ○ | ○ | ○ | ● | ⊖ | ● |
| ● | ● | ● | ⊖ | - | ● |
| ● | - | ⊖ | ● | ⊖ | ● |
| ● | ● | ● | ● | ● | ○ |