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N-Queens

Main Class

The main class is the only class in our project. It handles every step of each of the various hill-climbing algorithms with the global variables and methods listed below.

public static int SIZE;

- Global variable for the number of queens and size of the board

private int[][] board;

- Global variable for the board

private int[] queenPos;

- Global variable for the positions for each of the queens

public static void main(String[] args)

- Handles user input for the size of the board and which hill-climbing algorithm

public static void steepestAscent()

- Handles the steepest ascent algorithm

public static void sidewaysMove()

- Handles the sideways move algorithm

public static void randomRestart()

- Handles the random restart algorithm

public static void randomRestartAndSideways()

- Handles the random restart algorithm with sideways move

public Main(int[][] board, int[] positions)

- Constructor

public int conflicts()

- Calculates the heuristic

private int[] randQueenPositions()

- Get random queen positions for the starting board

public void queensOnBoard()

- Place the queens in their random positions

public void changeQueen(int row)

- Remove a queen based on queenPos

public void replaceQueen(int row)

- Place a queen based on queenPos

public void removeQueen(int i, int j)

- Change the spot where a queen used to be (i, j) back to 0

public void placeQueen(int i, int j)

- Place a queen at (i, j)

public void displayBoard()

- Used to display the board

Sample Output

Steepest Ascent	Sideways	Random Restart without Sideways	Random Restart with Sideways
NEW BOARD: 0, 0, 0, 0, 0, 0, 0, 0, 0 0, 1, 0, 0, 0, 0, 0, 1, 0 0, 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 0, 0 1, 0, 0, 1, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 1, 0, 0, 0 0, 0, 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 0, 0	NEW BOARD: 0, 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1, 1 0, 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 0, 0 1, 0, 0, 0, 1, 0, 0, 0, 0 0, 1, 0, 1, 0, 0, 0, 0, 0 Board Heuristic: 8	Average Number of Restarts: 10.0 Average Number of Steps: 23.0	Average Number of Restarts with Sideways Move: 0.32 Average Number of Steps: 62.0

<p>Heuristic: 9</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0, 1, 0</p> <p>0, 0, 0, 1, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>1, 0, 0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 1, 0, 0, 0</p> <p>0, 0, 1, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>Heuristic: 5</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0, 1, 0</p> <p>0, 0, 0, 1, 0, 0, 0, 0, 0</p> <p>1, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 1, 0, 0, 0</p> <p>0, 0, 1, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>Heuristic: 3</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0, 1, 0</p> <p>0, 0, 0, 1, 0, 0, 0, 0, 0</p> <p>1, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 0, 0, 0, 0</p> <p>0, 0, 1, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 1, 0, 0</p> <p>Heuristic: 1</p> <p>0, 0, 0, 0, 0, 0, 0, 1, 0</p> <p>0, 1, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 1, 0, 0, 0, 0, 0</p> <p>1, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 0, 0, 0, 0</p>	<p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 1, 1</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 1, 0, 0, 0, 0, 0, 0</p> <p>1, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 1, 0, 0, 0, 0</p> <p>0, 1, 0, 1, 0, 0, 0, 0, 0</p> <p>Board Heuristic: 5</p> <p>0, 0, 0, 1, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 1, 1</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 1, 0, 0, 0, 0, 0, 0</p> <p>1, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 1, 0, 0, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0, 0, 0</p> <p>Board Heuristic: 3</p> <p>0, 0, 0, 1, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 1, 0</p> <p>0, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 1, 0, 0, 0, 0, 0, 0</p> <p>1, 0, 0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 0, 0, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0, 0, 0</p> <p>Board Heuristic: 2</p> <p>0, 0, 0, 1, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 1, 0</p> <p>1, 0, 0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 1, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 0, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0, 0, 0</p> <p>Board Heuristic: 1</p> <p>0, 0, 0, 1, 0, 0, 0, 0, 0</p>		
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0, 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0, 0 Heuristic: 0 Success! NEW BOARD: 0, 1, 0, 1, 0, 0, 1, 0 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 0, 0, 0 1, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 0, 1 0, 0, 0, 0, 0, 1, 0, 0 0, 0, 0, 0, 0, 0, 0, 0 Heuristic: 6 0, 1, 0, 0, 0, 0, 1, 0 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 0, 0, 0 1, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 0, 1 0, 0, 0, 0, 0, 1, 0, 0 0, 0, 0, 1, 0, 0, 0, 0 Heuristic: 3 0, 1, 0, 0, 0, 0, 1, 0 0, 0, 0, 0, 1, 0, 0, 0 0, 0, 1, 0, 0, 0, 0, 0 1, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 0, 1, 0, 0 0, 0, 0, 1, 0, 0, 0, 0 Heuristic: 1 NEW BOARD: 0, 0, 0, 0, 0, 1, 0, 0	0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 Board Heuristic: 1 0, 0, 0, 1, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 Board Heuristic: 1 0, 0, 0, 1, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 0, 0, 0 0, 1, 0, 0, 0, 0, 0 Board Heuristic: 1 0, 0, 0, 1, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 1, 0, 0, 0, 0, 0 Board Heuristic: 0 Success! NEW BOARD: 1, 0, 0, 0, 0, 0, 0		
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0, 0, 0, 0, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 1, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 1 0, 0, 1, 0, 0, 0, 1, 0 0, 1, 0, 0, 0, 0, 0, 0 Heuristic: 4 0, 0, 0, 0, 0, 1, 1, 0 0, 0, 0, 0, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 1, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 1 0, 0, 1, 0, 0, 0, 0, 0 0, 1, 0, 0, 0, 0, 0, 0 Heuristic: 3 0, 0, 0, 0, 0, 0, 1, 0 0, 0, 0, 0, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 1, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 1 0, 0, 1, 0, 0, 0, 0, 0 0, 1, 0, 0, 0, 0, 0, 0 Heuristic: 2 Average Steps for Success: 4.0 Average Steps for Failure: 3.0 Success Rate: 14.0 Failure Rate: 86.0	0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 0, 0, 1, 0, 0, 0 0, 1, 1, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 Board Heuristic: 5 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 0, 0, 1, 0, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 1, 0 Board Heuristic: 3 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 1, 0, 0, 0 0, 0, 1, 0, 0, 1, 0 Board Heuristic: 2 1, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 1, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 Board Heuristic: 1 1, 0, 0, 0, 0, 0, 0 0, 0, 1, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 0		
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	<p>0, 0, 0, 0, 0, 0, 1 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 1, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 Board Heuristic: 0 Success!</p> <p>NEW BOARD:</p> <p>0, 0, 1, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 1, 0, 0, 0 1, 0, 0, 0, 0, 1, 0 Board Heuristic: 2</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 1, 0, 0, 0, 0, 1, 0 Board Heuristic: 2</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1</p>		
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	<p>0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0</p>		
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	<p>0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 0, 0, 0, 0 0, 0, 0, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0</p>		
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	<p>Board Heuristic: 1</p> <p>0, 0, 1, 0, 0, 0, 0</p> <p>0, 0, 0, 1, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 1, 0</p> <p>1, 0, 0, 0, 0, 0, 0</p> <p>Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 1, 0</p> <p>1, 0, 0, 0, 0, 0, 0</p> <p>Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0</p> <p>1, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 1, 0</p> <p>0, 0, 0, 0, 0, 0, 0</p> <p>Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 0, 1</p> <p>0, 0, 0, 0, 1, 0, 0</p> <p>0, 1, 0, 0, 0, 0, 0</p> <p>0, 0, 0, 0, 0, 1, 0</p> <p>1, 0, 0, 0, 0, 0, 0</p> <p>Board Heuristic: 1</p>		
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	<p>0, 0, 1, 1, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 1, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 0, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 1, 0, 0, 0, 0 1, 0, 0, 0, 0, 0, 0</p>		
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	0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 0, 1, 0, 0, 0 Board Heuristic: 1 0, 0, 1, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 0, 0, 0, 0, 0 Board Heuristic: 1 0, 0, 0, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 1, 0, 0, 0, 0 Board Heuristic: 1 0, 0, 0, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 1 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 1, 0, 0, 0, 0 Board Heuristic: 1 0, 0, 0, 1, 0, 0, 1 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 0		
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	<p>0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 1, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 0, 1, 0, 0, 1 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 1, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 0, 1, 0, 0, 1 0, 0, 0, 0, 0, 0, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 1, 0, 0, 0, 0 Board Heuristic: 1</p> <p>0, 0, 0, 0, 0, 0, 1 0, 0, 0, 1, 0, 0, 0 1, 0, 0, 0, 0, 0, 0 0, 0, 0, 0, 1, 0, 0 0, 1, 0, 0, 0, 0, 0 0, 0, 0, 0, 0, 1, 0 0, 0, 1, 0, 0, 0, 0 Board Heuristic: 0 Success!</p> <p>Average Success Step: 21.0 Average Failure Step: 100.0 Success Rate: 81.0</p>		
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	Failure Rate: 19.0		
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