Reversi: Implementation and Strategies

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Revisiting engineering design

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  - **Implement** and **test** each of the pieces
  - **Compose** solutions for the smaller pieces into a solution for the overall complex problem
- May have many "levels" of dividing, implementing and testing (especially for a very complex problem)
- Many times, decomposing a complex problem into manageable pieces is challenging in itself and often requires creativity!

Imagine you are playing Reversi with a friend using a board, what are the actions of play?

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- Can you think of a simpler version that isn't complete, but would allow us to test things along the way?

Go Partway First

```
turn = Black // initially
computer = White // for example
while (true) {
  if (turn == computer)
    computer makes ANY legal move
  else
    human should make a move

  turn = findOpposite(turn)
}
```

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- How do we make the computer play any legal move?

  - In your lab 7, you already printed out all available moves for each colour. You can use that code to make the computer play the first available move.

Back to the Full Implementation

Is a Move Available for a Colour?

- How would you decide if a player has an available move?
- Let’s break it down into small pieces …

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    - Hint: Use your functionality from Lab 7

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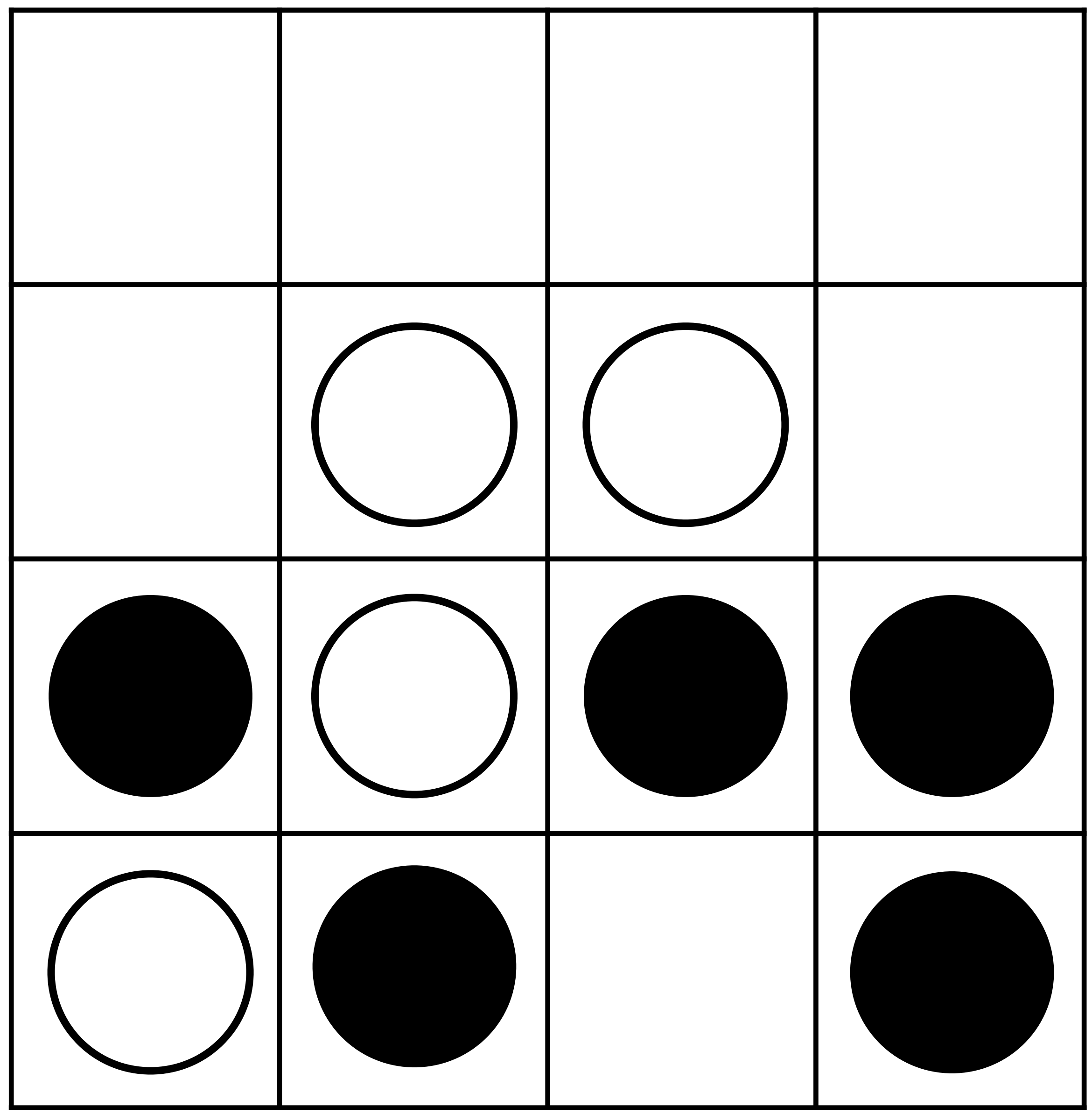
  - Hint: call `isValidMove` above

Smart Computer Moves: Part 1



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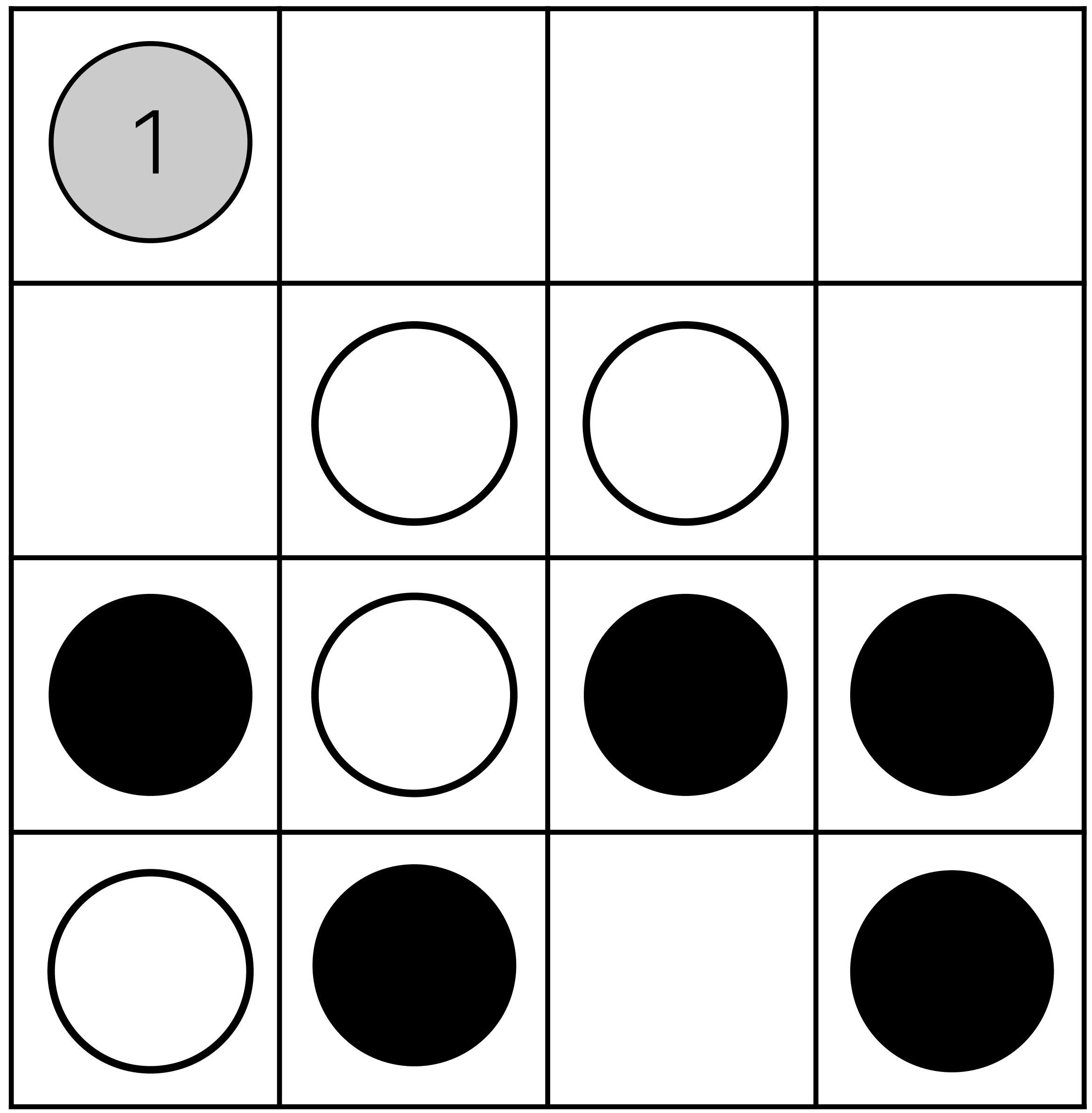

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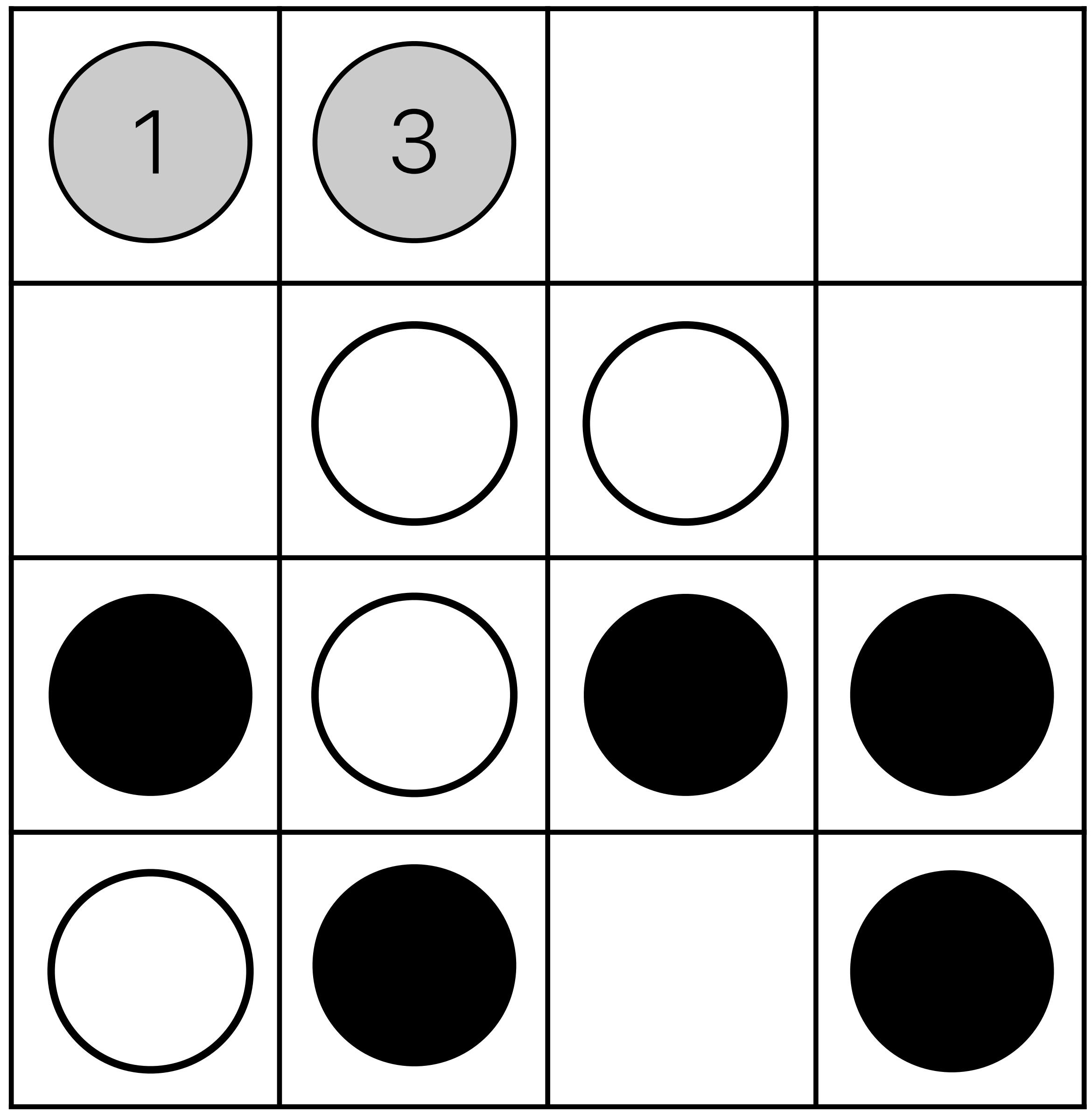

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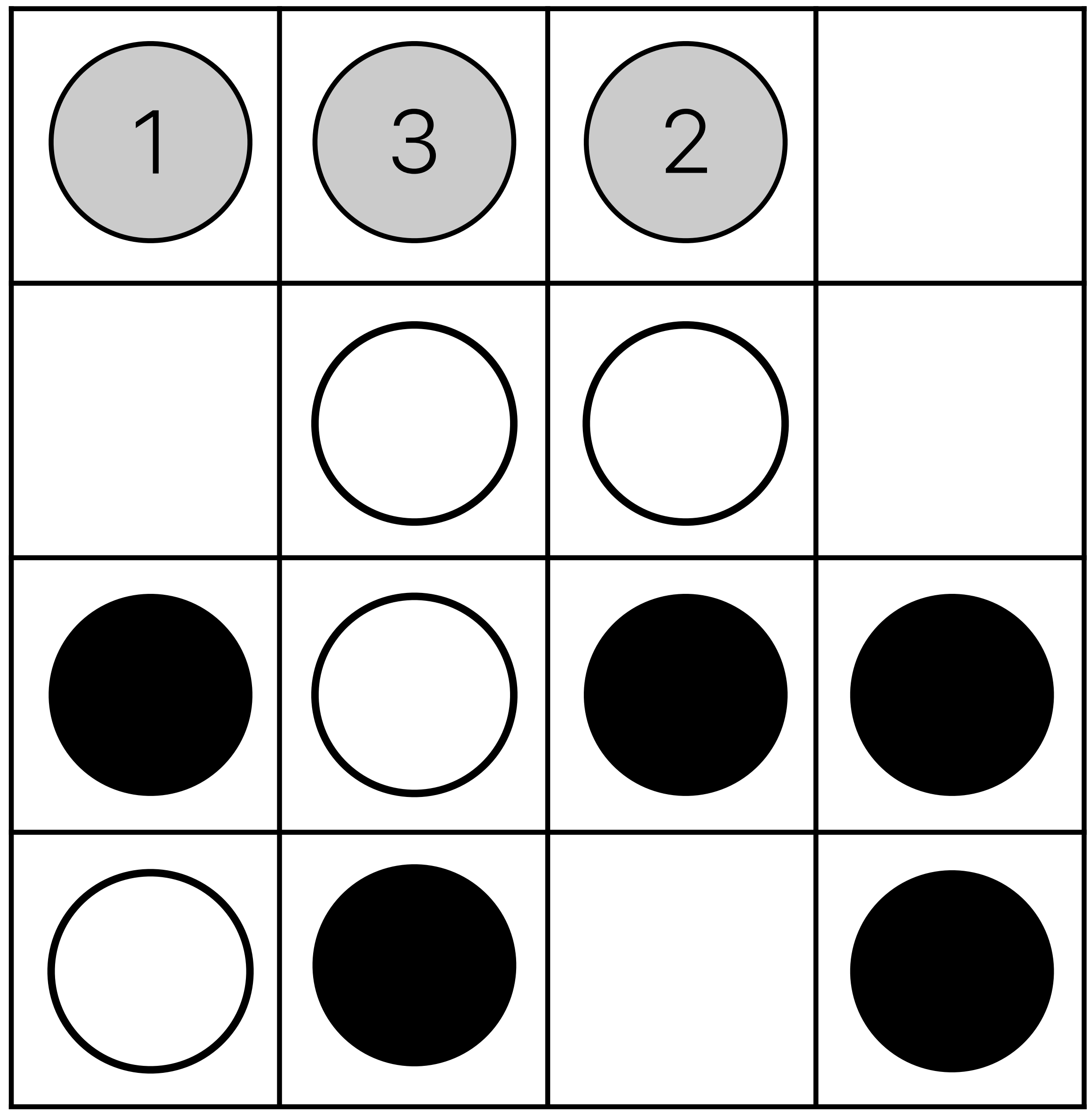

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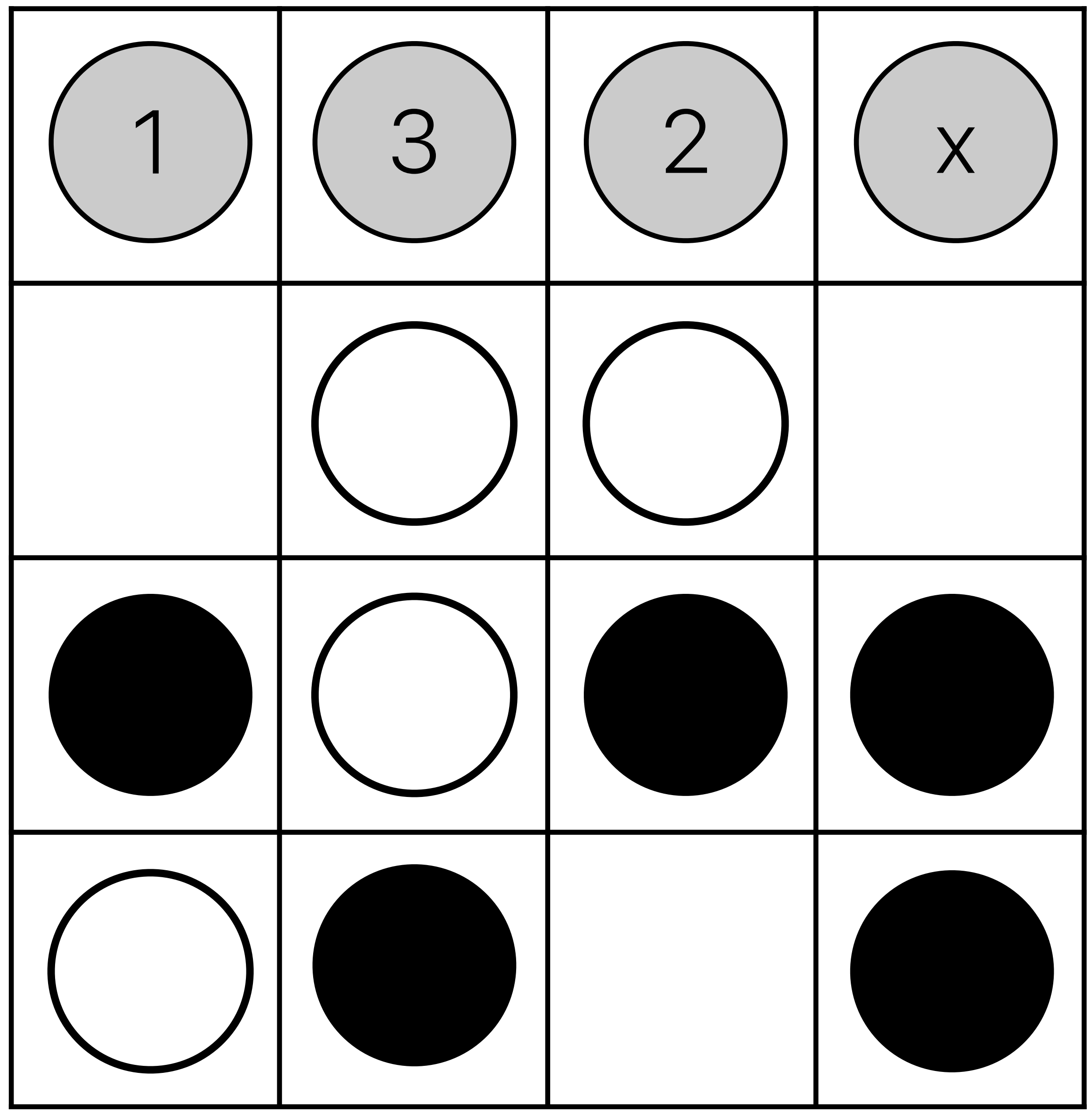

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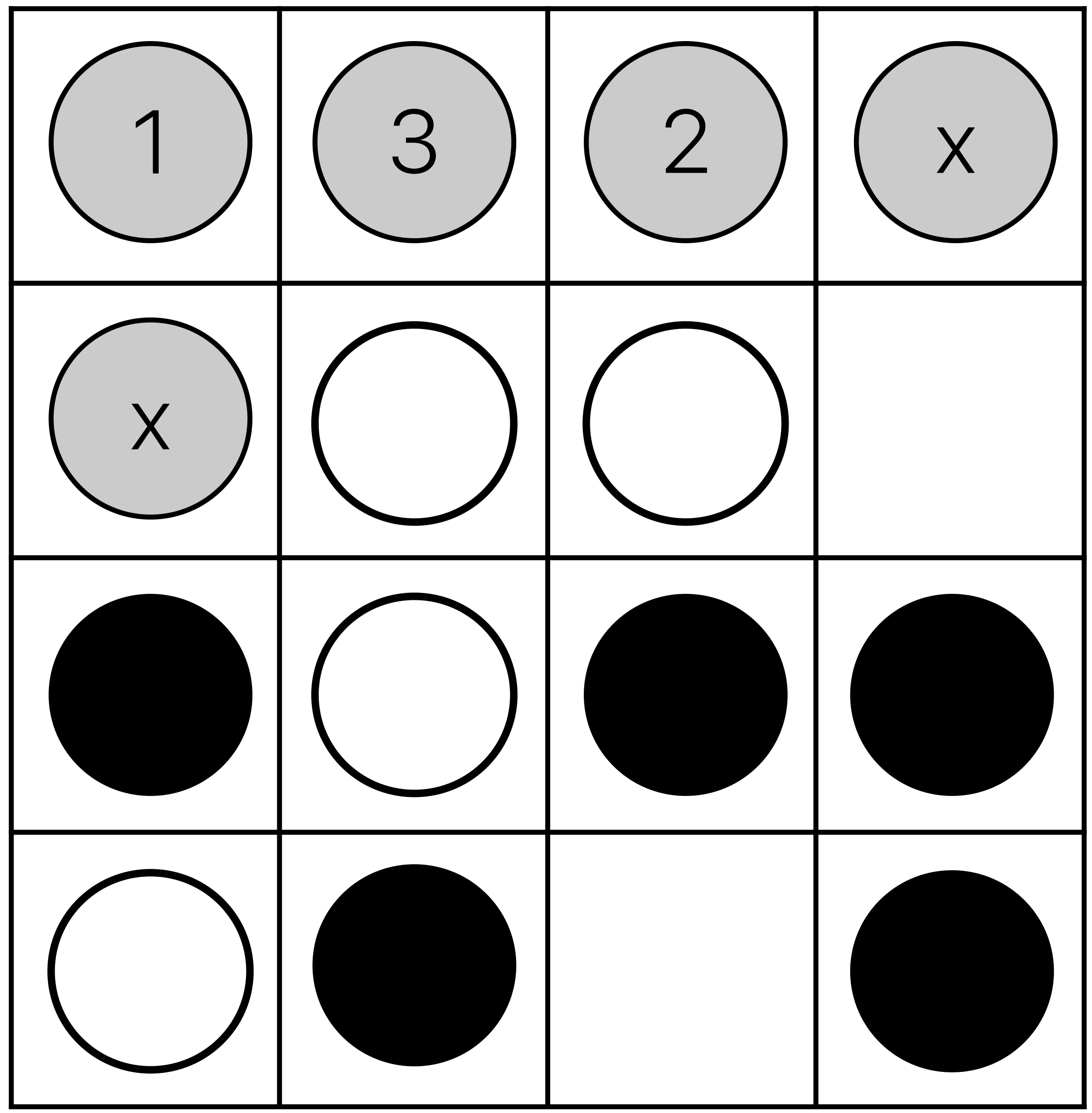

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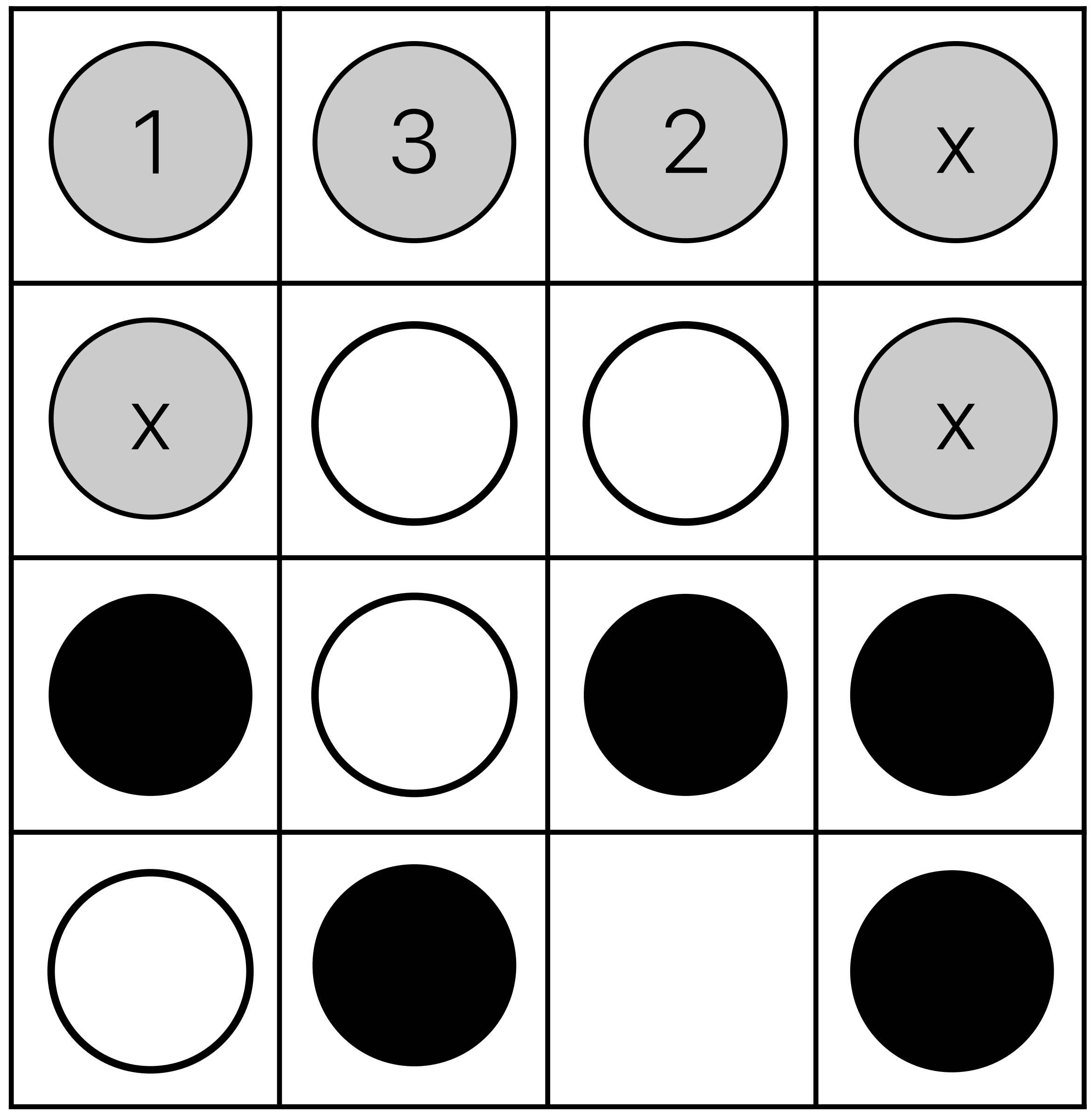

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  - How do you solve this problem?

Introduce a boolean parameter

```
int checkValidAndFlip(char board[][26],
int row, int col, char colour, int n,
bool flip)

  // 'flip' tells me if I really want
  to flip the tiles when computing the
  score

  // the function returns the score for
  (row, col) position and the colour
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    - Flip tiles in the board copy using the Lab 7 solution
    - Count the number of Black tiles in the board copy, call it **blackCountAfterFlip**
    - **Score** for candidate location **= blackCountAfterFlip - blackCountBeforeFlip - 1**

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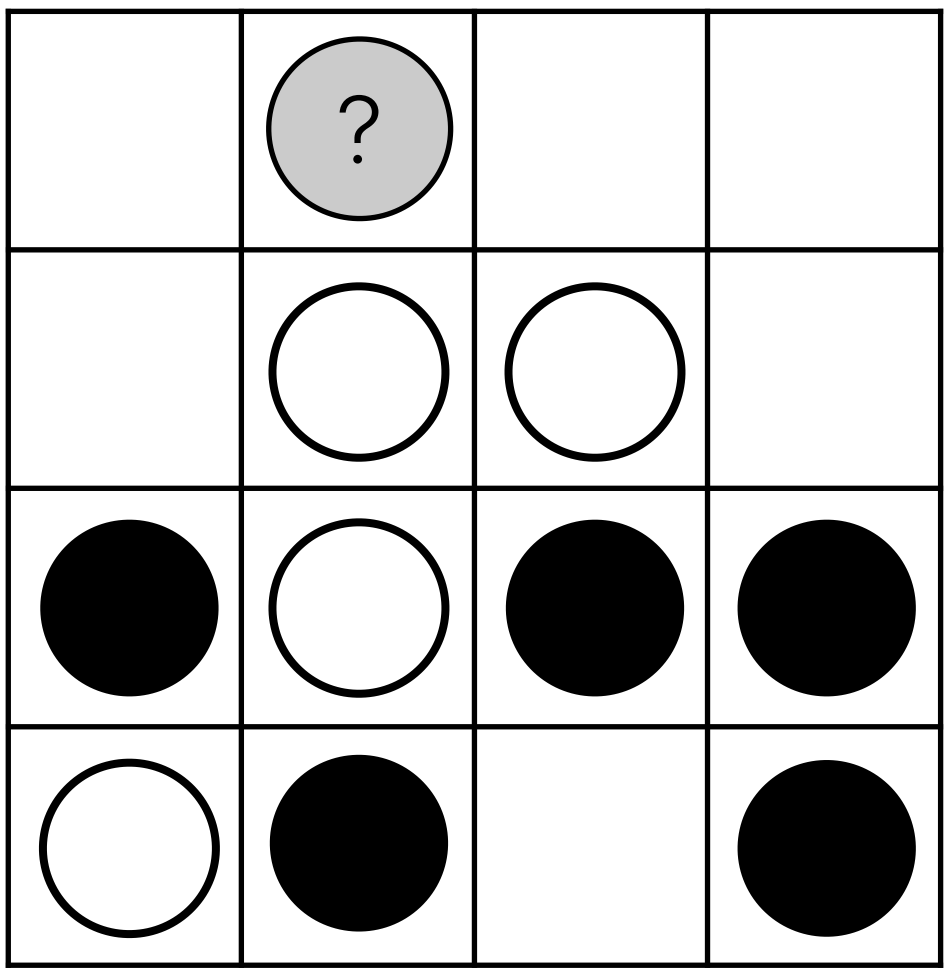

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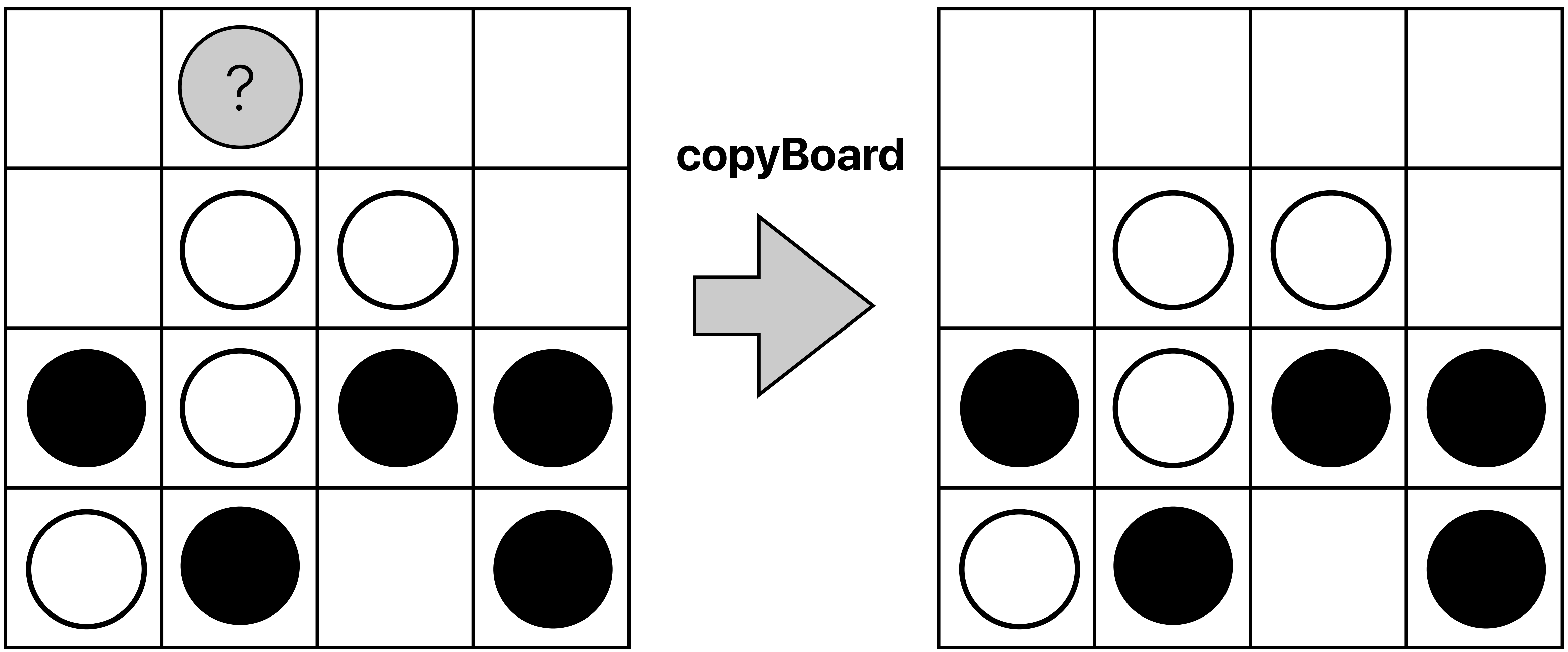

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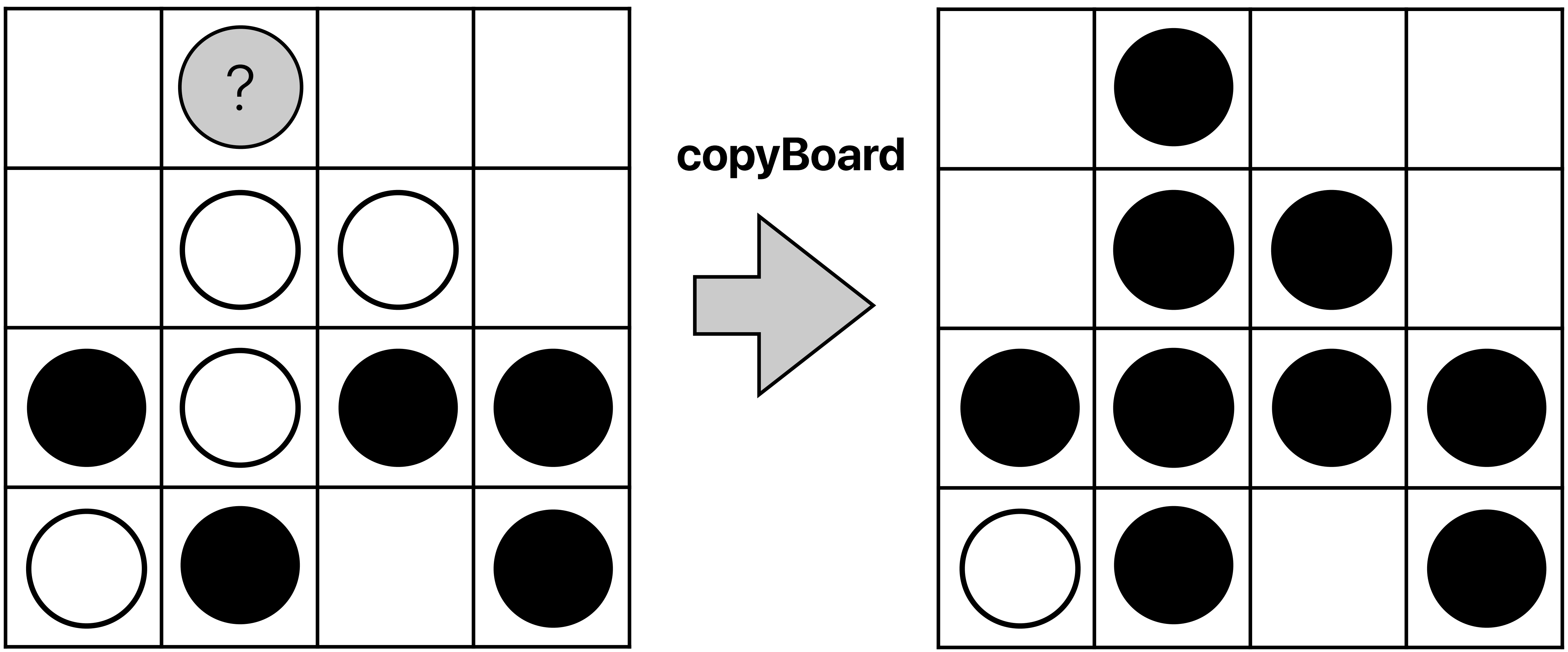

blackCountBeforeFlip = 5

blackCountAfterFlip = 9

Computer plays Black

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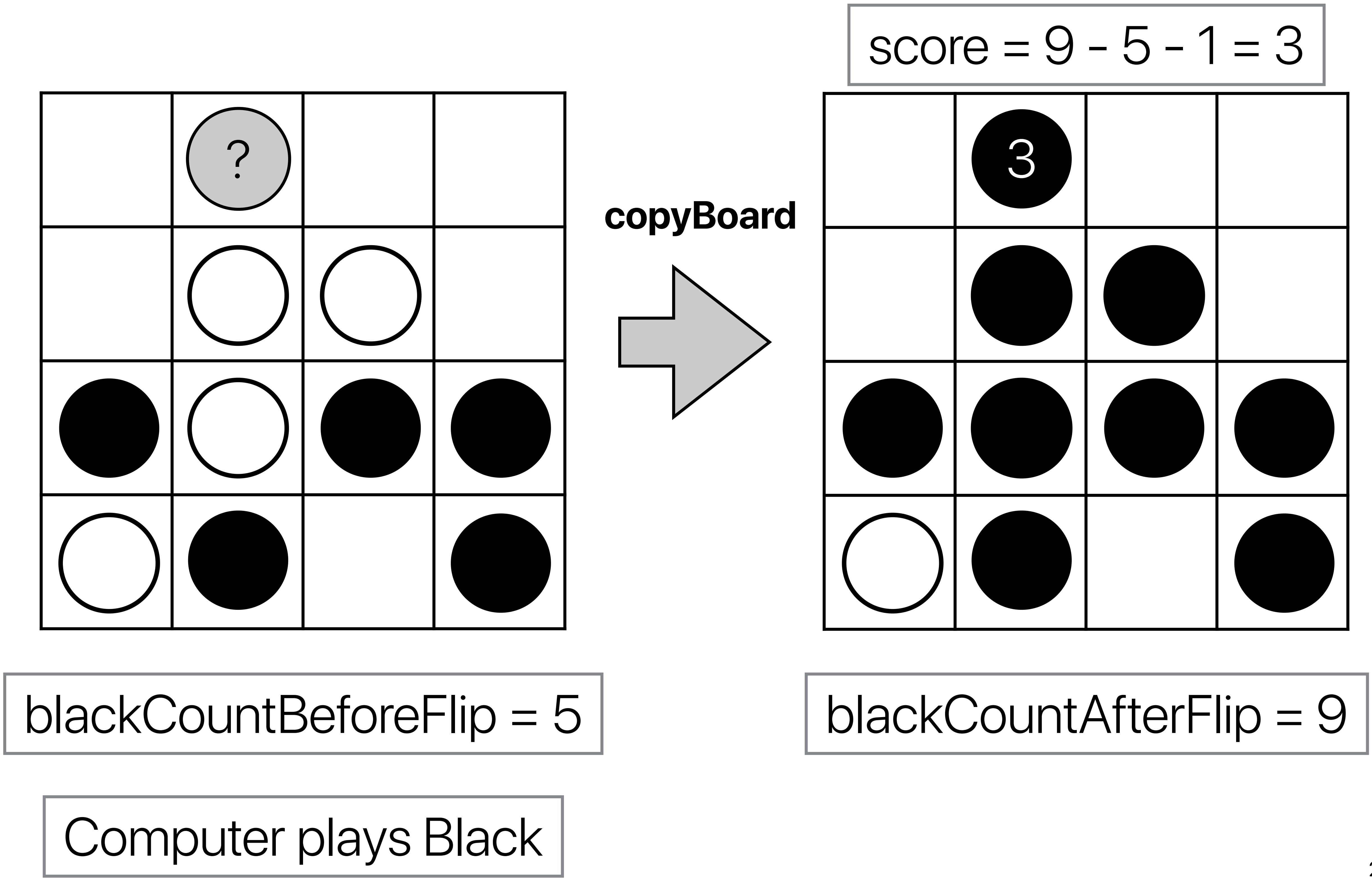

Part II: Strategies

- This is really just about different (more clever) ways of scoring locations
- The Part I approach is called “**greedy**”
  - Goes for the maximum # of flips, regardless of consequences
- What are other factors to consider in a location’s score?

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  - Corners of the board are good
  - Fewer available counter-moves for the opponent
  - Opponent's potential response to computer's move

Composite scoring

- You can consider a “composite” scoring function:

```
score = a * #flips + b * #corners + c
* #opponentMovesEliminated

(a, b and c are constants you set
empirically)
```

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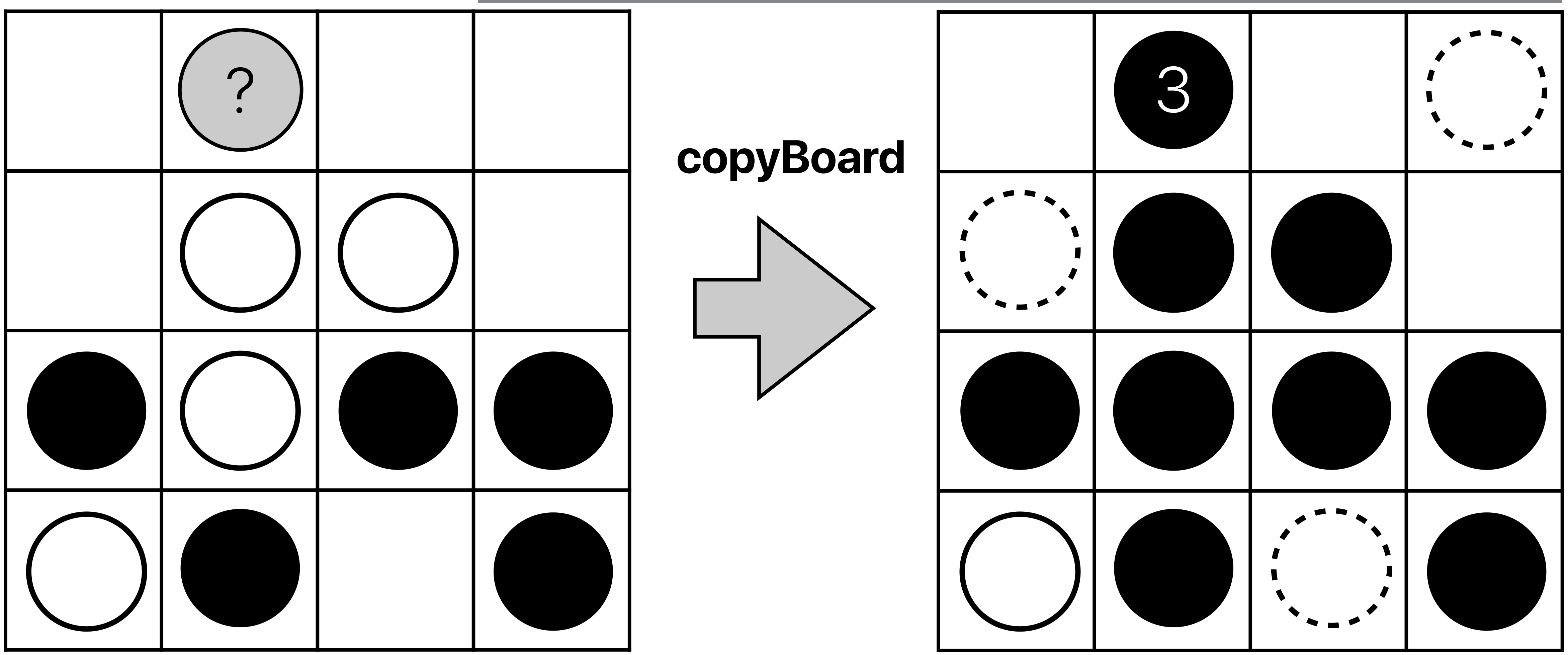
- How would you find, for a candidate move position, the number of locations in which the opponent could play after the flipping?
  - Use the copy of the board
  - Use a nested loop and the `isValidMove` function we talked about before

Scoring a Location

In how many locations can White play? **3**



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With a copy of the board as a “scratch pad,” we can call **isValidMove** to find out possible opponent moves!

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- When humans play these games, good players can "look several moves into the future" to see eventual consequences of a move
- A "game tree" is a way of looking into the future within a computer program

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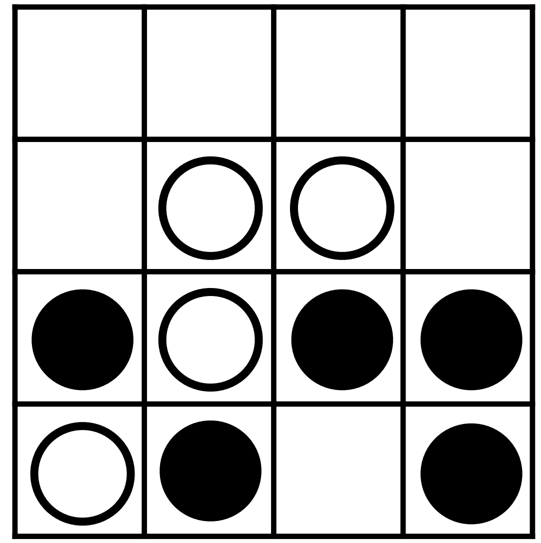

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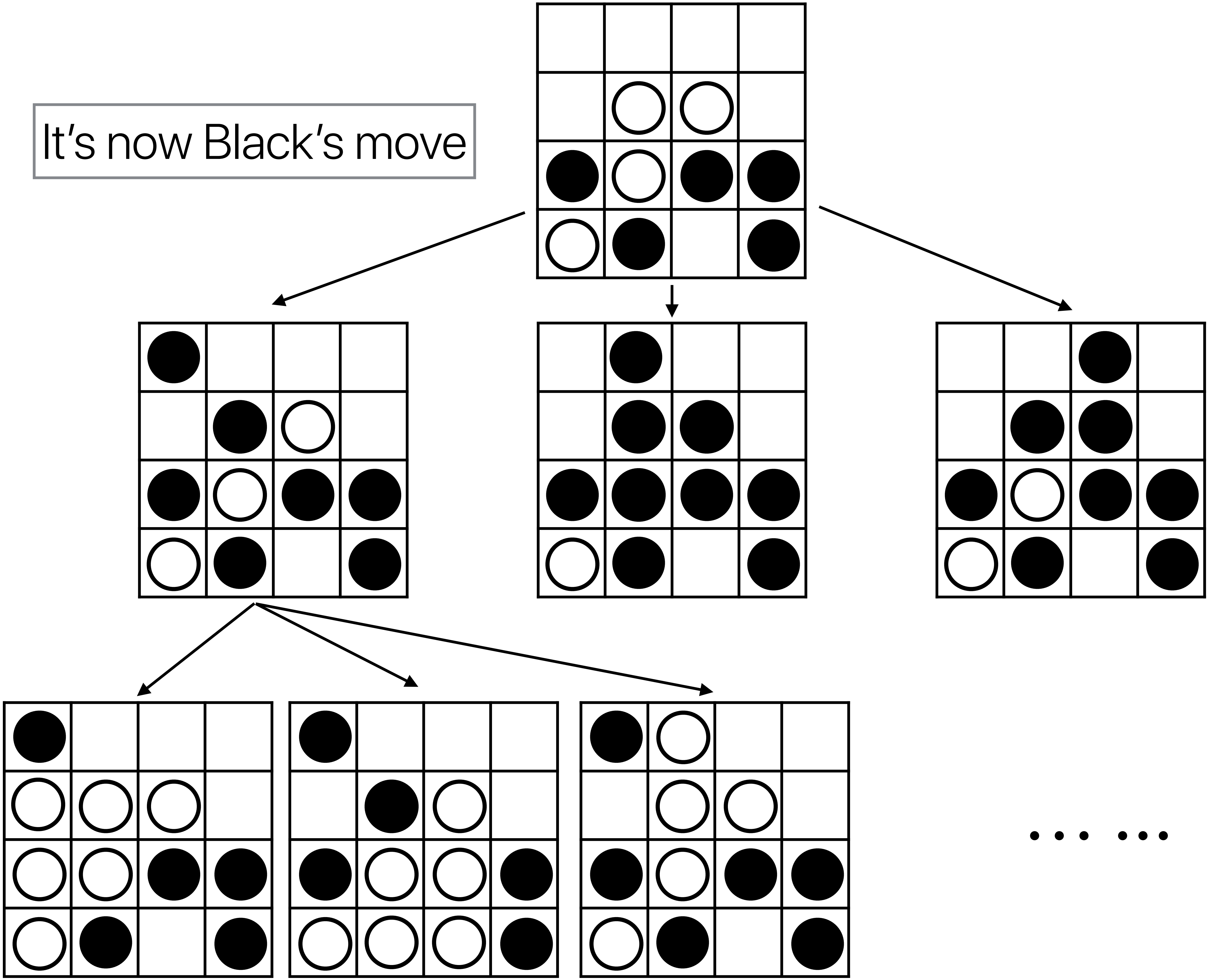

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- For each of Black's candidate moves, expect the opponent to play its best possible response

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- Manage copies of the board representing future configurations
- Handling the case when one player gets a chance to make multiple moves in succession (the opponent has no valid moves)

Game Tree: Challenges

- Manage copies of the board representing future configurations
- Handling the case when one player gets a chance to make multiple moves in succession (the opponent has no valid moves)
- Google "game tree" and "minimax" to learn more about it

Fourth time in this course:

APS 105 competition leaderboard

http://aps105.ece.utoronto.ca:8090

The APS 105 Reversi Leaderboard

Reversi Project Top Leaderboard

Rank	Student	Score	Indicator	Status
0	SiweiHe	∞	∞ %	PASS
1	harri658	1911.05	100 %	TLE
2	dicksimo	1810.2	94.72 %	TLE
3	guptar56	1747.25	91.43 %	TLE
4	pacynkod	1746.9	91.41 %	IM TLE

The APS 105 Reversi Leaderboard

- Entered automatically when you submit your Lab 8 Part 2 to examify.ca, if your submission passes the test cases

Reversi Project Top Leaderboard

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0	SiweiHe	∞	∞ %	PASS
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2	dicksimo	1810.2	94.72 %	TLE
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4	pacynkod	1746.9	91.41 %	IM TLE

The APS 105 Reversi Leaderboard

- Entered automatically when you submit your Lab 8 Part 2 to examify.ca, if your submission passes the test cases
- Pairwise competitions between leaderboard participants

Reversi Project Top Leaderboard

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0	SiweiHe	∞	∞ %	PASS
1	harri658	1911.05	100 %	TLE
2	dicksimo	1810.2	94.72 %	TLE
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The APS 105 Reversi Leaderboard

- Entered automatically when you submit your Lab 8 Part 2 to examify.ca, if your submission passes the test cases
- Pairwise competitions between leaderboard participants
- Two games are played between each pair of finalists, and the results are scored and ranked

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The APS 105 Reversi Leaderboard

- Entered automatically when you submit your Lab 8 Part 2 to examify.ca, if your submission passes the test cases
- Pairwise competitions between leaderboard participants
- Two games are played between each pair of finalists, and the results are scored and ranked
- Continuously run every several days, submit as many times as you wish

Reversi Project Top Leaderboard

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Enjoy the lab and have fun!