Assignment 4, Part 2

Program Structure Hints

public boolean makeMove()

- makeMove doesn't receive any arguments, but recall that since it extends TicTacToe, we have access to:
  - TicTacToeArray
  - step
  - winner
  - player

  And all the methods of TicTacToe, including:

  updateTTT(char sym, int row, int col)

public boolean makeMove()

- First, create the two main arrays, and fill them with zeros.

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

defensiveOppsArray

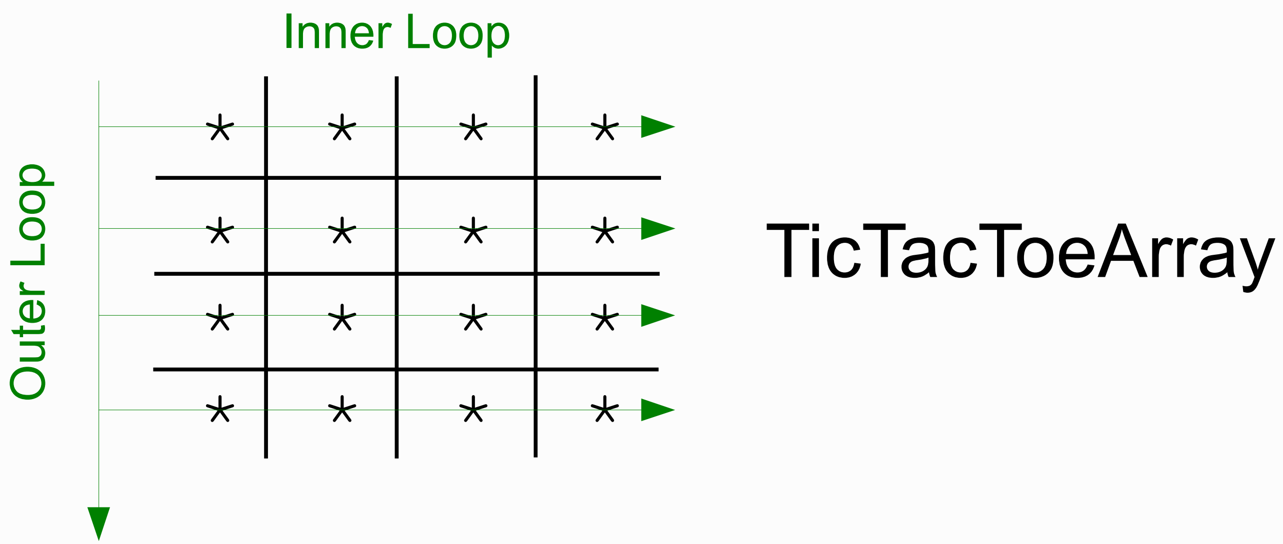
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

offensiveOppsArray

- Our goal is to populate these arrays, (one element at a time) sum them together, and select the max.

public boolean makeMove()

- Recall: the cells of defensiveOppsArray and offensiveOppsArray correspond to the defensive and offensive value of playing that position for the next move.
- We consider each cell (row,col) independently, which means we need a double loop.



public boolean makeMove()

- For each cell (inside the double loop):

    1. If the cell is already played, skip it and *continue* on to the next cell.

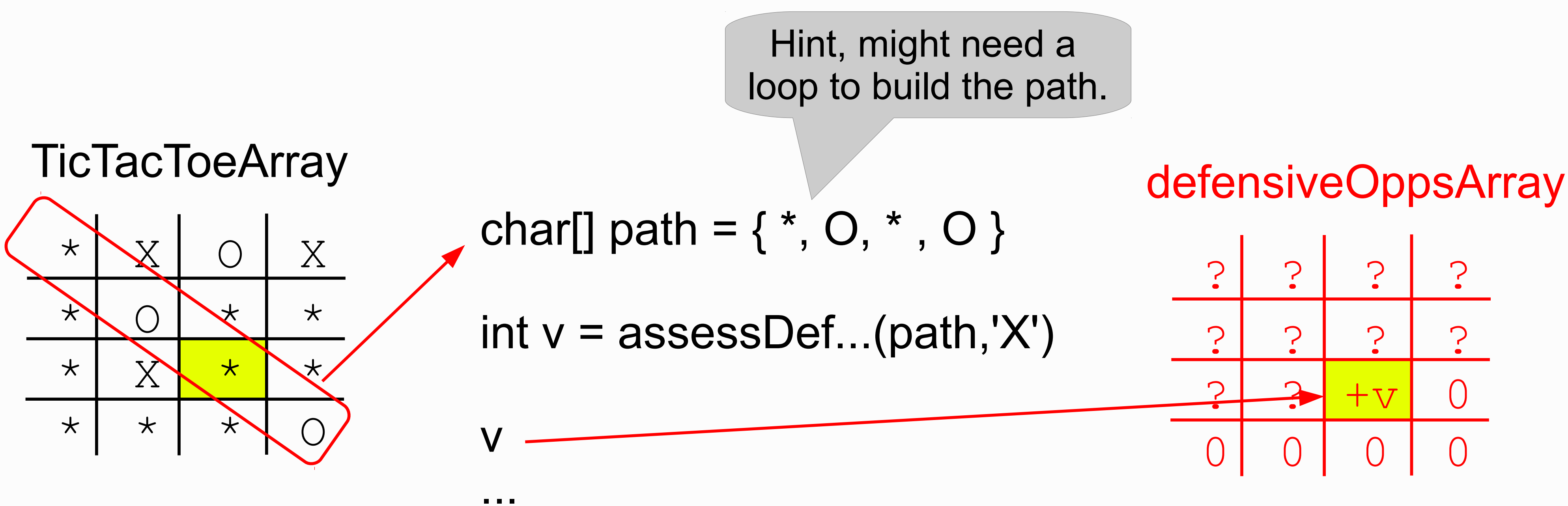
Skip these. Their values in the OppsArrays should be left at 0.

X	*	*	*
*	*	O	*
*	*	*	*
*	X	*	*

TicTacToeArray

public boolean makeMove()

- For each cell (still in the double loop):
  2. If the cell is on left-leaning diagonal, do this:
     - Copy the diagonal into a path array
     - Call assessDefensiveOpps and assessOffensiveOpps on the path.
     - Add the return values to the OppsArrays.



public boolean makeMove()

- For each cell (still in the double loop):

  3. If the cell is on right-leaning diagonal, do this:

     - Copy the diagonal into a path array
     - Call assessDefensiveOpps and assessOffensiveOpps on the path.
     - Add the return values to the OppsArrays.

Hint, might need a loop to build the path.

TicTacToeArray

*	X	O	X
*	O	*	*
*	X	*	*
*	*	*	O

```
char[] path = { *, X, * , X }

int v = assessDef...(path,'X')

v
...
```

defensiveOppsArray

?	?	?	?
?	?	?	?
?	?	?	?
+v	0	0	0

public boolean makeMove()

- For each cell (still in the double loop):

  4. Always do this:

     - Copy the cell's row into a path array
     - Call assessDefensiveOpps and assessOffensiveOpps on the path.
     - Add the return values to the OppsArrays.

Hint, might need a loop to build the path.

TicTacToeArray

*	X	O	X
*	O	*	*
*	X	*	*
*	*	*	O

char[] path = { *, *, * , O }

int v = assessDef...(path,'X')

v

...

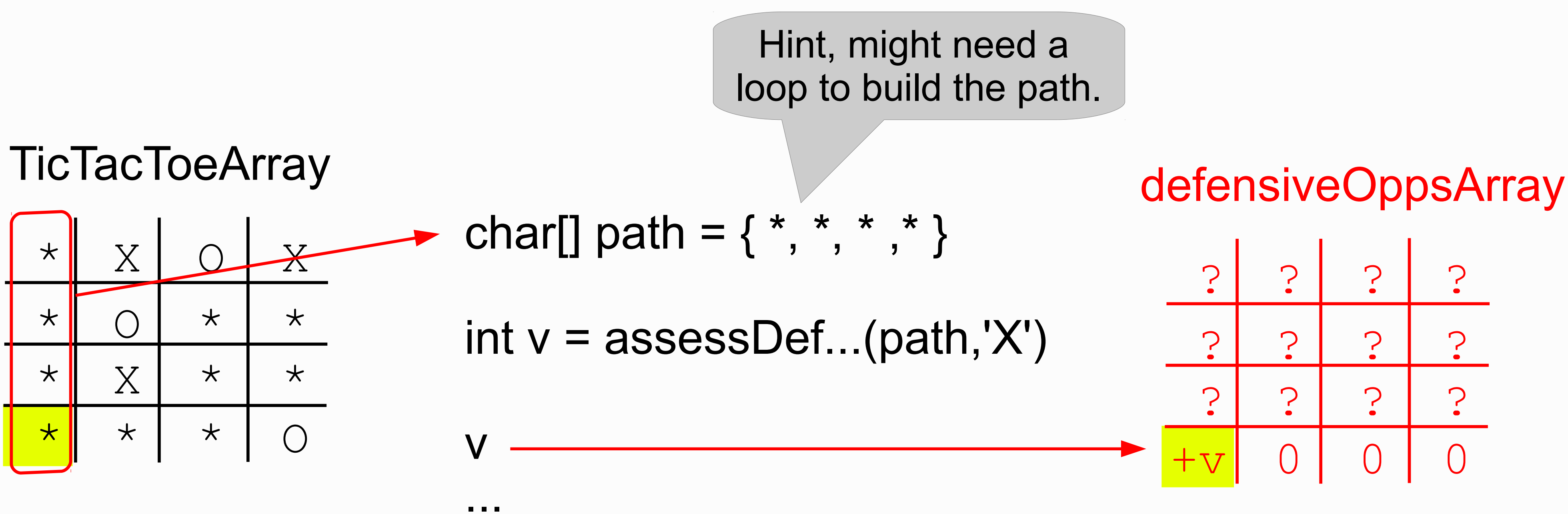
defensiveOppsArray

?	?	?	?
?	?	?	?
?	?	?	?
+v	0	0	0

public boolean makeMove()

- For each cell (still in the double loop):

  5. Always do this:
     - Copy the cell's column into a path array
     - Call assessDefensiveOpps and assessOffensiveOpps on the path.
     - Add the return values to the OppsArrays.



public boolean makeMove()

- Now you should have fully populated OppsArrays.
- Here would be a good place to print out your OppsArrays to make sure they match the web simulator.
  - If you do this, be sure to comment it out before submitting, or you'll lose points! makeMove shouldn't print anything in your final submission.

public boolean makeMove()

- Walk over the two arrays. The best move is the (row,col) value where the sum of defensiveOppsArray[row][col] and offensiveOppsArray[row][col] is maximized.
  - (Hint: requires a double loop, and some state variables to keep track of the max value and coordinates).
- If both arrays are full of zeros, then there is no best move. Return false.
- Otherwise, call updateTTT to play the move and return true. If two moves tie, play the 1st occurrence of the tie in a row-major scan of the array.
  - Hint: row major means your outer loop walks over the rows, the inner loop walks over the columns, as shown on slide 4.

public void int assessDefensiveOpps(char[] path, char sym)

- Count the number of opponents in the path by walking over the path array. (requires a loop)
  - If at any point you encounter your own piece (sym), then return 0 because the path is already blocked.
- Now that you know how many opponents are in the path, a simple if statement will determine if this is a critical move.
- At this point, a simple one-line mathematical expression should give you your return value.

public void int assessOffensiveOpps(char[] path, char sym)

- Very similar to assessDefensiveOpps.

Assignment 4, Part 3

Using ArrayList to implement a memory

Goal

- Computing the ***defensiveOppsArray*** and ***offensiveOppsArray*** takes time.
- Perhaps we can optimize our code by adding the concept of memory to our program.
- If a board state has been encountered before in a previous game, we don't need to recompute the OppsArrays if we saved them somewhere (ie. “memory”).
- The goal of Part 3 is to implement such a memory.

ArrayList

- Recall that an ArrayList is an array that can grow dynamically.
- We add items to an ArrayList by calling the add method.
- The type of data an ArrayList can hold is specified in <>.
  - Example:

```
ArrayList<String> al = new ArrayList<String>()
al.add(“hello”);
al.add(“world”);
System.out.println(al.get(1)); //prints world
```

ArrayList for Memory

- How can an ArrayList be used to implement a memory?
  - Store all the previously encountered board states, and their corresponding computed OppsArrays.
- First we need to create a data type.

```
public class BoardState{
    public String TTTState;
    public int[][] defensiveOppsArray;
    public int[][] offensiveOppsArray;
}
```

- Now we can do: `new ArrayList<BoardState>()`

Saving to Memory

- To store an item in memory, just create an instance of BoardState and add it.

```
BoardState addMe = new BoardState();
addMe.offensiveOppsArray = offensiveOppsArray;
addMe.offensiveOppsArray = offensiveOppsArray;
```

- But wait, TTTState is a String, and the game board is a char[][]. Why?
- Solution is to create a method that converts the char[][] into a String array.
- Now we can do:

```
addMe.TTTState = convertTTTArrayToString();
```

Using the Memory

- To check for a board state in memory, just walk over all the elements in the ArrayList and compare their TTTState to the current board's TTTState.
  - This check should be done before building the OppsArrays.
- If you do have to build the OppsArrays, make sure to save them to memory immediately after.

Example:

This program asks a user to enter a string, and keeps track of how many times they enter each string.

```
public class StringEncounter{
   public String str;
   public int count;
}
```

```
import java.util.ArrayList;

public class ArrayListDemo{
  public static void main(String[] args){
    ArrayList<StringEncounter> al =
      new ArrayList<StringEncounter>();
    for(;;){
      //query the user to enter a string
      System.out.print("Enter a string: ");
      String x = UserInput.readString();
      System.out.println("");
      //check memory to see if we've
      //typed that before
      boolean found = false;
      for(int i=0; i < al.size(); i++){
        StringEncounter test = al.get(i);
        if(test.str.equals(x)){
          System.out.println("You've typed that "
            +test.count+" times.");
          test.count++;
          found = true;
        }
      }
      //if this was the first time we typed
      //that string, add it to the list
      if(!found){
        System.out.println("Looks like the"+
          " first time you've typed that.");
        StringEncounter se = new StringEncounter();
        se.str = x;
        se.count = 1;
        al.add(se); //add it to the memory
      }
      System.out.println("");
    }
  }
}
```