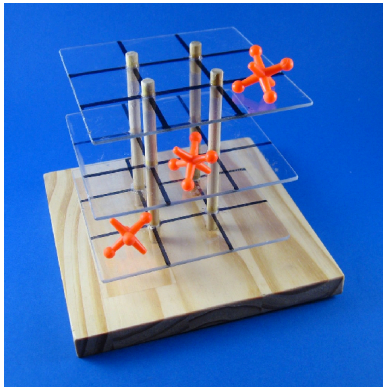
CS 134:
Tic Tac Toe (2)

Announcements & Logistics

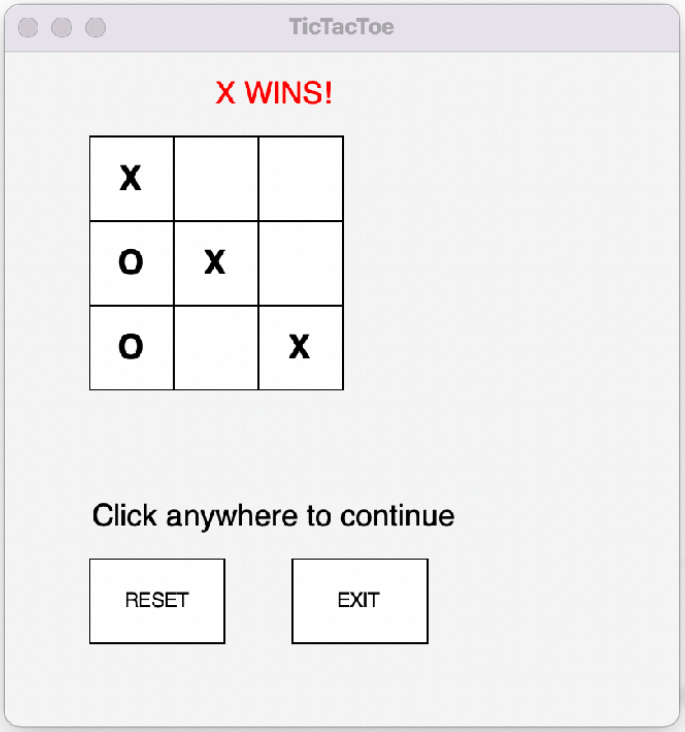
- **Lab 7** feedback coming soon
- **HW 8** posted later today, due Monday April 25 11 pm
- **Lab 9 Boggle** will be released on Friday: multi-week partners lab (counts as a two labs in terms of grade; Lab is decomposed into four logical parts
  - **Parts 1 & 2 (BoggleLetter & BoggleBoard)** due Apr 27/28
  - We will run our tests on these and return automated feedback (similar to Lab 4 part 1), but you are allowed to revise it afterwards
  - **Parts 3 & 4 (BoggleWords & Game)** due May 4/5
  - Look for another form from Lida about partners soon

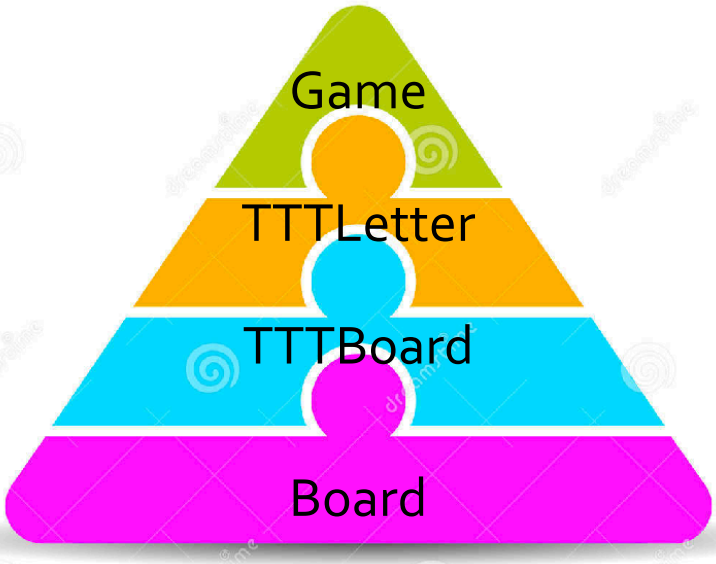
Do You Have Any Questions?

Last Time



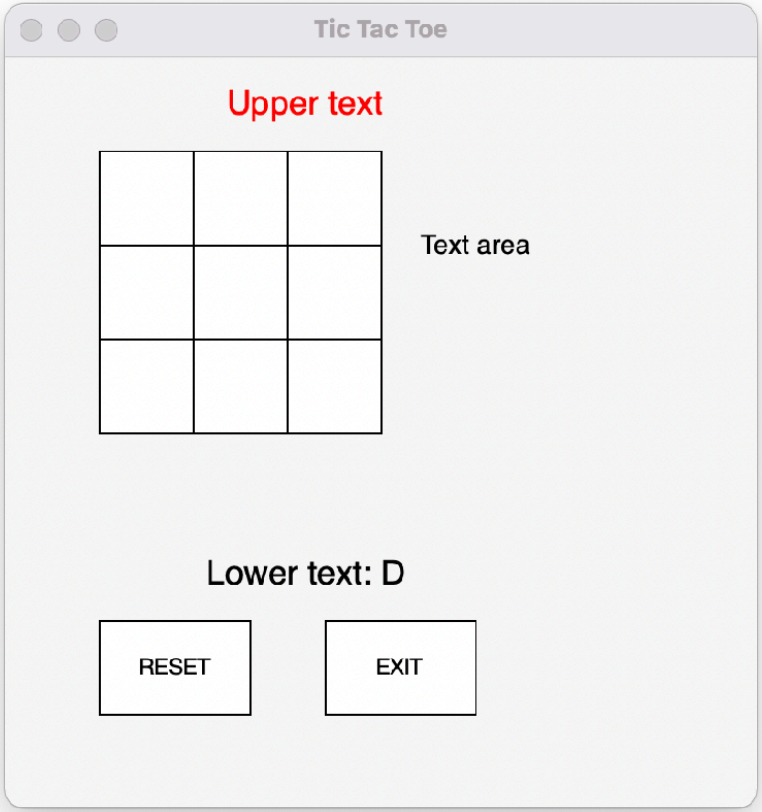
- Started to discuss an application of object-oriented design
  - Started to build a graphical board game: **`Board`** class
  - Used the **`graphics`** package as a black box tool for our design
  - Discussed decomposition by breaking tic-tac-toe into layers



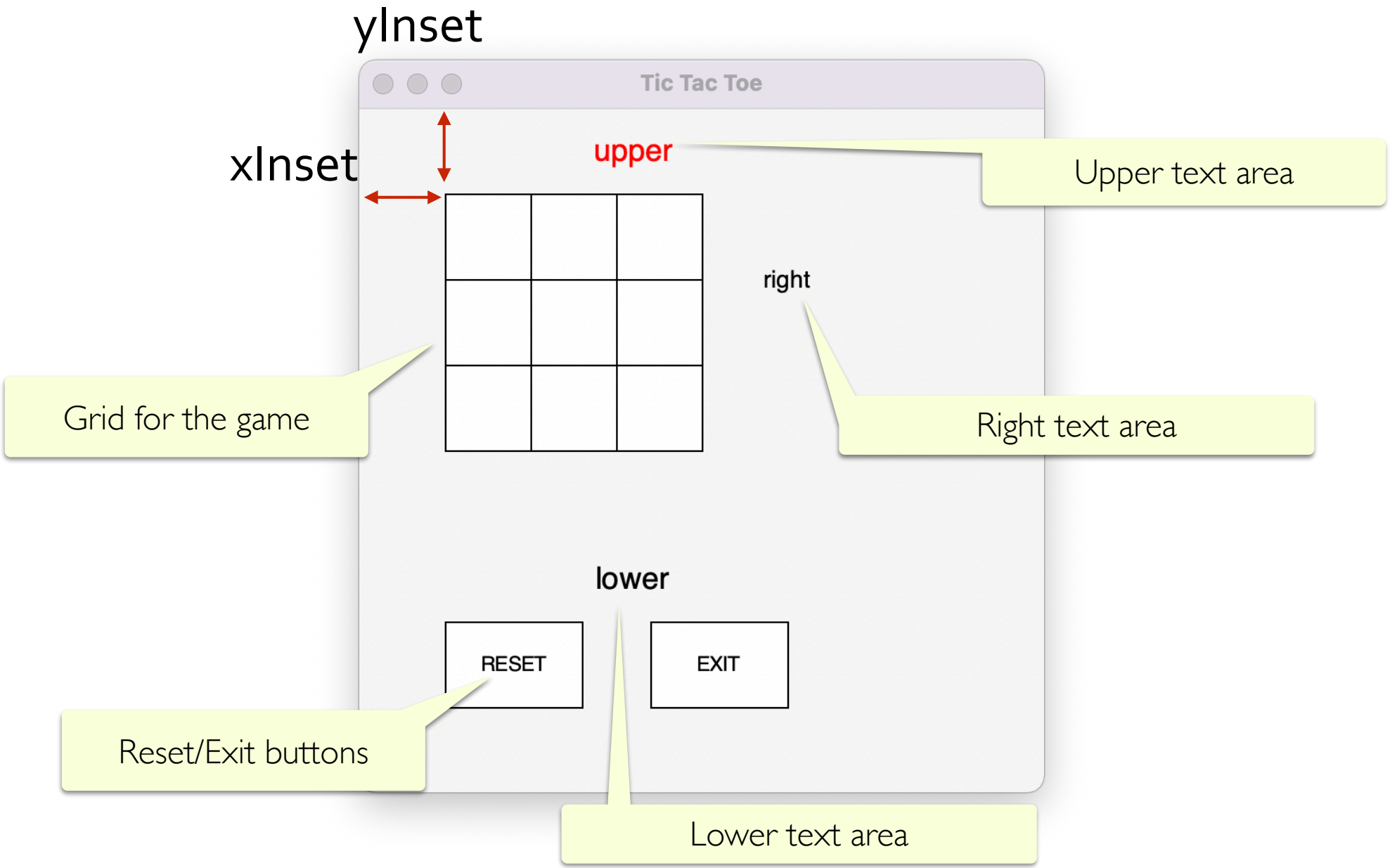


Last Time: Board class

- Basic features of our game board:
  - Text areas: above, below, right of grid
  - Grid of squares of set size: rows x cols
  - Reset and Exit buttons
  - React to mouse clicks (we'll discuss this)
- These are all **graphical** (GUI) components
  - Used graphics package to create rectangles/window/text
  - object.draw(win) draws object on graphical window win



Board Class: All the Pieces



Today's Plan

- Look at some of the helper methods in the `Board` class
- Talk about building the Tic Tac Toe board by inheriting from `Board` class
    - How can we extend board for a Tic Tac Toe (TTT) game?
    - What TTT-specific new methods/attributes do we need?
- Move up to the next layer: TTT Letter
    - What attributes/methods can we use to implement functionality of a single Tic Tac Toe letter?
- Next time: Wrap up Tic Tac Toe by completing the logic of the game

Helper Methods: Board

- Now that we have a board with a grid, buttons, and text areas, it would be useful to define some methods for interacting with these objects (aside from getters, setters, __init__, etc)
- Helpful methods?

Helper Methods: Board

- Now that we have a board with a grid, buttons, and text areas, it would be useful to define some methods for interacting with these objects (aside from getters, setters, __init__, etc)
- Helpful methods?
  - Get grid coordinate of mouse click
  - Determine if click was in grid, reset, or exit buttons
  - Set text to one of 3 text areas
  - …
- Note that none of this is specific to Tic Tac Toe (yet)!
- Always good to start general and then get more specific

Helper Methods

```
class Board(builtins.object)
 |  Board(win, xInset=50, yInset=50, rows=3, cols=3, size=50)
 |
 |  Methods defined here:
 |
 |  __init__(self, win, xInset=50, yInset=50, rows=3, cols=3, size=50)
 |      Initialize self.  See help(type(self)) for accurate signature.
 |
 |  addStringToLowerText(self, text)
 |      Add text to text area below grid.
 |      Does not overwrite existing text.
 |
 |  addStringToTextArea(self, text)
 |      Add text to text area to right of grid.
 |      Does not overwrite existing text.
 |
 |  addStringToUpperText(self, text)
 |      Add text to text area above grid.
 |      Does not overwrites existing text.
 |
 |  clearLowerText(self)
 |      Clear text area below grid.
 |
 |  clearTextArea(self)
 |      Clear text in text area to right of grid.
 |
 |  clearUpperText(self)
 |      Clear text area above grid.
 |
 |  inExit(self, point)
 |      Returns true if point is inside exit button (rectangle)
 |
 |  inGrid(self, point)
 |      Returns True if a Point (point) exists inside the grid of squares.
 |
 |  inReset(self, point)
 |      Returns true if point is inside exit button (rectangle)
 |
 |  setStringToLowerText(self, text)
 |      Set text to text area below grid.
 |      Overwrites existing text.
 |
 |  setStringToTextArea(self, text)
 |      Sets text to text area to right of grid.
 |      Overwrites existing text.
 |
 |  setStringToUpperText(self, text)
 |      Set text to text area above grid.
 |      Overwrites existing text.
```

Working with Mouse Clicks

- `win.getMouse()` returns a `Point` object, which has an `x` and `y` coordinate (tuple) determined by the screen coordinate
- We can use helper methods (with simple calculations) to test which grid square or button the click occurred in
- This will be useful in our next step!

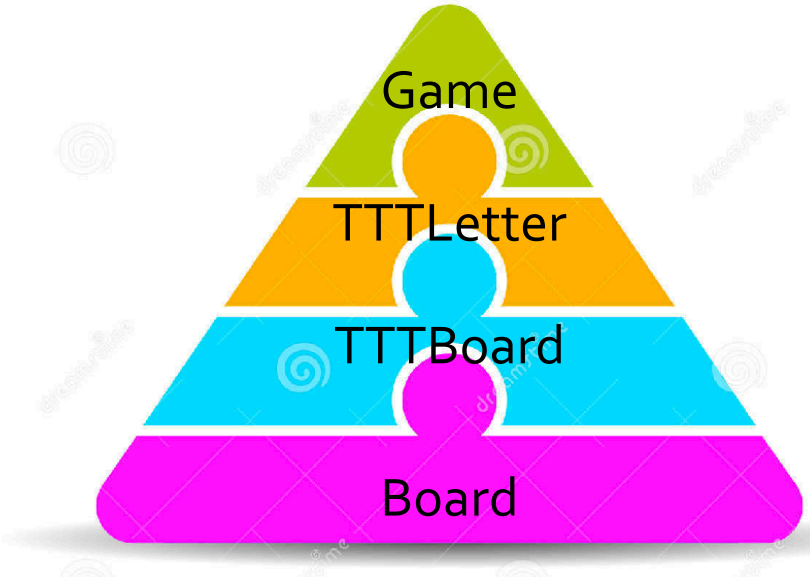
```
>>> python3 board.py
```

Board Class: Bigger Picture

- Tic Tac Toe is not the only text based board game
- Our `Board` class that can be used for other games as well, such as Boggle! (Lab 9)
- Summary of our basic `Board` class implementation:
    - Create a grid of a certain size (e.g., 3 by 3 for Tic Tac Toe)
    - Define attributes and methods (getters) to access rows, cols, size, etc
    - Provide helper methods to recognize and interpret a mouse click on the board
    - Provide other basic features (and methods for manipulating them) such as text areas for indicating whose turn it is, printing who wins, etc
- Through the power of inheritance we can use the same board class for TicTacToe and Boggle!

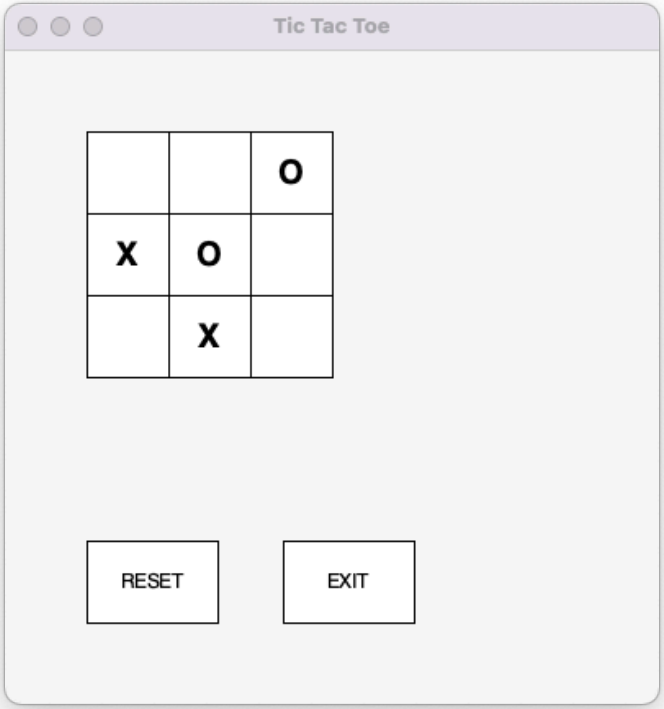
Moving up: TTTBoard

- Although our Board class provides a lot of useful functionality, there are some Tic Tac Toe specific features we need to support
- We can do this by ***inheriting*** from the Board class
- We can take advantage of all of the methods and attributes defined in `Board` and add any (specific) extras we may need for TTT
- What extra attributes and/or methods might be useful?



TTT Board Design

- Think of the grid composed of `TTTLetters`
  - Initially populate grid with `TTTLetters` that are "empty"
- Lets think about the Board state in the "middle of the game"
- What are some helper methods that can help get/set the game state?
  - Check individual `TTTLetters` for X or O
  - Setting individual `TTTLetters` to X or O
  - Check for win (how?)
  - Need helper methods for row/column/diag checks



TTTLetter

- To use TTTLetter, we just need to know its documentation (not how it is implemented)
- We will explore the implementation later

```
class TTTLetter(builtins.object)
 |  TTTLetter(win, col=-1, row=-1, letter='')
 |
 |  A TTT letter has several attributes that define it:
 |  *  _row, _col coordinates indicate its position in the grid (ints)
 |  *  _textObj denotes the Text object from the graphics module,
 |     which has attributes such as size, style, color, etc
 |     and supports methods such as getText(), setText() etc.
 |
 |  Methods defined here:
 |
 |  __init__(self, win, col=-1, row=-1, letter='')
 |      Initialize self.  See help(type(self)) for accurate signature.
 |
 |  __repr__(self)
 |      Return repr(self).
 |
 |  __str__(self)
 |      Return str(self).
 |
 |  getLetter(self)
 |      Returns letter (text of type str) associated with property textObj
 |
 |  setLetter(self, char)
```

TTTLetter

- To use TTTLetter, we just need to know its documentation (not how it is implemented)
- To use TTT letters we need to know that they have:
  - `(col, row)` position on game grid
  - a `letter` (string) which is what we care about
    - Going to be "X" or "O" in this game
  - methods for getting and setting `letter`

Initializing the TTT Board

- What attributes do we need?
  - Everything inherited from **`Board`** class
  - A grid: a list of lists of **`TTTLetters`**

Inherit from Board

Call parent's __init__ method

Populate grid with empty TTTLetters

```
class TTTBoard(Board):
    """TTT Board class implements the functionality of a
    Tic Tac Toe board. It inherits from the Board class and
    extends it by creating a grid of TTTLetters."""

    __slots__ = ['_grid']

    def __init__(self, win):
        super().__init__(win)

        # initialize a grid of TTTLetters (list of lists)
        self._grid = []
        for col in range(self._cols):
            grid_col = []
            # next part could be a list comprehension!
            for row in range(self._rows):
                # create new TTTLetter, specifying grid coord
                letter = TTTLetter(win, col, row)

                # add TTTLetter to column
                grid_col.append(letter)

            # add column to grid
            self._grid.append(grid_col)
```

Accessing Letters on the Board

- Right now our board is blank. To put some characters on the board, what do we need to do?
  - Change the **`TTTLetter`** object from "" (empty) to "X" or "O"
- Let's write a few getter methods to help us get **`TTTLetter`** objects from our grid

```
def getTTTLetterAtPosition(self, position):
    """Returns the TTTLetter at grid position (a tuple)"""
    (col, row) = position
    return self._grid[col][row]

def getTTTLetterAtPoint(self, point):
    """Returns the TTTLetter at point (a screen coord tuple)"""
    (col, row) = self.getPosition( (point.getX(), point.getY()) )
    return self._grid[col][row]
```

Works with grid locations (such as (1,0) or (1,2))

Works with screen coordinates from mouse clicks (such as (100, 200))

Setting Letters on the Board

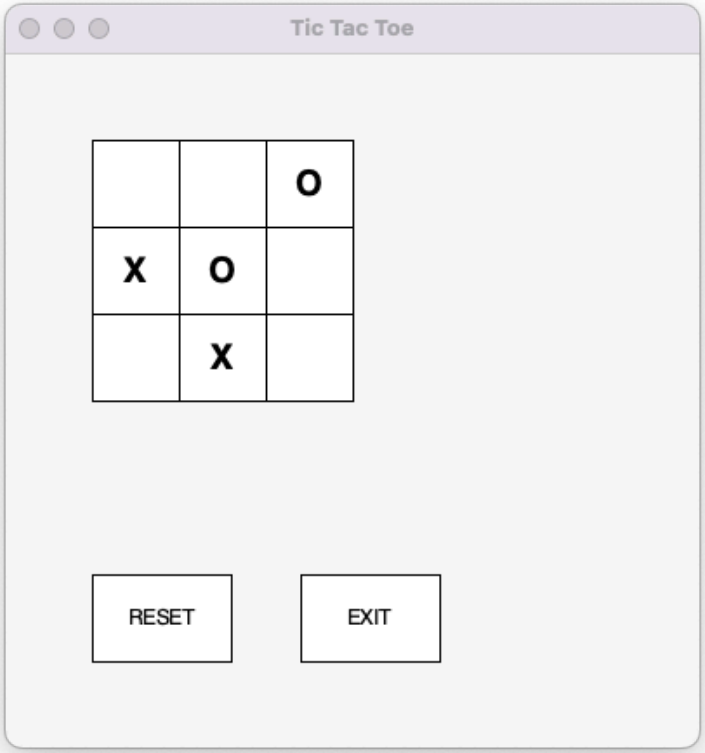
- Once we have a **`TTTLetter`** object, we can use the **`setLetter()`** method to change the character to an "X" or "O"

```
In [3]: tttboard.getTTTLetterAtPosition((1, 2)).setLetter("X")
        tttboard.getTTTLetterAtPosition((2, 0)).setLetter("O")
        tttboard.getTTTLetterAtPosition((0, 1)).setLetter("X")
        tttboard.getTTTLetterAtPosition((1, 1)).setLetter("O")
```

Draw Board with Letters

In [2]:
```
win = GraphWin("Tic Tac Toe", 400, 400)
tttboard = TTTBoard(win)
```

In [3]:
```
tttboard.getTTTLetterAtPosition((1, 2)).setLetter("X")
tttboard.getTTTLetterAtPosition((2, 0)).setLetter("O")
tttboard.getTTTLetterAtPosition((0, 1)).setLetter("X")
tttboard.getTTTLetterAtPosition((1, 1)).setLetter("O")
```



Resetting the TTTBoard

- As we are building the Board it would be helpful for us to have a way to reset the state of the board to be blank
- This, of course, is also helpful during play (if we hit the reset button or the game ends in Win/Draw and we want to restart)
- What do we need to change to reset the board?
  - Reset every **`TTTLetter`** to empty string

```
# reset all letter objects in grid
def reset(self):
    """Clears the TTT board by clearing letters."""
    for x in range(self._cols):
        for y in range(self._rows):
            # get letter out of grid and reset it
            let = self._grid[x][y]
            let.setLetter("")
```

Getting Closer

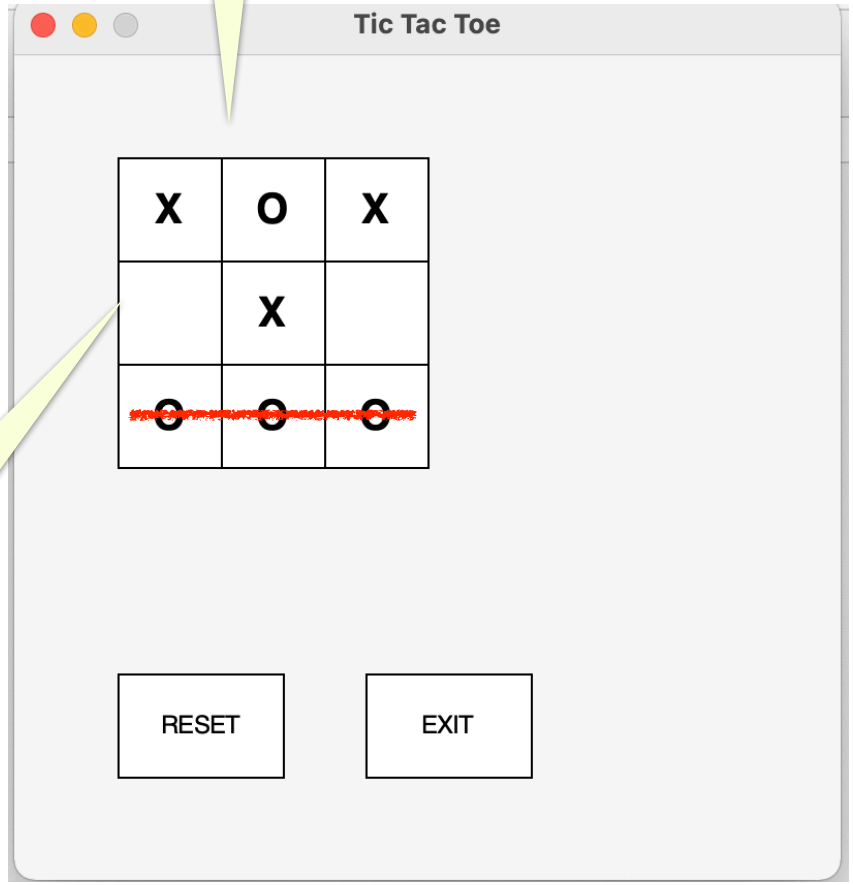
- What other helper methods do we need?
    - Checking for win of a player "X" or "O"
- A player ("X" or "O") wins if:
    - There exists a column filled with their letter, OR
    - There exists a row filled with their letter, OR
    - There exists a diagonal that is filled with their letter
- Let's break that down into separate private helper methods
    - _checkRows
    - _checkCols
    - _checkDiagonals

Checking the Rows

- For a given letter ("X" or "O"), we need to find if there is ANY row that is made of only `letter`
- How can we approach this?

```
def _checkRows(self, letter):
    pass
```

Grid positions are `(col, row)`



checkRows checks the board **horizontally**

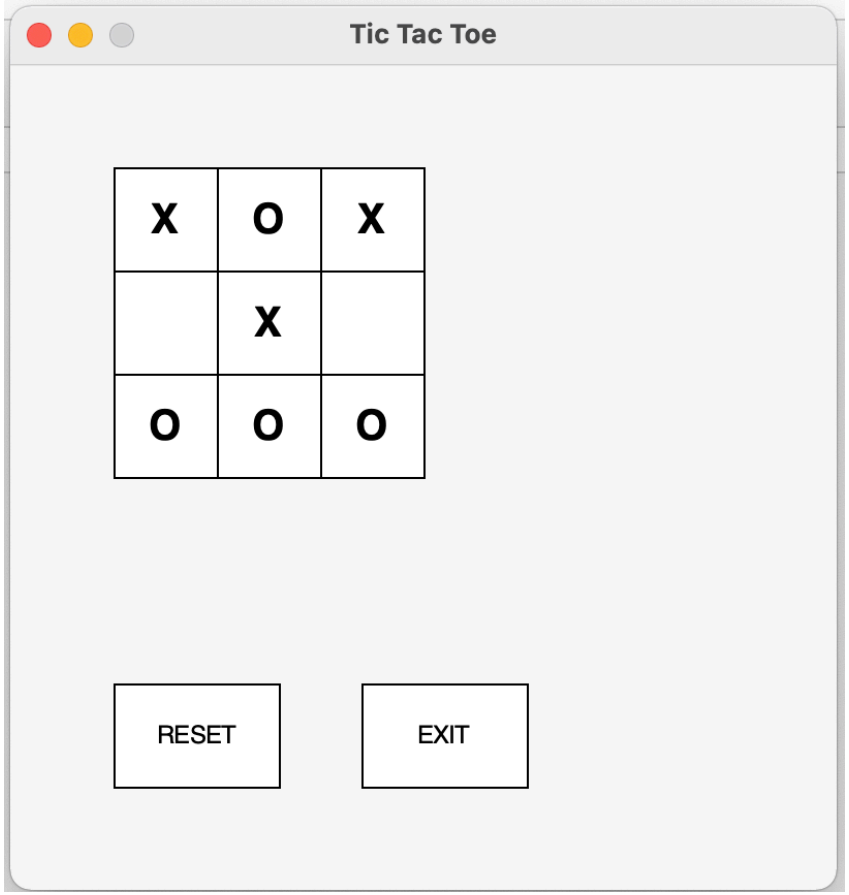
Checking the Rows

- For a given letter ("X" or "O"), we need to find if there is ANY row that is made of only `letter`
- Fix a row, go through each column

Why initialize `count` here?

```
# checking for win methods:
def _checkRows(self, letter):
    """Check rows for a win (3 in a row)."""
    for row in range(self._rows):
        count = 0
        for col in range(self._cols):
            tttLet = self._grid[col][row]

            pass

    # no winning row found
    return False
```

What next?



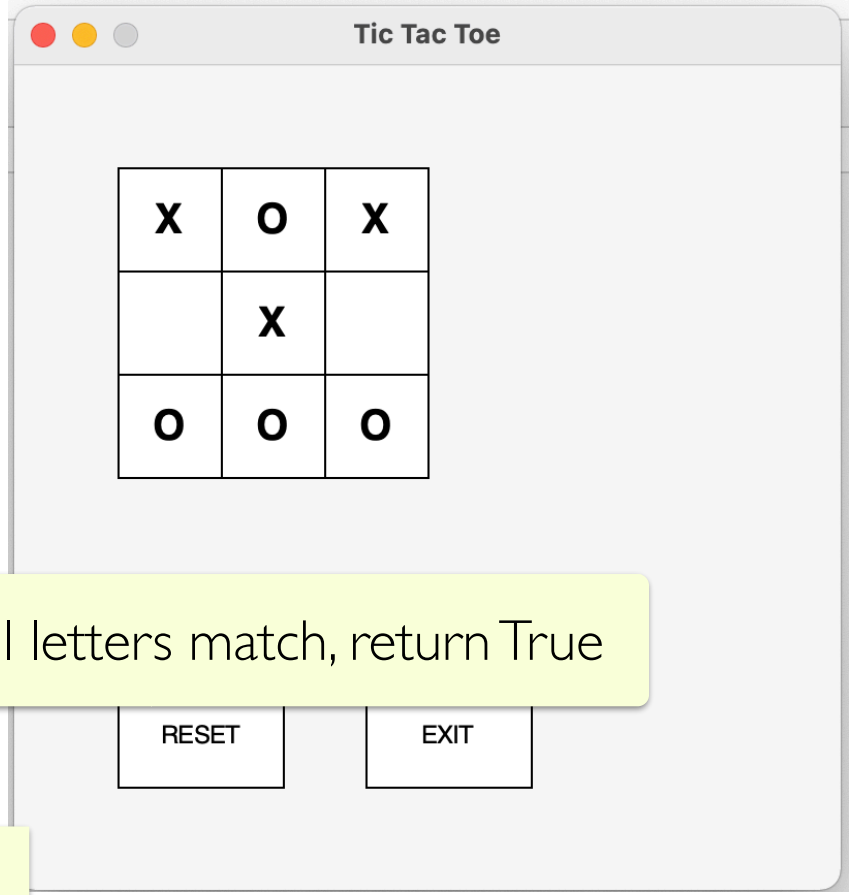
Checking the Rows

- For a given letter ("X" or "O"), we need to find if there is ANY row that is made of only **`letter`**
- Fix a row, go through each column

```
# checking for win methods:
def _checkRows(self, letter):
    """Check rows for a win (3 in a row)."""
    for row in range(self._rows):
        count = 0
        for col in range(self._cols):
            tttLet = self._grid[col][row]

            # check how many times letter appears
            if tttLet.getLetter() == letter:
                count +=1

        # if this is a winning row
        if count == self._rows:
            return True

    # no winning row found
    return False
```

If all letters match, return True

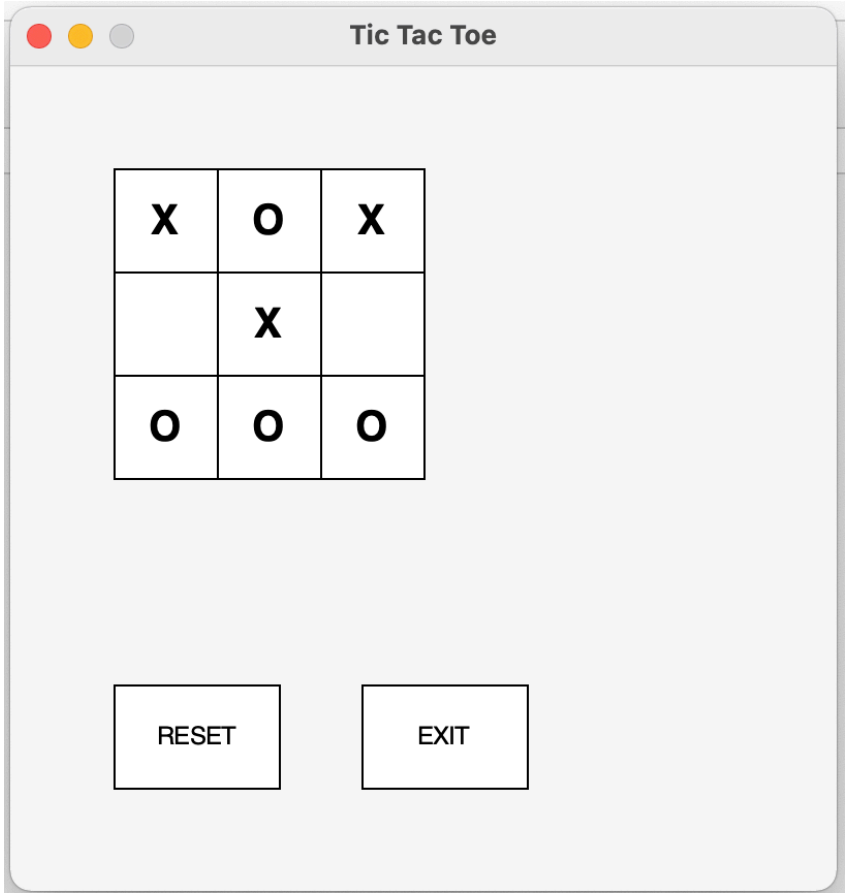
If no winning row, return False



Similarly Check Columns

- We can similarly check a column for a win

```
def _checkCols(self, letter):
    """Check columns for a win (3 in a row)."""
    for col in range(self._cols):
        count = 0
        for row in range(self._rows):
            tttLet = self._grid[col][row]

            # check how many times letter appears
            if tttLet.getLetter() == letter:
                count +=1

        # if this is a winning row
        if count == self._cols:
            return True

    # if no winning rows
    return False
```

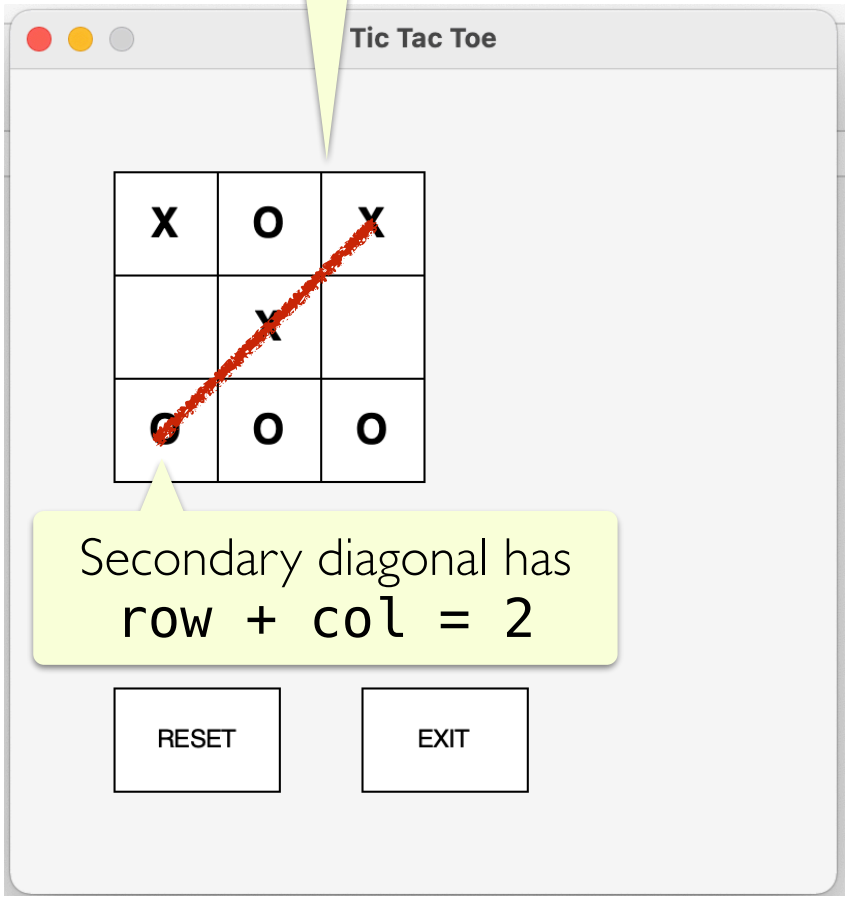


Check Diagonals

Primary diagonal has row/col same

```
def _checkDiagonals(self, letter
    """Check diagonals for a win  3 in a row)."""
    # counts for primary and sec dary diagonal
    countPrimary, countSecond =  0

    for col in range(self._cols):
        for row in range(self._r ws):
            tttLet = self._grid[c l][row]

            # update count for primary diagonal
            if (row == col and
                tttLet.getLetter() == letter):
                countPrimary += 1

            # update count for secondary diagonal
            if (row + col == self._rows - 1 and
                tttLet.getLetter() == letter):
                countSecond += 1

    # return true if either return in win
    return countPrimary == self.getRows() or
           countSecond == self.getRows()
```

Secondary diagonal:
(0, 2), (1,1), (2, 0) for a 3x3 board

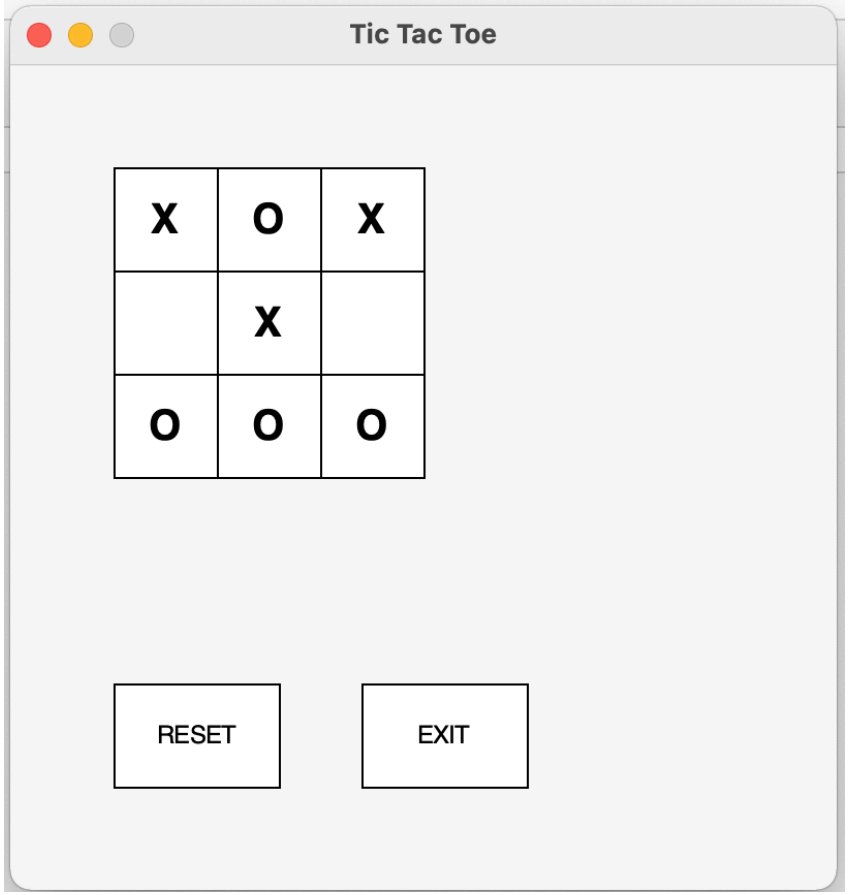


Secondary diagonal has
`row + col = 2`

Final Check for Win

- Putting it all together: the board is in a winning state if any of the three winning conditions are true
- We will make this method public as it will needed outside of this class

```
def checkForWin(self, letter):
    rowWin = self._checkRows(letter)
    colWin = self._checkCols(letter)
    diagWin = self._checkDiagonals(letter)

    return rowWin or colWin or diagWin
```



Leftovers: Next time

- We don't have a working Tic Tac Toe game yet
  - But we're getting close!
- What's left?
  - We have been using TTTLetter, so we'll look at it briefly
  - We need to implement the game logic
- What do we need to do to put this all together?
  - Keep track of mouse clicks
  - Keep track of players ("X" and "O" must alternate)
  - Use TTTLetter and TTTBoard to check for win