CS 134:
Tic Tac Toe

Announcements & Logistics

- **Lab 8 today/tomorrow** (due Wed/Thur)
  - When working with a partner, remember to take turns "driving"
  - Questions?
- **HW 7** due tonight at 11pm

Do You Have Any Questions?

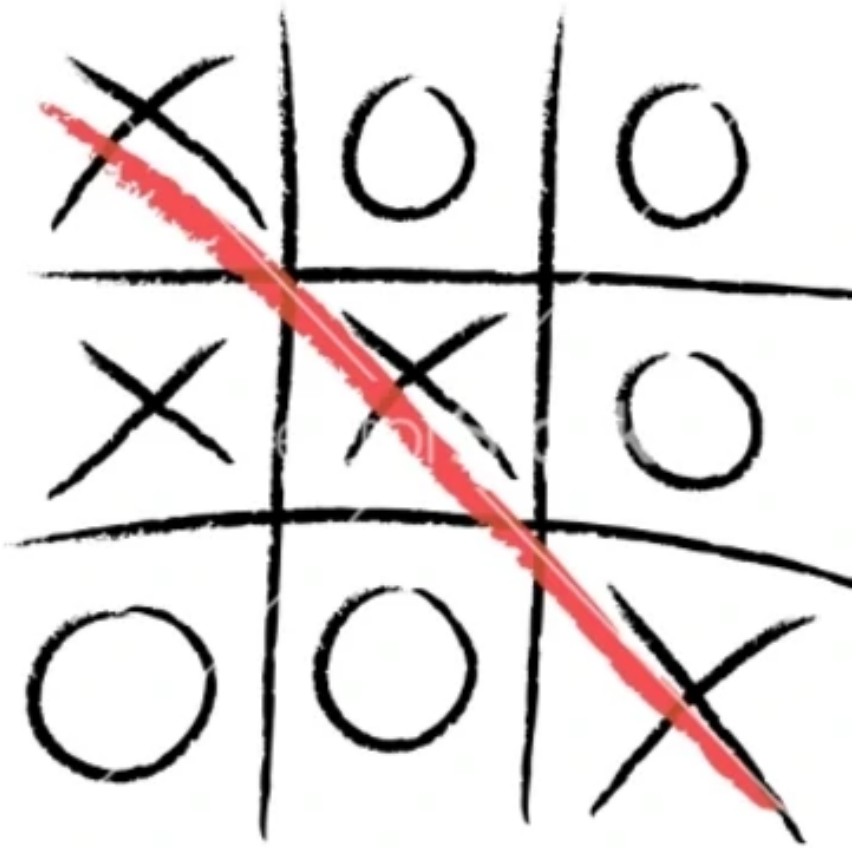
Last Time

- Learned a bit more about classes and special __ (double underscore) methods
    - `__str__` : print representation of objects
    - `__init__` : initialize objects
- Began talking about inheritance

Today's Plan

- Discuss inheritance and object oriented design for Tic Tac Toe
    - Think about how to **decompose** a game into multiple pieces
        - Board, TTTBoard, TTTLetters, and Game

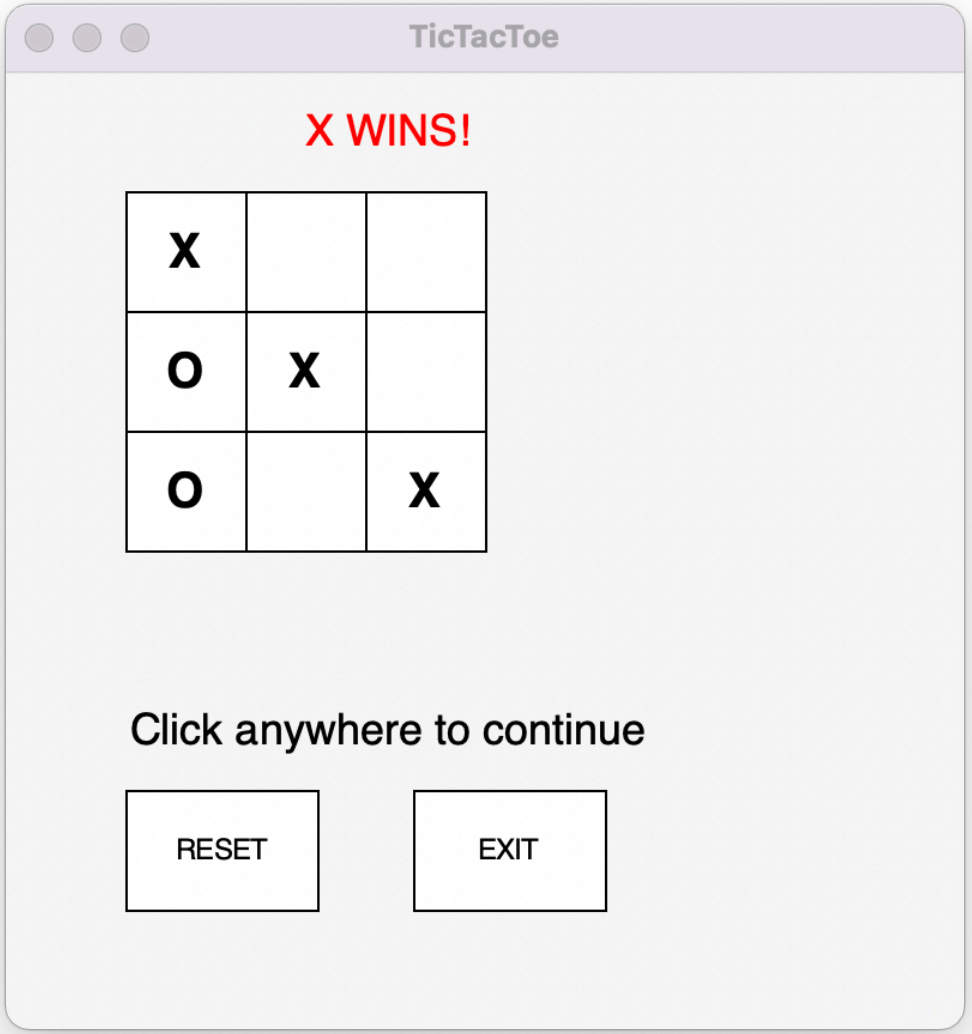
Tic Tac Toe



Implementing Tic Tac Toe

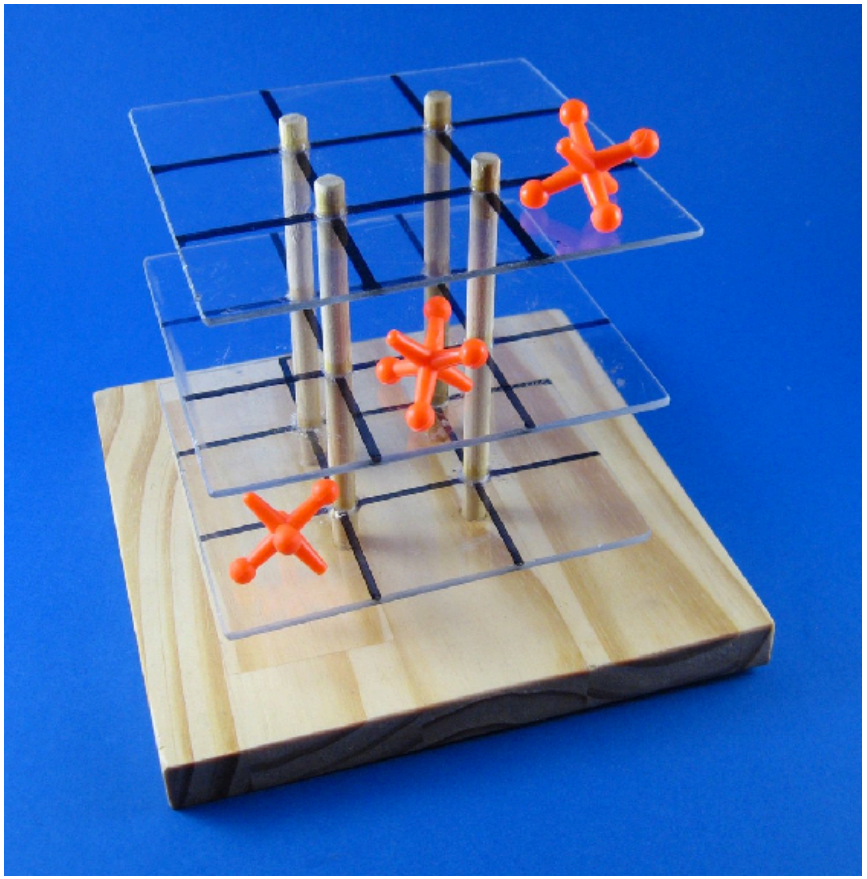
- Suppose we want to implement Tic Tac Toe
- Teaser demo…

```
>>> python3 game.py
```

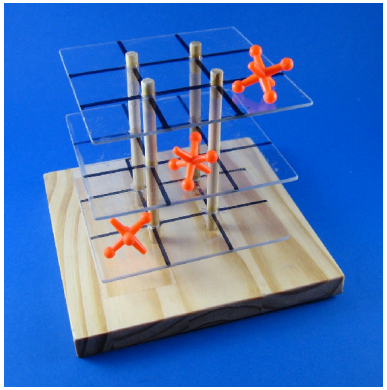


Decomposition

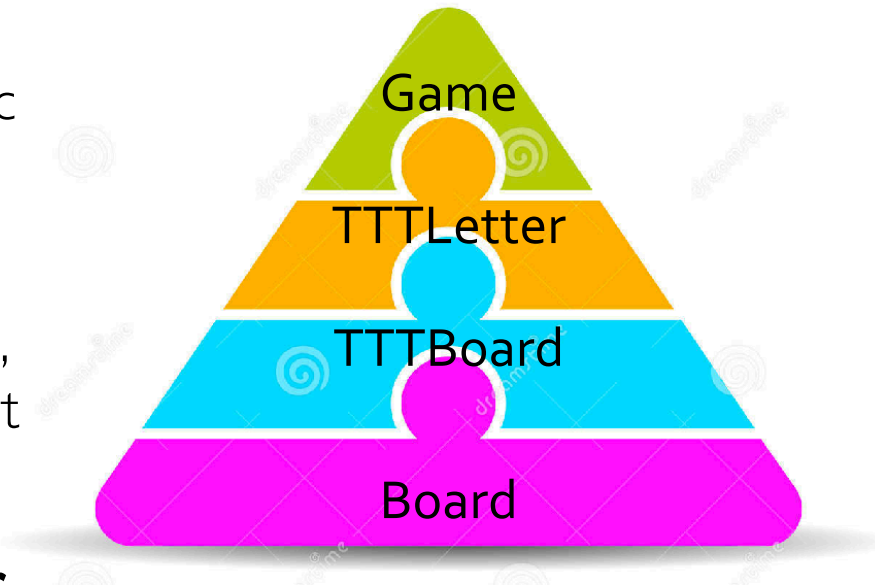
- Let's try to identify the "layers" of this game
- Through abstraction, each layer can ignore what's happening in the other layers
- What are the layers of Tic Tac Toe?



Decomposition

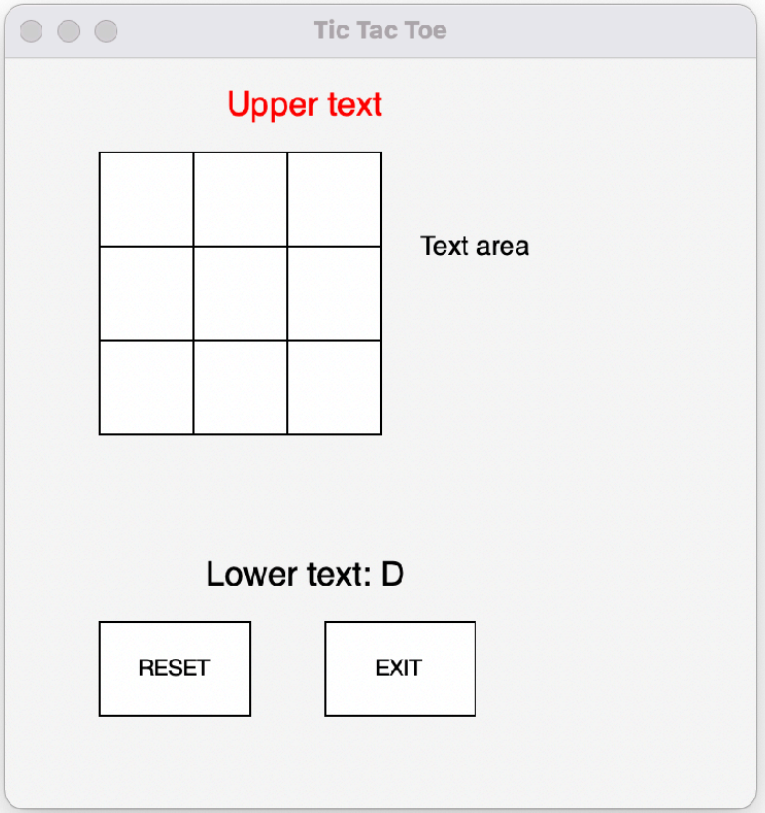


- Let's try to identify the "layers" of this game
- Through abstraction and encapsulation, each layer can ignore what's happening in the other layers
- What are the layers of Tic Tac Toe?
  - Bottom layer: **Basic board** w/buttons, text areas, mouse click detection (not specific to Tic Tac Toe!)
  - Lower middle layer: Extend the **basic board with Tic Tac Toe specific features** (3x3 grid, of TTTLetters, initial board state: all letters start blank)
  - Upper middle layer: **Tic Tac Toe "spaces" or "letters"** (9 in total!); set text to X or O
  - Top layer: **Game logic** (alternating turns, checking for valid moves, etc)



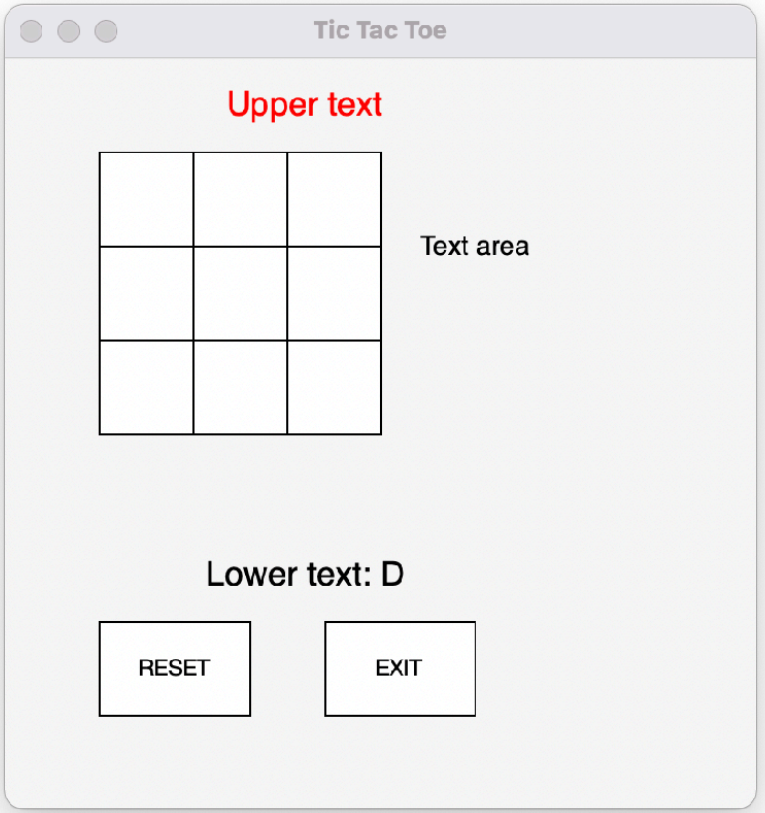
Board class

- Let's start at the bottom: Board class
- What are basic features of all game boards?
  - Think generally…many board-based games have the similar basic requirements
  - (For example, Boggle, TicTacToe, Scrabble, etc)



Board class

- Let's start at the bottom: Board class
- What are basic features of all game boards?
  - Text areas: above, below, right of grid
  - Grid of squares of set size: rows x cols
  - Reset and Exit buttons
  - React to mouse clicks (less obvious!)
- These are all **graphical** (GUI) components
  - Code for graphics is a little messy at times
  - Lot's of things to specify: color, size, location on screen, etc



Graphics Package for Board

```
In [1]: from graphics import *
```

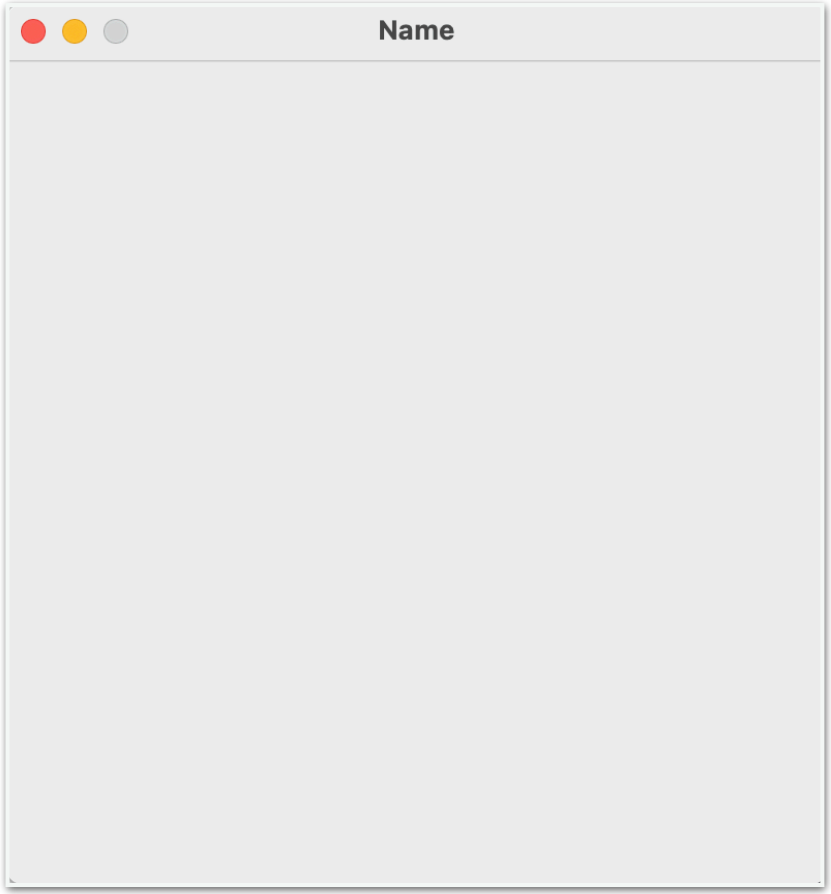
We are going to use a simple graphics package to implement our game board

```
In [2]: # takes title and size of window
win = GraphWin("Name", 400, 400)
```

Create a window with title "Name" and size 400x400 (measured in pixels)

400 pixels

400 pixels



A **pixel** is one of the small dots or squares that make up an image on a computer screen.

Graphics Package for Board

```
In [3]: # create point obj at x, y coordinate in window
        pt = Point(200, 200)
```

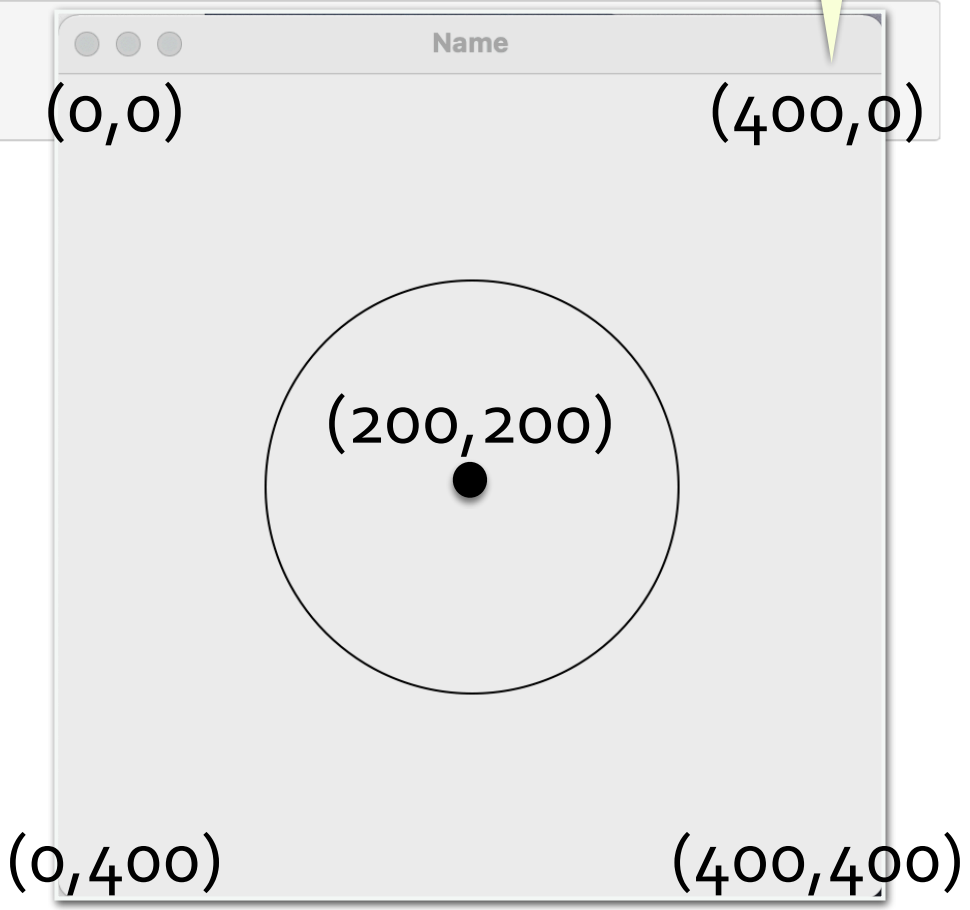
```
In [4]: # create circle with center at pt and radius 100
        c = Circle(Point(200,200), 100)
```

```
In [5]: # draw the circle on the window
        c.draw(win)
```

```
Out[5]: Circle(Point(200.0, 200.0), 100)
```

We can draw other shapes as well.

We'll want to draw Rectangles in our Board class.



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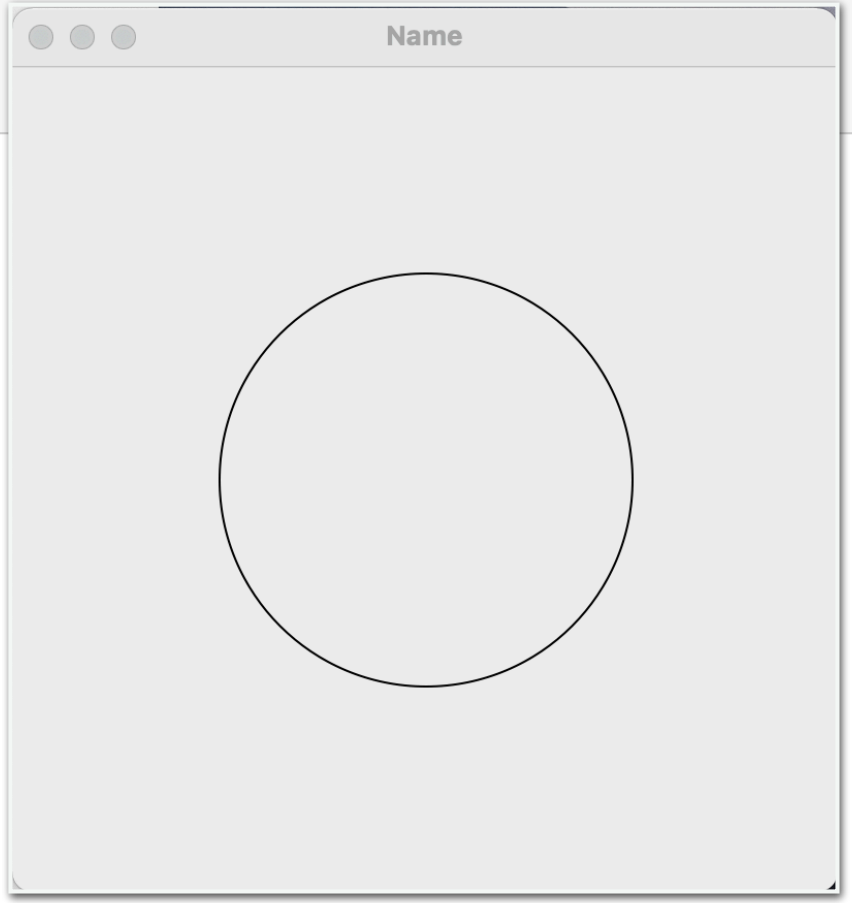


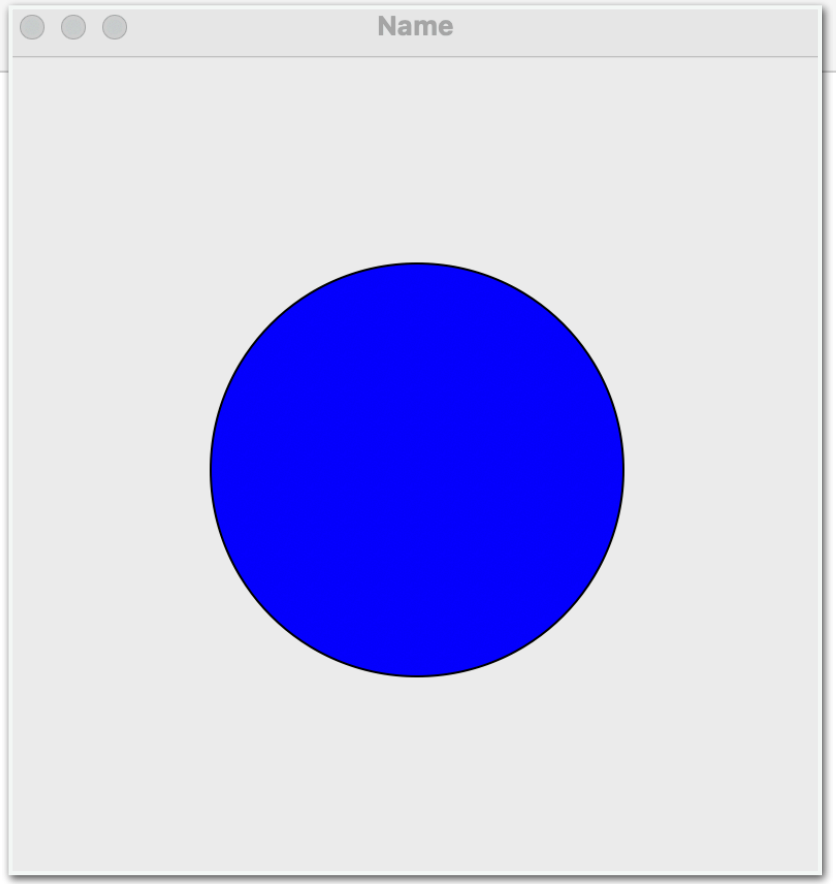
Graphics Package for Board

```
In [6]: # set color to blue
        c.setFill("blue")
```

```
In [7]: # Pause to view result
        win.getMouse()
        # Close window when done
        win.close()
```

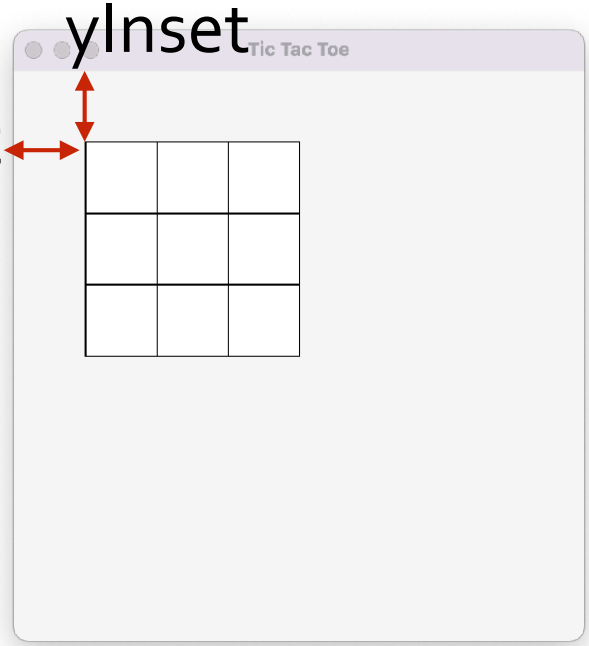
Detecting "***events***" like mouse clicks are an important part of a graphical program.

`win.getMouse()` is a ***blocking*** method call that "blocks" or ***waits*** until a click is detected.



Board class: Getting Started

- Attributes:



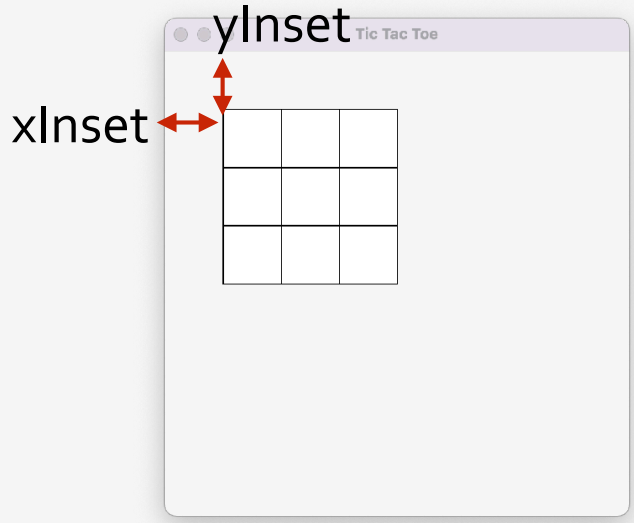

```
# _win: graphical window on which we will draw our board
# _xInset: avoids drawing in corner of window
# _yInset: avoids drawing in corner of window
# _rows: number of rows in grid of squares
# _cols: number of columns in grid of squares
# _size: edge size of each square
```

- (We will add a few more attributes later)
- We need to draw the **grid**, **text areas**, and **buttons**
- Might need some helper methods to organize our code
- Let's start by **drawing the grid** on our board

Board Class: __init__ and getters

```
from graphics import *

class Board:
    # _win: graphical window on which we will draw our board
    # _xInset: avoids drawing in corner of window
    # _yInset: avoids drawing in corner of window
    # _rows: number of rows in grid of squares
    # _cols: number of columns in grid of squares
    # _size: edge size of each square

    __slots__ = [ '_xInset', '_yInset', '_rows', '_cols', '_size', '_win', ]

    def __init__(self, win, xInset=50, yInset=50, rows=3, cols=3, size=50):
        # update class attributes
        self._xInset = xInset
        self._yInset = yInset
        self._rows = rows
        self._cols = cols
        self._size = size
        self._win = win

    # getter methods for attributes
    def getWin(self):
        return self._win

    def getXInset(self):
        return self._xInset

    def getYInset(self):
        return self._yInset

    def getRows(self):
        return self._rows

    def getCols(self):
        return self._cols

    def getSize(self):
        return self._size
```

Notice the default values

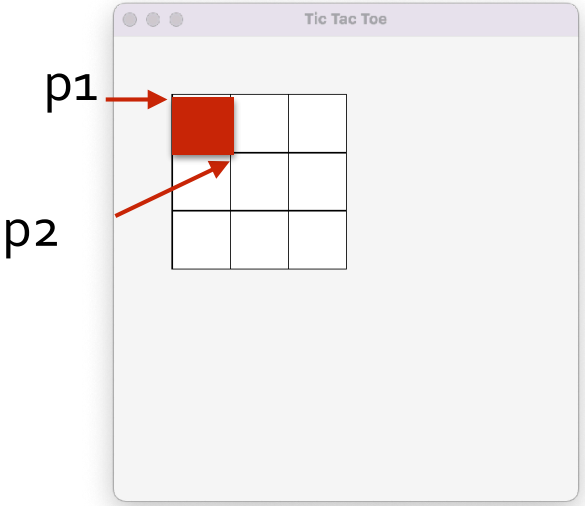


Board class: Drawing the grid

```
def __makeGrid(self):
    """Creates a row x col grid, filled with squares"""
    for x in range(self._cols):
        for y in range(self._rows):
            # create first point
            p1 = Point(self._xInset + self._size * x, self._yInset + self._size * y)
            # create second point
            p2 = Point(self._xInset + self._size * (x + 1), self._yInset + self._size * (y + 1))
            # create rectangle
            r = Rectangle(p1, p2)
            r.setFill("white")
            # add rectangle to graphical window
            r.draw(self._win)
```

We need a window (_win) on which to **draw**.

```
x=0, y=0:
  p1:
  xInset + (size * x) = xInset
  yInset + (size * y) = yInset
  p2:
  xInset + (size * (x+1)) = xInset + size
  yInset + (size * (y+1)) = yInset + size
```

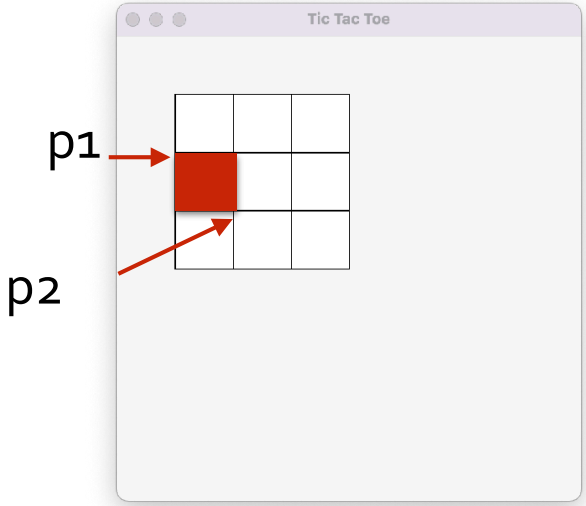


Board class: Drawing the grid

```
def __makeGrid(self):
    """Creates a row x col grid, filled with squares"""
    for x in range(self._cols):
        for y in range(self._rows):
            # create first point
            p1 = Point(self._xInset + self._size * x, self._yInset + self._size * y)
            # create second point
            p2 = Point(self._xInset + self._size * (x + 1), self._yInset + self._size * (y + 1))
            # create rectangle
            r = Rectangle(p1, p2)
            r.setFill("white")
            # add rectangle to graphical window
            r.draw(self._win)
```

We need a window (_win) on which to **draw**.

```
x=0, y=1:
  p1:
  xInset + (size * x) = xInset
  yInset + (size * y) = yInset + size
  p2:
  xInset + (size * (x+1)) = xInset + size
  yInset + (size * (y+1)) = yInset + 2 * size
```

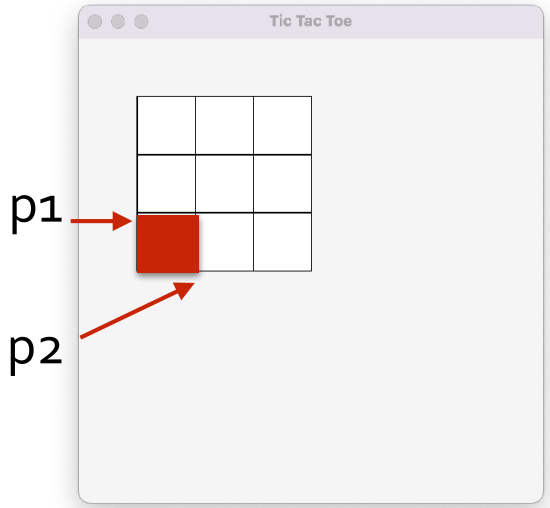


Board class: Drawing the grid

```
def __makeGrid(self):
    """Creates a row x col grid, filled with squares"""
    for x in range(self._cols):
        for y in range(self._rows):
            # create first point
            p1 = Point(self._xInset + self._size * x, self._yInset + self._size * y)
            # create second point
            p2 = Point(self._xInset + self._size * (x + 1), self._yInset + self._size * (y + 1))
            # create rectangle
            r = Rectangle(p1, p2)
            r.setFill("white")
            # add rectangle to graphical window
            r.draw(self._win)
```

We need a window (_win) on which to **draw**.

```
x=0, y=2:
  p1:
  xInset + (size * x) = xInset
  yInset + (size * y) = yInset + 2 * size
  p2:
  xInset + (size * (x+1)) = xInset + size
  yInset + (size * (y+1)) = yInset + 3 * size
```

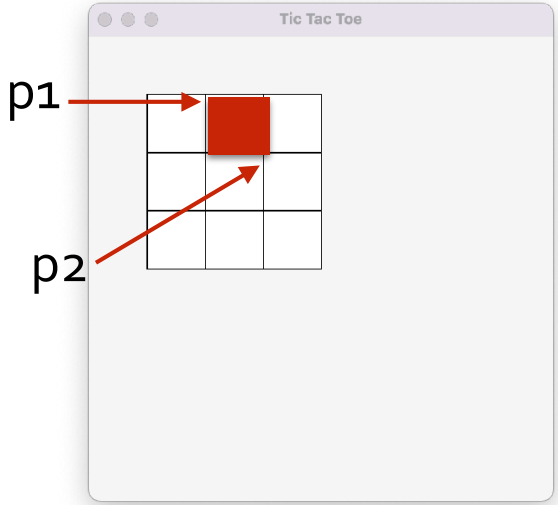


Board class: Drawing the grid

```
def __makeGrid(self):
    """Creates a row x col grid, filled with squares"""
    for x in range(self._cols):
        for y in range(self._rows):
            # create first point
            p1 = Point(self._xInset + self._size * x, self._yInset + self._size * y)
            # create second point
            p2 = Point(self._xInset + self._size * (x + 1), self._yInset + self._size * (y + 1))
            # create rectangle
            r = Rectangle(p1, p2)
            r.setFill("white")
            # add rectangle to graphical window
            r.draw(self._win)
```

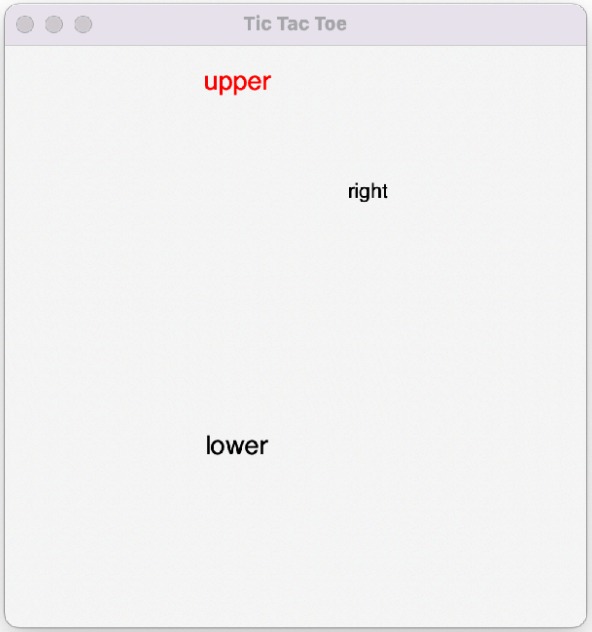
We need a window (_win) on which to **draw**.

```
x=1, y=0:
  p1:
  xInset + (size * x) = xInset + size
  yInset + (size * y) = yInset
  p2:
  xInset + (size * (x+1)) = xInset + 2 * size
  yInset + (size * (y+1)) = yInset + size
```



And so on…

Board class: Getting Started



- Attributes:

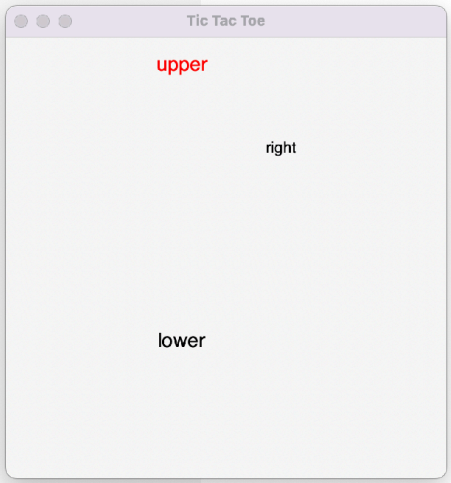
```
# _win: graphical window on which we will draw our board
# _xInset: avoids drawing in corner of window
# _yInset: avoids drawing in corner of window
# _rows: number of rows in grid of squares
# _cols: number of columns in grid of squares
# _size: edge size of each square
```

- (We will add a few more attributes later)
- We need to draw the **grid**, **text areas**, and **buttons**
- Might need some helper methods to organize our code
- Now let's **draw the text areas** (we need 3!)
  - Text areas are just called `Text` objects in our graphics package
  - We can customize the font size, color, style, and size and call "`setText`" to add text

Initializing and Drawing the Text Areas

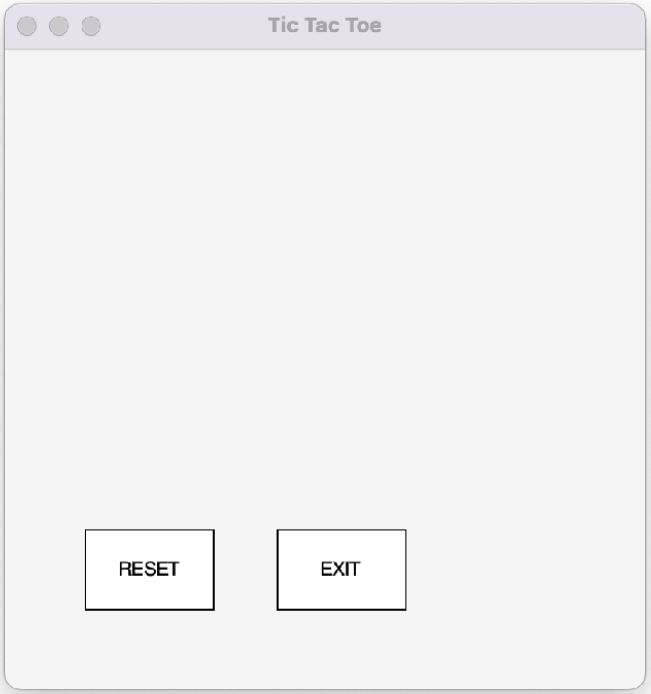
- We'll add attributes for the text areas:
  `_textArea, _lowerWord, _upperWord`

```
def __initTextAreas(self):
    # initialize text areas
    self._textArea = Text(Point(self._xInset * self._rows + self._size * 2,
                                self._yInset + 50), "")
    self._textArea.setSize(14)
    self._lowerWord = Text(Point(160, 275), "")
    self._lowerWord.setSize(18)
    self._upperWord = Text(Point(160, 25), "")
    self._upperWord.setSize(18)
    self._upperWord.setTextColor("red")

def __drawTextAreas(self):
    """Draw the text area to the right/lower/upper side of main grid"""

    #initialize before drawing
    self.__initTextAreas()

    # draw main text area (right of grid)
    self._textArea.draw(self._win)

    #draw the text area below grid
    self._lowerWord.draw(self._win)

    #draw the text area above grid
    self._upperWord.draw(self._win)
```



Board class: Getting Started

- Attributes:
  `_win`, `_rows`, `_cols`, `_size`, `_xInset`, `_yInset`, `_textArea`, `_upperWord`, `_lowerWord`
  - Also `_resetButton`, `_exitButton`
- We need to draw the **grid**, **text areas**, and **buttons**
- Might need some helper methods
- Finally, let's **draw the buttons**!
  - Buttons are just more rectangles…

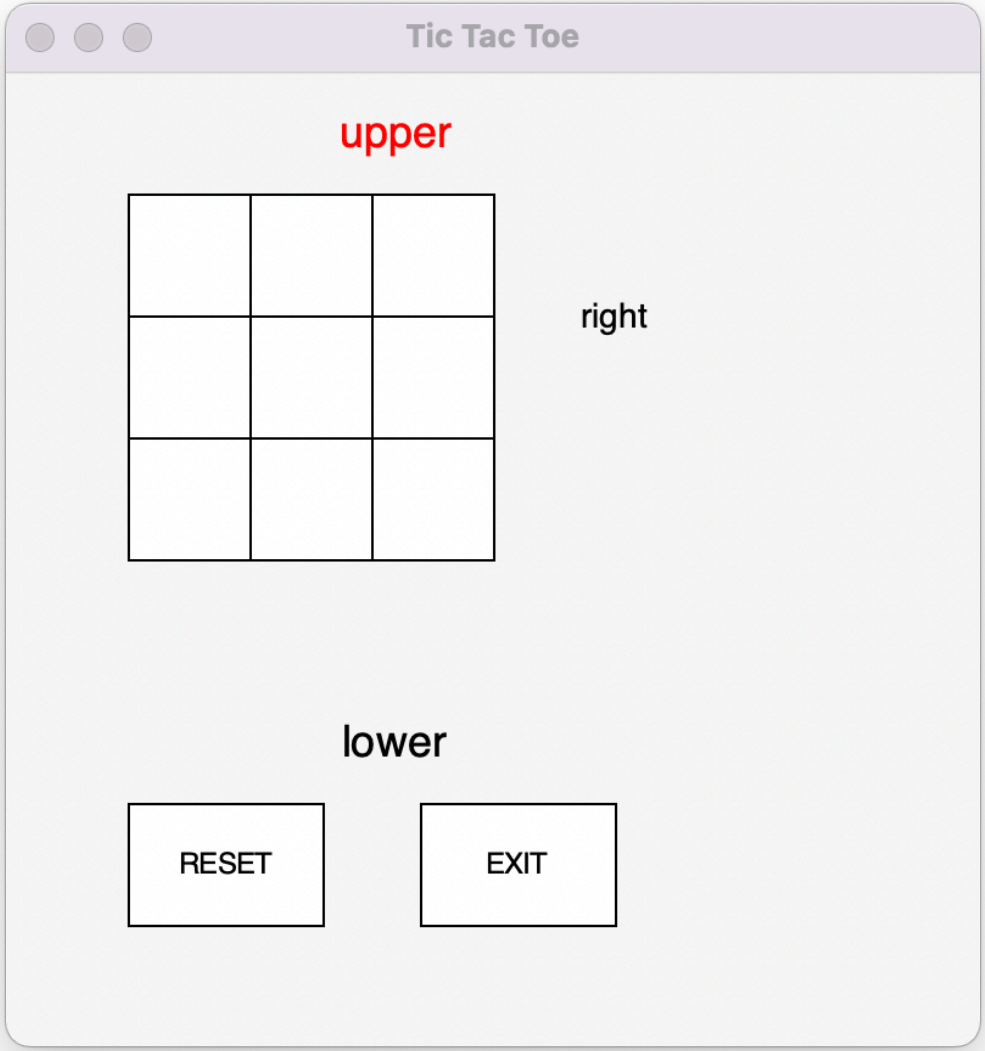


Initializing and Drawing the Buttons

```
def __makeResetButton(self):
    """Add a reset button to board"""
    self._resetButton = Rectangle(Point(50, 300), Point(130, 350))
    self._resetButton.setFill("white")
    self._resetButton.draw(self._win)
    Text(Point(90, 325), "RESET").draw(self._win)

def __makeExitButton(self):
    """Add exit button to board"""
    self._exitButton = Rectangle(Point(170, 300), Point(250, 350))
    self._exitButton.draw(self._win)
    self._exitButton.setFill("white")
    Text(Point(210, 325), "EXIT").draw(self._win)
```

```
def drawBoard(self):
    # this creates a row x col grid, filled with squares, including buttons
    self._win.setBackground("white smoke")
    self.__makeGrid()
    self.__makeResetButton()
    self.__makeExitButton()
    self.__drawTextAreas()
```

Putting it all together



Helper Methods

- 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
- Helpful methods?

Helper Methods

- 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
- 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

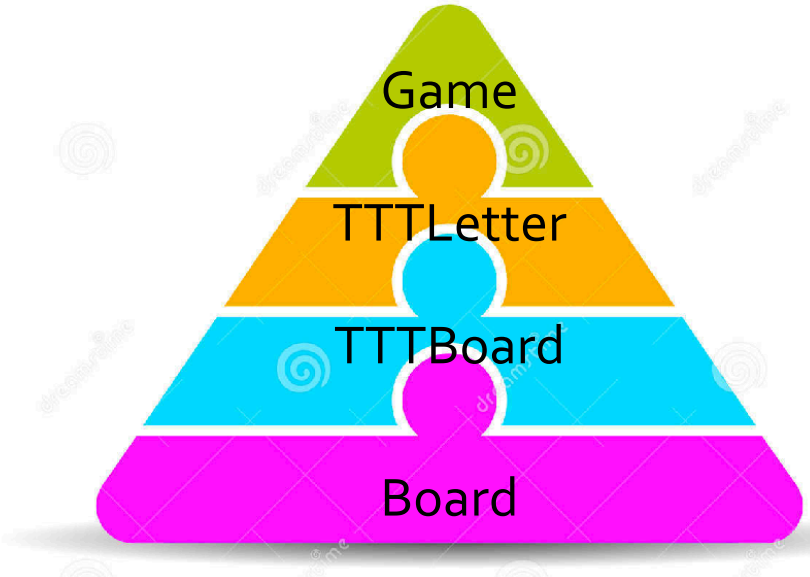
- `win.getMouse()` returns a `Point` object, which has an `x` and `y` coordinate (tuple) determined by the screen coordinate
- We can use helper methods (with simple calculations) to test which grid square or button the click occurred in
- This will be useful in our next step!
- (Run python3 board.py in Terminal)

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 properties (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 extras (attributes and/or methods) might be useful?



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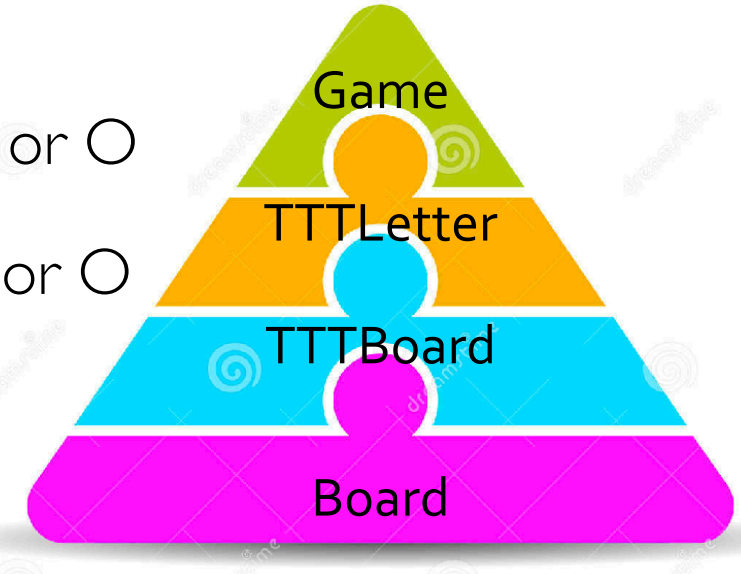
- We can do this by ***inheriting*** from the Board class
- We can take advantage of all of the methods and attributes defined in `Board` and add any (specific) extras we may need for TTT
- What extras (attributes and/or methods) might be useful?
  - Populate grid with `TTTLetters`
  - Check individual `TTTLetters` for X or O
  - Setting individual `TTTLetters` to X or O
  - Check for win (how?)



More next time!