In this lab, you will write a program that lets you play Tic-Tac-Toe against the computer. See https://en.wikipedia.org/wiki/Tic-tac-toe for details on the game. In this lab, you should try to write functions that are as concise as possible. In many cases, this means using loops even if a more tedious solution that doesn't use loops is possible.

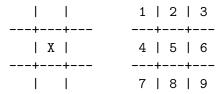
# Problem 1.

Your first task is to enable two users to play against each other. Download ttt.py, and understand the functions for creating an empty board and to print the board and the legend. Run ttt.py and observe how print\_board\_and\_legend(board) prints the list of lists board, which represents the board.

The goal is to be able to produce a game that goes, for example, as follows:



Enter your move: 5



Enter your move: 1

0	1   2   3
+	+
X	4   5   6
+	+
	7   8   9

Enter your move: 3

# Part (a)

Write a function that takes in an integer square\_num between 1 and 9, and returns a list coord such that board[coord[0]][coord[1]] = "X" would put an "X" in square square\_num (an integer from 1 to 9). Hint: the row number is ((square\_num - 1) // 3).

### Part (b)

Write a function put\_in\_board(board, mark, square\_num) that modifies the contents of board such that the string mark ("X" or "O") is put in the coordinates in board that correspond to square\_num.

### Part (c)

Write a loop that asks for the user to alternately enter coordinates for "X"s and "O"s such that two users can play against each other as shown in the example above. Reminder: there is an example of repeatedly asking the user for input here:

http://www.cs.toronto.edu/~guerzhoy/180/lectures/W04/lec2/WhileInput.html

### Problem 2.

The goal now is to write a simple function that would have the computer play against the user.

# Part (a)

Write a function with the signature get\_free\_squares(board) which creates and returns a new list which contains a list of the coordinates of the free squares in the board. For example, if the board is represented as follows

```
0 | X
---+--+--
| X |
---+--+--
```

, the function should return [[0, 1], [1, 0], [1, 2], [2, 1], [2, 2]].

## Part (b)

Now write a function make\_random\_move(board, mark) that finds a random free square in board, and puts the string mark in the free square. Hint: you can print a random number between 0 and n-1 as follows:

```
import random
print(n * random.random())
```

### Part (c)

Now use make\_random\_move() in order to have the computer play against the user.

## Problem 3.

Now, the goal is to automatically figure out if the game is over. The game is over if there is a line of 3 "X"s or a line of 3 "0"s.

### Part (a)

Write a function with the signature is\_row\_all\_marks(board, row\_i, mark) which returns True iff the row with index row\_i in board contains 3 marks equal to mark.

### Part (b)

Write a function with the signature is\_col\_all\_marks(board, col\_i, mark) which returns True iff the column with index row\_i in board contains 3 marks equal to mark.

### Part (c)

Using the functions above, and also checking the diagonals, write a function with the signature is\_win(board, mark) that returns True iff the mark mark won on the board board (i.e., there is a line of 3 marks somewhere in board).

### Part (d)

Incorporate is\_win() into the program such that the game stops when either the user or the computer win, and prints the result of the game.

# Problem 4.

Your job now is to improve the function that makes the computer's move.

### Part (a)

Write a function which tries to put the computer's mark in every free square on the board, and checks whether <code>is\_win()</code> returns <code>True</code> for the new board, returns if it does, and removes the mark and tries to place it in another square otherwise. If there is no square such that putting a mark in it leads to an immediate win, the function should put <code>mark</code> in a random free square.

#### Part (b)

Improve the algorithm that plays for the computer as much as you can.