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.

Bit first, three (mandatory) warm-up questions

Problem 1.

Consider the following list:

Write code that prints the element 99 from this list.

Problem 2.

Now, write a function get_nums(L)) that takes in a list in a format similar to L, and returns a list like [92, 98, 99, 95]. Hint: look are the code for the matrix-vector product from lecture, and understand how the result res was built up.

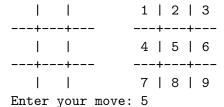
Problem 3.

Write a function lookup(L, num) that takes in a list like L and an argument like 99 and returns the corresponding value (like "103"). Return the first value if there are multiple matches. Return None if there are no matches.

Problem 4.

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:



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.

Here is a piece of code that counts how many times the user failed to input "hi" when repeatedly trying.

```
count = 0
input_str = ""
while input_str != "hi":
  input_str = input("Please say hi: ")
  count += 1

print(f"The user did not say hi {count} times")
```

Problem 5.

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(int(n * random.random()))
```

Part (c)

Now use make_random_move() in order to have the computer play against the user.

Problem 6.

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 "O"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 7.

Your job now is to improve the 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.