

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:

```

  |  |      1 | 2 | 3
---+---+---
  |  |      4 | 5 | 6
---+---+---
  |  |      7 | 8 | 9
Enter your move: 5

```

```

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

```

, 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 "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 `col_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 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 `is_win()` returns `True` 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 `mark` in a random free square.

Part (b)

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