Tictactoe Game

Making Game with Python (1)

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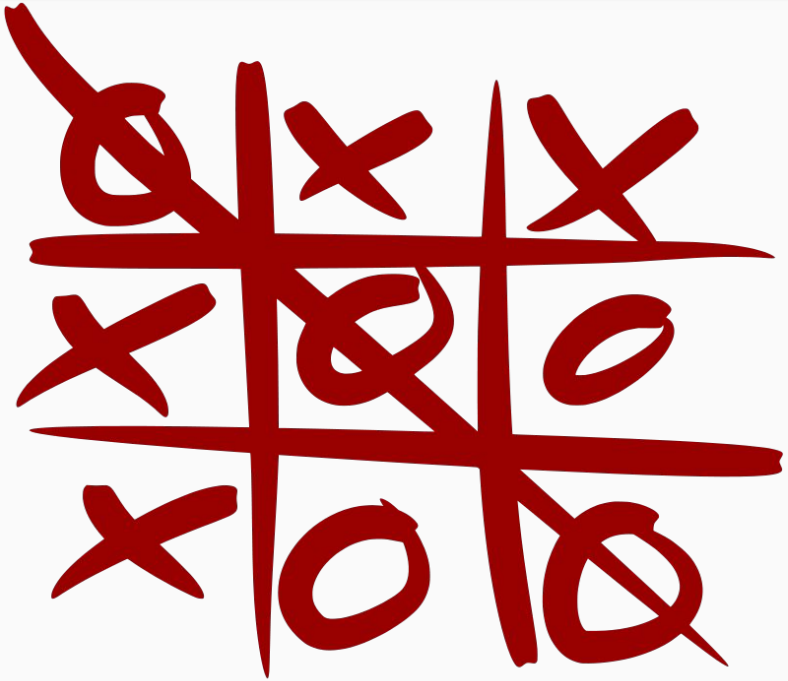
Agenda

- Introduction
- Numpy (multi-dimensional arrays)
- Flowchart
- function definition and test
  - create_board, input_player_selection, who_go_first, make_move
  - game_won, column_won, row_won, diag_won
  - Get_available_move, get_player_move, get_random_move
- Main function

Introduction



Numpy

- NumPy is a Python library, adding support for large, multi-dimensional arrays, along with a large collection of high-level mathematical functions
- Installation:
  - Find the python executable path:
    - import sys
    - print(sys.executable)
  - Pip install
    - Go to the path
    - python -m pip install numpy
  - Test
    - Import numpy

Numpy (cont): create 2D arrays

- Import numpy as np
- a = np.full((height, width), value)
- Size of array: a.shape (height, width)
- Exercise:
  - Import numpy as np
  - a = np.full((3,3), ‘ ‘)
  - print(a)
  - print(a.shape)
  - c = np.arange(6)
  - print(c, c.shape)
  - d = c.reshape((2,3))
  - print(d, d.shape)

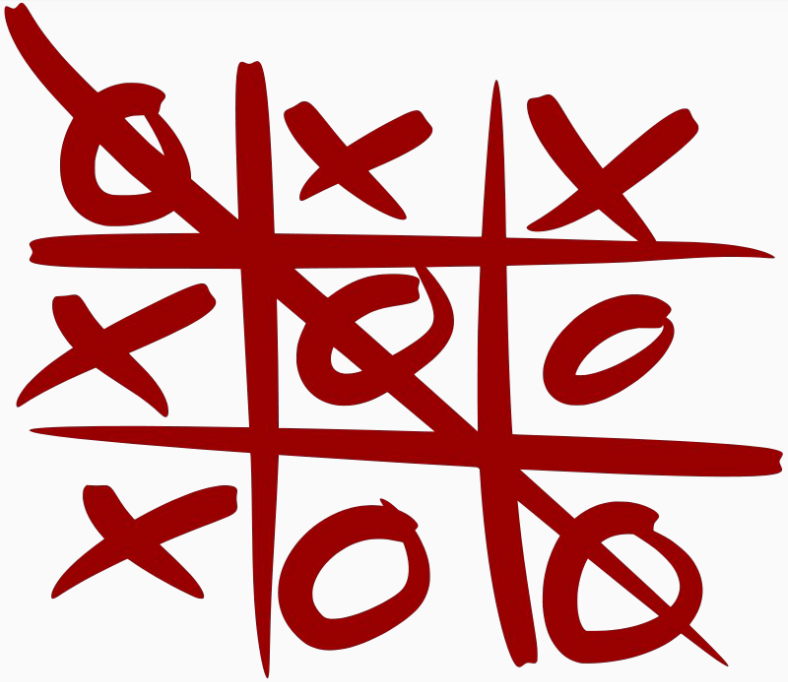
```
A= array([[ 0,  1,  2],
       [ 3,  4,  5],
       [ 6,  7,  8],
       [ 9, 10, 11]])

print(A)

A.shape
# (4,3):  height=4, width=3

print(A[2,1])
# 7
```

Numpy (cont): access

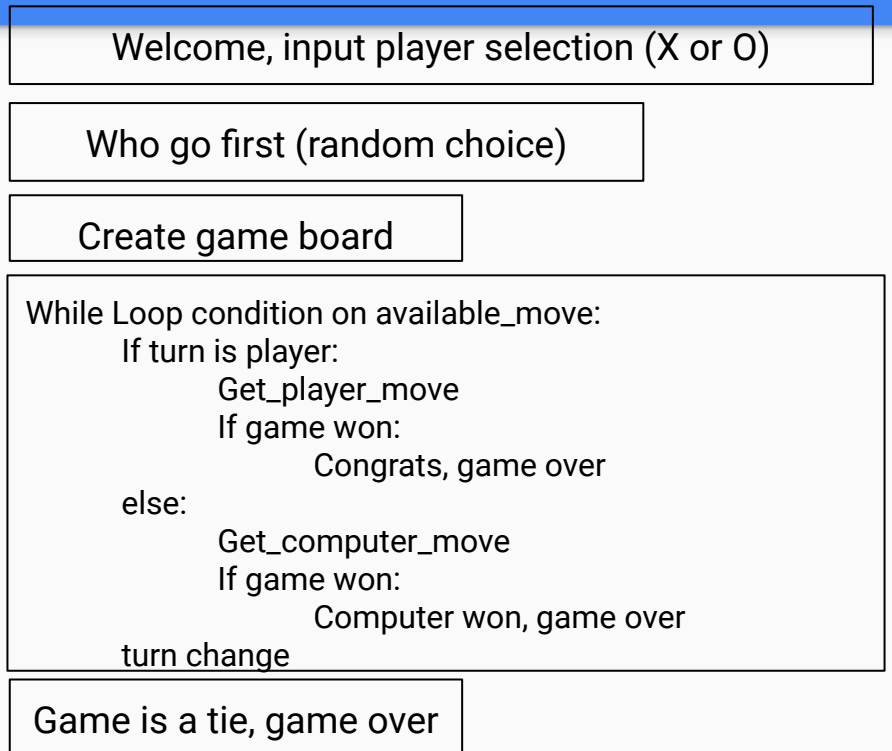
- array[y_index, x_index]
- Exercise:
  - a = np.arange(6).reshape((2,3))
  - print(a)
  - print(a[0,1])
  - a[0,1] = 9
  - print(a)
- For loop:
- Exercise:

```
for row in a:
        print(row)
        for x in row:
                print(x)
```

Tictactoe (pause to draw the flowchart)



Flowchart


Welcome, input player selection (X or O)
Who go first (random choice)
Create game board
While Loop condition on available_move:
If turn is player:
Get_player_move
If game won:
Congrats, game over
else:
Get_computer_move
If game won:
Computer won, game over
turn change
Game is a tie, game over

Debug: function definition and test

Tictactoc.py: Function definition

```
def game_won():
        …..
```

tictactoe_test.py

```
from tictactoe import *
print(game_won())
assert create_board==True, 'Fail'
```

If tictactoe_test.py fails, go to check code

import module

- Module must be at current directory or system path
- import module
  - import random
  - random.randint(1,5)
- from module import function
  - from random import randint
  - randint(1, 5)
- from module import *
  - from random import *
  - randint(1, 5)

Assertion

- Assertion: boolean expression to check if the condition is true.
  - The expression is True: do nothing
  - The expression is False: the program stop and throw an error
- Syntax:
  - assert <condition>, <error message>
  - Exercise:
    - a = 1
    - assert a==1, ‘First check: Wrong’
    - assert a==2, ‘Second check: Wrong’

Create game board

```
def create_board(size, value=' '):
    board = np.full((size,size), value)
    return board
```

```
print('\n-----Test create_board\n')
print(create_board(3, ‘  ‘))
print(create_board(2, 5))
print(create_board(4))
```

input_player_selection

```
def input_player_selection():
    letter = ''
    while letter not in ['X', 'O']:
        letter = input('Do you want to be X or O?')
        letter = letter.upper()
    if letter == 'X':
        return ['X', 'O']
    else:
        return ['O', 'X']
```

```
print('\n-----test input_player_letter\n')
print(input_player_selection())
```

Who go first

```
def who_go_first():
    ans = random.randint(0,1)
    if ans:
        return 'computer'
    else:
        return 'player'
```

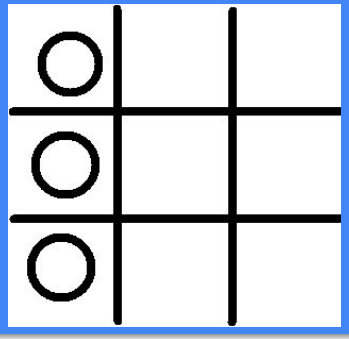
```
print('\n-----test who_go_first\n')
print(who_go_first())
print(who_go_first())
print(who_go_first())
```

Make move

```
def make_move(board, letter, position):
    board[position[0], position[1]] = letter
```

```
print('\n-----test make_move\n')
board = create_board(3)
make_move(board, 'X', (0, 0))
print(board)
make_move(board, 'O', (2, 2))
print(board)
```

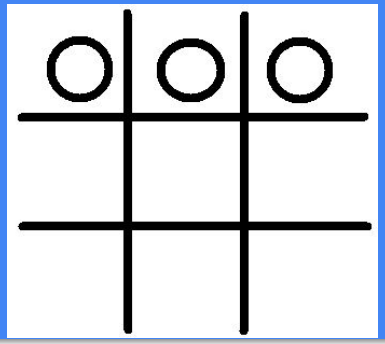
Check column won



```
def column_won(board, letter):
    height, width = board.shape
    for x in range(width):
        won = True
        for y in range(height):
            if board[y, x] != letter:
                won = False
                break
        if won:
            return True
    return False
```

```
print('\n-----test column_won\n')
board = create_board(3)
print(board)
ans = column_won(board, 'X')
assert not ans, 'Fail'
board[0, 0] = 'X'
board[1, 0] = 'X'
board[2, 0] = 'X'
print(board)
ans = column_won(board, 'X')
assert ans, 'Fail'
```

Check row won



```
def row_won(board, letter):
    height, width = board.shape
    for y in range(height):
        won = True
        for x in range(width):
            if board[y, x] != letter:
                won = False
                break
        if won:
            return True
    return False
```

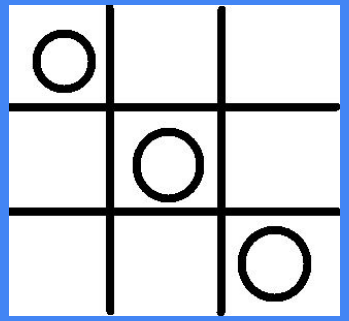
```
print('\n-----test row_won\n')
board = create_board(3)
print(board)
ans = row_won(board, 'X')
assert not ans, 'Fail'
board[1, 0] = 'X'
board[1, 1] = 'X'
board[1, 2] = 'X'
print(board)
ans = row_won(board, 'X')
assert ans, 'Fail'
```

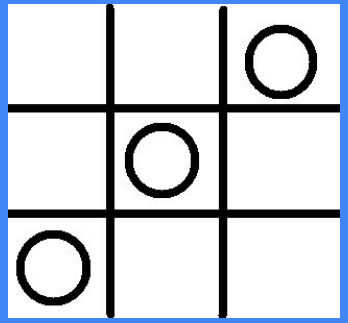
Combination of column and row check

```
def column_row_won(board, letter, flag):
    height, width = board.shape
    if flag == 'column':
        list1, list2 = range(width), range(height)
    else:
        list1, list2 = range(height), range(width)
    for i in list1:
        won = True
        for j in list2:
            if flag == 'column':
                v = board[j, i]
            else:
                v = board[i, j]

            if v != letter:
                won = False
                break
        if won:
            return True
    return False
```

```
ans = column_row_won(board, 'X', 'column')
assert ans, 'Fail'

ans = column_row_won(board, 'X', 'row')
assert ans, 'Fail'
```

Check diagonal won





```
def diag_won(board, letter):
    height, width = board.shape
    won = True
    for y in range(height):
        if board[y, y] != letter:
            won = False
            break
    if won:
        return True

    won = True
    for y in range(height):
        if board[y, height-1-y] != letter:
            won = False
            break

    return won
```

```
print('\n-----test diag_won\n')
board = create_board(3)
print(board)
ans = diag_won(board, 'X')
assert not ans, 'Fail'
board[0, 0] = 'X'
board[1, 1] = 'X'
board[2, 2] = 'X'
print(board)
ans = diag_won(board, 'X')
assert ans, 'Fail'
board = create_board(3)
board[0, 2] = 'X'
board[1, 1] = 'X'
board[2, 0] = 'X'
print(board)
ans = diag_won(board, 'X')
assert ans, 'Fail'
```

Check game won

```
def game_won(board, letter):
    return column_won(board, letter) \
           or row_won(board, letter) \
           or diag_won(board, letter)
```

```
print('\n------test game_won\n')
board = create_board(3)
ans = game_won(board, 'X')
assert not ans, 'Fail'
board[0, 2] = 'X'
board[1, 2] = 'X'
board[2, 2] = 'X'
ans = game_won(board, 'X')
assert ans, 'Fail'
print('\n==== Success====\n')
```

Get available move

```
def get_available_move(board):
    height, width = board.shape
    move = []
    for y in range(height):
        for x in range(width):
            if board[y, x] == ' ':
                move.append([y, x])
    return move
```

```
print('\n-----test get_available_move\n')
board = create_board(3)
board[0, 0] = 'X'
board[1, 1] = 'O'
board[2, 2] = 'O'
ans = get_available_move(board)
print(board)
print('available_move: {}'.format(ans))
```

Get player move

```
def get_player_move(board, letter):
    height, width = board.shape
    available_move = get_available_move(board)
    move = (-1, -1)
    while move not in available_move:
        ans = input('What is your next move? ‘)
        move = ans.split(',')
        move = list(map(int, move))
    make_move(board, letter, move)
```

```
print('\n-----test get_player_move\n')
board = create_board(3)
print(board)
get_player_move(board, 'X')
print(board)


A = ‘1,2’
A = A.split(‘,’)        # [‘1’, ‘2’]
A = map(int, A)
A = list(A)             # [1, 2]
```

Get random move

```
def get_random_move(board, letter):
    print('computer move')
    available_move = get_available_move(board)
    move = random.choice(available_move)
    make_move(board, letter, move)
```

```
print('\n--------test get_random_move\n')
board = create_board(3)
get_random_move(board, 'O')
print(board)
board = create_board(3)
get_random_move(board, 'O')
print(board)
```

Main function

```
def tictactoe():
    print('Welcom to Tic-Tac-Toe!')
    player, computer = input_player_selection()
    print('You are {}, and computer is {}'.format(player, computer))
    first = who_go_first()
    print('{} go first'.format(first))
    board = create_board(3)
    turn = first
```

Main function (cont)

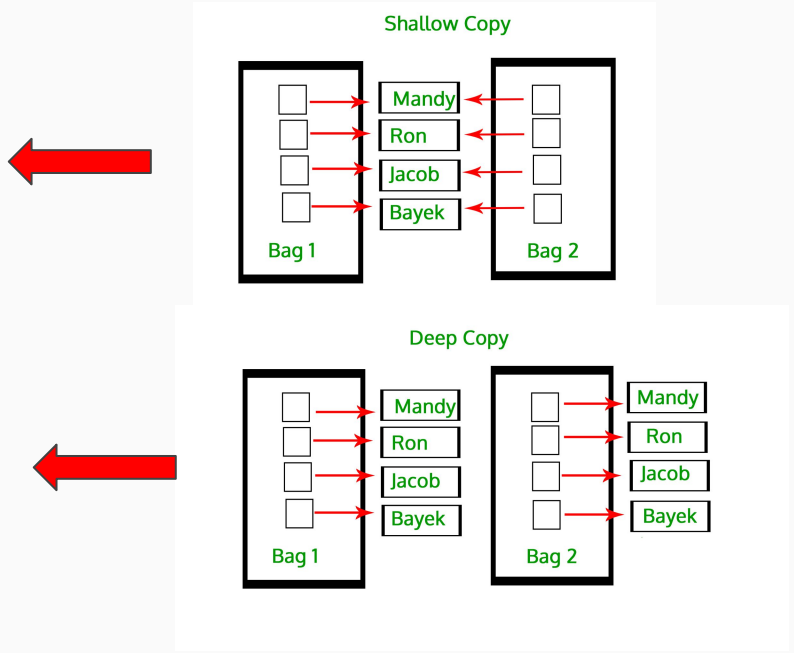
```
while get_available_move(board):
    if turn == 'player':
        get_player_move(board, player)
        print(board)
        turn = 'computer'
        if game_won(board, player):
            print('Congratulations. You won the game')
            return
    else:
        get_random_move(board, computer)
        print(board)
        turn = 'player'
        if game_won(board, computer):
            print('The computer won the game')
            return
print('The game is a tie')
```

program entry

```
if __name__ == '__main__':
    tictactoe()
```

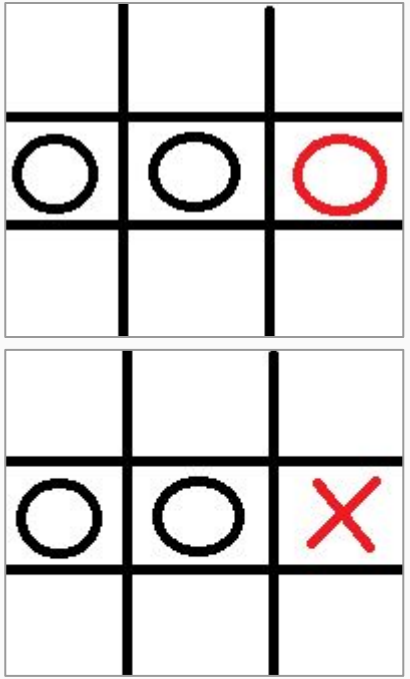
Shallow copy and deep copy

```
import numpy as np
A = np.full((3,3), ' ')
B = A
B[0,0] = 'X'
print(B)
print(A)

import copy

A = np.full((3,3), ' ')
B = copy.deepcopy(A)
B[0,0] = 'X'
print(B)
print(A)
```



Get smart move

```
def get_win_defense_move(board, letter, available_move, win_defense_flag):
    if win_defense_flag: # win check
        target = letter
    else:               # defense check
        if letter == 'O':
            target = 'X'
        else:
            target = 'O'
    for move in available_move:
        board_clone = copy.deepcopy(board)
        make_move(board_clone, target, move)
        if game_won(board_clone, target):
            make_move(board, letter, move)
            return True
    return False
```



Get smart move

```
def get_smart_move(board, letter):
    available_move = get_available_move(board)
    win_move = get_win_defense_move(board, letter, available_move, True)
    if win_move:
        return True
    return get_win_defense_move(board, letter, available_move, False)
```

```
print('\n--------test get_smart_move\n')
board = create_board(3)
board[1, 0:2] = ['X', 'X']
print(board)
get_smart_move(board, 'X')
print(board)
assert game_won(board, 'X'), 'Fail'
board = create_board(3)
board[1, 0:2] = ['O', 'O']
print(board)
get_smart_move(board, 'X')
print(board)
assert not game_won(board, 'X'), 'Fail'
print('\n==== Success====\n')
```

Main function

```
def tictactoe():
    print('Welcom to Tic-Tac-Toe!')
    player, computer = input_player_selection()
    print('You are {}, and computer is {}'.format(player, computer))
    first = who_go_first()
    print('{} go first'.format(first))
    board = create_board(3)
    turn = first
```

Main function (cont)

```
while get_available_move(board):
    if turn == 'player':
        get_player_move(board, player)
        print(board)
        turn = 'computer'
        if game_won(board, player):
            print('Congratulations. You won the game')
            return
    else:
        if not get_smart_move(board, computer):
                get_random_move(board, computer)
        print(board)
        turn = 'player'
        if game_won(board, computer):
            print('The computer won the game')
            return
print('The game is a tie')
```