Homework 2 (Intro to DS)

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Probability

- I have 2 kids. Given that one of them is a boy. What is the probability that both are boys? (10 points)

  Ans:

  $P(A)$ = one of two kids is a boy = $\frac{1}{2}$
  $P(B)$ = the other kid is a boy = $\frac{1}{2}$
  $P(A \cup B)$ = at least one kid is a boy = $\frac{3}{4}$
  $P(A \cap B)$ = two kids are boys = $P(A)*P(B) = \frac{1}{4}$

  $$P(A \cap B \mid A \cup B) = P(A \cup B \mid A \cap B) * P(A \cap B) / P(A \cup B)$$
  $$= 1 * \tfrac{1}{4} / \tfrac{3}{4}$$
  $$= \tfrac{1}{3}$$

  The probability is **$\frac{1}{3}$**.

- A fair six-sided die is rolled twice. What is the probability of getting 2 on the first roll and not getting 4 on the second roll? (10 points)

  Ans:

  $P(A)$ = not getting 4 on the second roll = $\frac{5}{6}$
  $P(B)$ = getting 2 on the first roll = $\frac{1}{6}$
  $P(A|B) = P(A \cap B) / P(B) = \frac{5}{6} * \frac{1}{6} / \frac{1}{6} = \frac{5}{6}$

  The probability is $\frac{5}{6}$.

Python programming

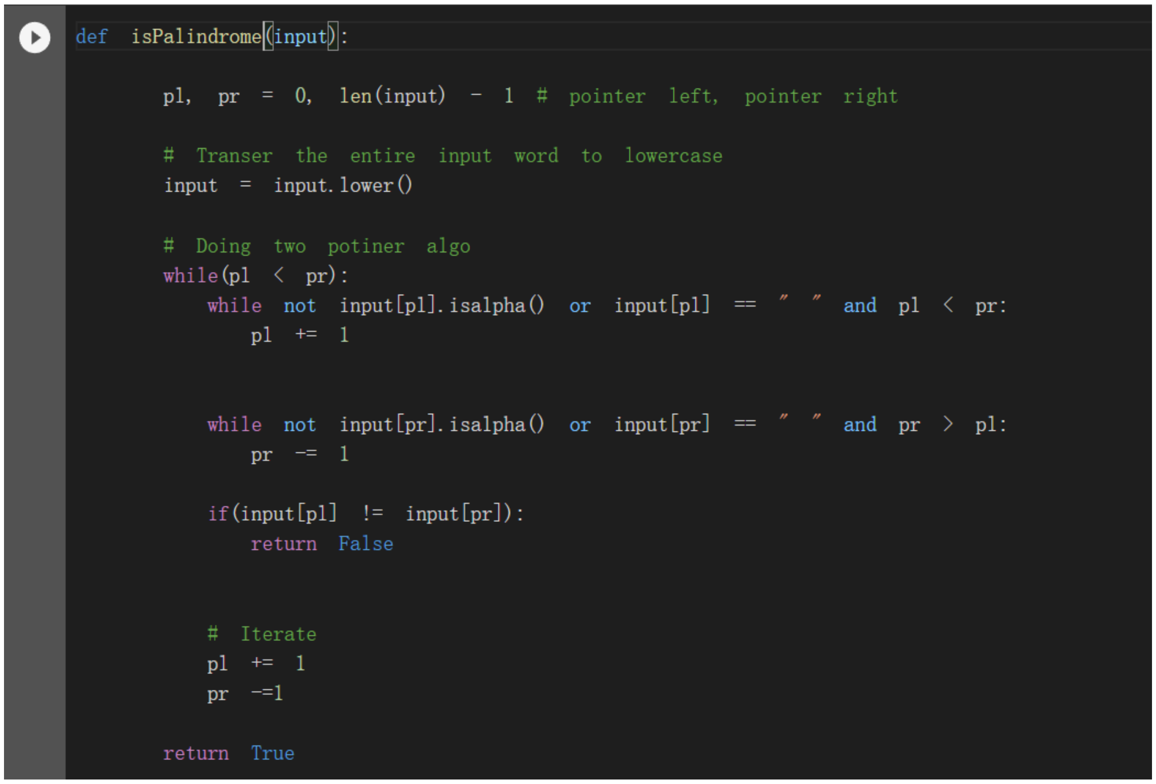
- Write a function that takes in a string and determines whether it is a palindrome. Ignore casing, punctuation, and spaces. (30 points)
    a. “palindrome” is a word, phrase, or sequence that reads the same backward as forward
    b. Ex: “aaabbaaa” - True
    c. Ex: “Mr. Owl ate my metal worm” - True
    d. Ex: “abcd” - False

Ans:

I want to use ***two pointer*** method to solve this problem.

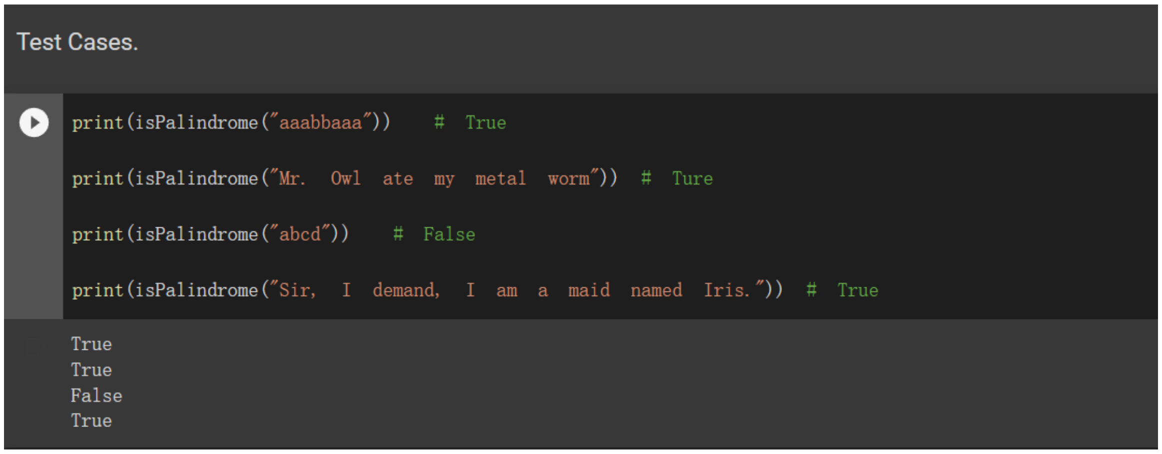
1. Because we need to ignore casing, I would set the entire input word to lowercase first.
2. Ignore punctuation and spaces: if one pointer to a string is not an alphabet or is a space, then set the pointer to the next position.

Writing down ***isPalindrome*** function



```python
def isPalindrome(input):

    pl, pr = 0, len(input) - 1 # pointer left, pointer right

    # Transer the entire input word to lowercase
    input = input.lower()

    # Doing two potiner algo
    while(pl < pr):
        while not input[pl].isalpha() or input[pl] == " " and pl < pr:
            pl += 1


        while not input[pr].isalpha() or input[pr] == " " and pr > pl:
            pr -= 1

        if(input[pl] != input[pr]):
            return False


        # Iterate
        pl += 1
        pr -=1

    return True
```

Test case


Test Cases.

```
print(isPalindrome("aaabbaaa"))    #  True

print(isPalindrome("Mr.  Owl  ate  my  metal  worm"))  #  Ture

print(isPalindrome("abcd"))    #  False

print(isPalindrome("Sir,  I  demand,  I  am  a  maid  named  Iris."))  #  True
```

```
True
True
False
True
```

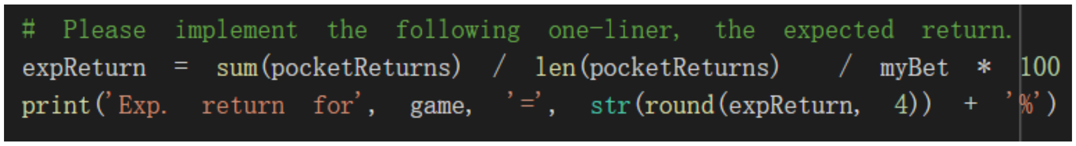
That seems the function works fine!

Monte Carlo Simulation

- Roulette is a casino game. For simplicity, we only allow betting on numbers. One number at a time. The following is such a Python implementation. Let's bet $1 on pocket number 7.
    1. Please complete the expectedReturn (the statement located next to the last line). (20 points)

       Ans:

       Expected value should be the total of pocketReturns divided by the length of pocketReturns, then by myBet, because we want to get the return rate rather than the total return amount. Also, don't forget to multiply *100* because we are going to print out the percentage of the rate of return.

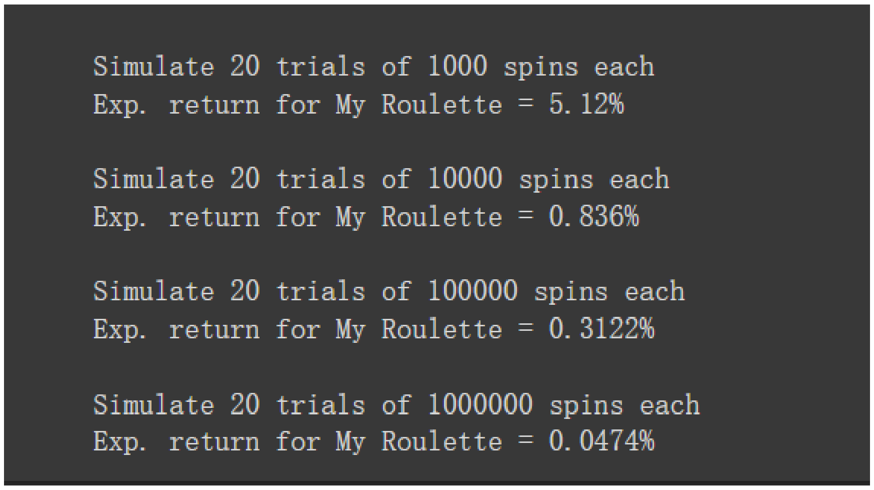


```
# Please implement the following one-liner, the expected return.
expReturn = sum(pocketReturns) / len(pocketReturns) / myBet * 100
print('Exp. return for', game, '=', str(round(expReturn, 4)) + '%')
```

    2. Please report the simulation results after completing the expectedReturn. (15 points)

       Ans:

       The simulation result is **5.12%**, **0.836%**, **0.3122%**, and **0.0474%** respectively.



```
Simulate 20 trials of 1000 spins each
Exp. return for My Roulette = 5.12%

Simulate 20 trials of 10000 spins each
Exp. return for My Roulette = 0.836%

Simulate 20 trials of 100000 spins each
Exp. return for My Roulette = 0.3122%

Simulate 20 trials of 1000000 spins each
Exp. return for My Roulette = 0.0474%
```

3. Please calculate the analytical answer of the expected return. (15 points)

   Ans:

   Expected return rate = (35 * 1/36 - 1 * 35/36) / 1 = **0.0%**

   To sum up, except for those who are doing this game for fun, hosting this game or playing this game in this way is wasting time in the long run.

```
import random

class MyRoulette():
    def __init__(self):
        self.pockets = []
        for i in range(1, 37):
            self.pockets.append(i)
        self.ball = None
        self.pocketOdds = len(self.pockets) - 1
    def spin(self):
        self.ball = random.choice(self.pockets)
    def betPocket(self, pocket, amt):
        if str(pocket) == str(self.ball):
            return amt*self.pocketOdds
        else: return -amt
    def __str__(self):
        return 'My Roulette'

def playRoulette(game, numSpins, pocket, bet, toPrint):
    totPocket = 0
    for i in range(numSpins):
        game.spin()
        totPocket += game.betPocket(pocket, bet)
    if toPrint:
        print(numSpins, 'spins of', game)
        print('Expected return betting', pocket, '=',\
              str(100*totPocket/numSpins) + '%\n')
    return (totPocket/numSpins)

def findPocketReturn(game, numTrials, trialSize, toPrint, pocket, bet):
    pocketReturns = []
    for t in range(numTrials):
        trialVals = playRoulette(game, trialSize, pocket, bet, toPrint)
        pocketReturns.append(trialVals)
    return pocketReturns

# Monte Carlo simulation begins.
random.seed(0)
numTrials = 20
# Instantiate the Roulette game.
game = MyRoulette()
myPocket = 7
myBet = 1
for numSpins in (1000, 10000, 100000, 1000000):
    print('\nSimulate', numTrials, 'trials of', numSpins, 'spins each')
    # The list of my simulation results.
    pocketReturns = findPocketReturn(game, numTrials, numSpins, False, myPocket, myBet)
    # Please implement the following one-liner, the expected return.
    expReturn =
    print('Exp. return for', game, '=', str(round(expReturn, 4)) + '%')
```