Problem Set #0

Due 07 Apr 2024

Note: you are submitting all your problems as Jupyter notebooks, so make your code, figures and text readable in a single file.

1) We are making N stone piles! The first pile has N stones. If N is even, then all piles have an even number of stones. If N is odd, all piles have an odd number of stones. Each pile must have more stones than the previous pile but as few as possible. Write a Python program to find the number of stones in each pile from the following inputs.

```
Input:  2
Output: [ 2, 4 ]
Input:  10
Output: [ 10, 12, 14, 16, 18, 20, 22, 24, 26, 28 ]
Input:  3
Output: [ 3, 5, 7 ]
Input:  17
Output: [ 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49 ]
```

2) Given a string consisting of whitespace and groups of matched parentheses, write a Python program to split it into groups of perfectly matched parentheses without any whitespace.

```
Input:  ( ()) ((()()())) (()) ()
Output: [ '(())', '((()()()))', '(())', '()' ]
Input:  () (( ( )() ( )) ) ( ())
Output: [ '()', '((()()()))', '(())' ]
```

3) Write a Python program to check whether the given strings are palindromes or not. Return True otherwise False.

```
Input:  [ 'palindrome', 'madamimadam', '', 'foo', 'eyes' ]
Output: [ False, True, True, False, False ]
```

4) Write a Python program to find all even palindromes up to n.

```
Even palindromes up to 50:  [ 0, 2, 4, 6, 8, 22, 44 ]
Even palindromes up to 100:  [ 0, 2, 4, 6, 8, 22, 44, 66, 88 ]
Even palindromes up to 500:  [ 0, 2, 4, 6, 8, 22, 44, 66, 88, 202, 212, 222, 232, 242, 252, 262, 272,
282, 292, 404, 414, 424, 434, 444, 454, 464, 474, 484, 494 ]
Even palindromes up to 2000:  [ 0, 2, 4, 6, 8, 22, 44, 66, 88, 202, 212, 222, 232, 242, 252, 262, 272,
282, 292, 404, 414, 424, 434, 444, 454, 464, 474, 484, 494, 606, 616, 626, 636, 646, 656, 666, 676,
686, 696, 808, 818, 828, 838, 848, 858, 868, 878, 888, 898 ]
```

5) Write a NumPy program to create a 4x4 array with random values and find the sum of each row.

6) Write a NumPy program to create a 5x5 array with random values and normalize it column-wise (normalize each column by subtracting its mean and dividing by its standard deviation).

7) Write a NumPy program to create a 5x5 array with random values and calculate the exponential of each element.

8) Build a random walk to run N simulations. What is maximum deviation from zero, the minimum and maximum for N=100, 10,000, and 1,000,000. How many simulations cross 30? How many times do the simulations cross zero? Tabulate the maximum and minimum distances from zero. Plot them, is this a normal distribution? Lastly, make a 2D version of your simulation.

9) Write a python script to solve the follow riddle:
How old is the captain, how many children has he, and how long is his boat? The product of the three desired numbers (integers) is 32,118. The length of the boat is given in feet (is at least several feet), the captain has both sons and daughters, he has more years than children, but he is not yet one hundred years old. (Hint: the first part of the script will be to find the prime factors of 32,118).