CPSC 1301, Computer Science I Programming Exercise 09

Week 09, MagicNumbers.py

1 Introduction

This activity consists of four programming exercises. The following exercises are open book and open note. You are free to use any written documentation you wish. However, these are individual exercises, and you cannot consult with each other in writing your programs.

This programming exercise has four parts consisting of four requirements. The grade for each requirement is indicated, for a maximum of 100 points. At a minimum, your program must compile successfully and run.

2 Exercise requirements

As a developer or programmer, one very important proficiency, and perhaps the most important proficiency, is the ability to understand abstract concepts and implement them into code that compiles, runs, and returns the correct response. In this exercise, you will convert four abstract concepts into code. The abstractions are expressed as mathematical equations, shown below. Also shown is my `Main` method, and the expected output.

2.1 Instructions:

You are allowed to use *only* the appropriate repetition constructs (for, while), the appropriate selection constructs (if, switch), and the mathemetical and logical operators. *Do not use any builtin methods except those shown below.*

2.2 Square root of 2

Write a method that returns the square root of 2, 1.4142135623730951, to an acceptable error. The formula is shown by equation 1.[1]

$$\sqrt{2} = \left[F(n) = f\left(F(\frac{\frac{2}{n}+n}{2})\right)\right] \tag{1}$$

2.3 pi

Write a method that returns pi, 3.141592653589793, to an acceptable error. The formula is shown by equation 2.

$$\pi = \sum_{i=0}^{i=\infty}\left(\frac{4}{(i*4)+1} - \frac{4}{(i*4)+3}\right) \tag{2}$$

2.4 e

Write a method that returns E, 2.7182818284590455, to an acceptable error. The formula is shown by equation 3.

$$e = \sum_{i=1}^{i=\infty}\frac{1}{i!} \tag{3}$$

2.5 phi

Write a method that returns phi, 1.618033988749895, to an acceptable error. The formula is shown by equation 4.

$$\phi = \lim_{n\to\infty} \frac{F_{n+1}}{F_n}, F = \text{Fibonacci sequence, i.e., 1, 1, 2, 3, 5, 8, 13, 21, 34, etc.} \quad (4)$$

3 Starter template

```
#!python
# Name: MagicNumbers.py
# Author: Your Name
# Date: current date
# Purpose: magic numbers, pi, e, sqrt(2), and phi

# import statements here (if any)
import math

# define methods here (if any)
def hello():
    print("Hello from 'MagicNumbers.py'")

def sqrt_2():
    pass

def e():
    pass

def pi():
    pass

def phi():
    pass

#main function executes the defined functions
if __name__ == '__main__':
    hello()

    #calculate the square root of 2
    print("calculating sqrt(2)")
    result = sqrt_2()
    error = math.sqrt(2) - result
    print(result, "error", error)

    #calculate Euler's number, e
    print("calculating e")
    result = e()
    error = math.e - result
    print(result, "error", error)

    #calculate pi
    print("calculating pi")
    result = pi()
    error = math.pi - result
    print(result, "error", error)

    #calculate phi, which is the square root of 5, plus 1 as numerator, divided by 2
    print("calculating phi(2)")
    result = phi()
    error = ((math.sqrt(5) + 1) / 2) - result
    print(result, "error", error)
```

4 Sample output

```
Hello from 'MagicNmbers.py'
calculating sqrt(2)
1.414213562373095 error 2.220446049250313e-16
calculating e
2.7182818284590455 error -4.440892098500626e-16
calculating pi
3.1415864035897374 error 6.25000005571863e-06
calculating phi(2)
1.618033988749895 error 0.0
```