Lab 5: Python Functions

Please visit `https://www.w3schools.com/python/python_functions.asp` to familiarize yourself with Python functions.

Examples

Example 1.

Create a Python function, and use it to calculate the balance after adding simple interest given by the formula $I = PRT$, where P, R, T are principal, interest rate (in decimals), and time (in years), respectively.

a. $P = 5,050,\ R = 6.5\%,\ T = 4$ years

b. $P = 8,010,\ R = 5.25\%,\ T = 3.5$ years

```
def get_balance(P,R,T):
# A = balance
  A = P + P*R*T
  return A
# use the function as follows:

balance_a = get_balance(5050,.065,4) # Answer for part a
print(f"The balance for part a is{balance_a: .2f}")

balance_b = get_balance(8010,0.0525,3.5) # Answer for part b
print(f"The balance for part b is{balance_b: .2f}")
```

When we run the script, we get the following outputs:

```
The balance for part a is 6363.00
The balance for part b is 9481.84
```

Alternatively, we can ask for user input as follows:

```
def get_balance_input():
    P = float(input("Enter the principal: "))
    R = float(input("Enter the rate in decimal: "))
    T = float(input("Enter the time in years: "))
    A = P + P*R*T
    return A
#use the function as follows:
balance = get_balance_input()
print(f"The balance is{balance: .2f}")
# answers (a) The balance is 6363.00 (b) The balance is 9481.84
```

Example 2.

Note that the volume and surface area of a right circular area are given by $V = \pi r^2 h$ and $S = 2\pi rh + 2\pi r^2$, respectively. Write a **Python function** that asks for the user inputs and computes the volume and the surface area simultaneously. Use the function to compute the V and S for the following questions. *Write the answers as comments.*

(a) $r = 2, h = 10$ (b) $r = 4, h = 6$

```
import numpy as np
def get_vol_surf_area_input():
    r = float(input("Enter a value for r: "))
    h = float(input("Enter a value for h: "))
    V = np.pi * r**2 * h
    S = 2 * np.pi * r * h + 2 * np.pi * r**2
    return V, S

# usuage of the function

volume, surf_area = get_vol_surf_area_input() # both outputs
print(f'The volume is{volume: .4f}')
print(f'The surace area is{surf_area: .4f}')

#(a) V = 125.6637, S = 150.7964 ; (b) V = 301.5929, S = 251.3274
```

When you run the script, it asks for inputs. Then you will have the following for (a):

```
Enter a value for r: 2
Enter a value for h: 10
The volume is 125.6637
The surace area is 150.7964
```

Alternatively, we can use the following. (fix the indentation)

```
import numpy as np
def get_vol_surf_area_input():
   r,h = map(float, input("Enter r and h separated by a space: ").split())
   V = np.pi * r**2 * h
   S = 2 * np.pi * r * h + 2 * np.pi * r**2
   return V, S

   volume, surf_area = get_vol_surf_area_input()
   print(f'The volume is {volume:.4f} , and surf area is {surf_area:.4f}')
```

Example 3.

Create a Python function for the Newton's method and use it with the specified initial approximation x_0 to find x_{10}. Round your answer to 8 decimal places. (compare this with Lab 4)

$$x + e^x = 2, \qquad \text{with} \quad x_0 = 1.$$

```
import numpy as np
def newt_method(f, df, x0):

# f is the function where f(x)=0
# df is the derivative of the function

  x=x0 # x0 is the initial value
  for i in range(9):
    x = x - f(x) / df(x)
  return x

# usuage of the function

result=newt_method(lambda x: x+np.exp(x)-2, lambda x: 1+np.exp(x), 1)


# lambda command is used to create a short function anonymously
# that is typically used for a short period of time


print(f'The 10th iterative approximate solution is{result: .8f}')
```

Run this script to get

```
The 10th iterative approximate solution is 0.44285440
```

Modified Secant Method:

Formula:

$$x_{n+1} = x_n - \frac{\delta * f(x_n)}{f(\delta + x_n) - f(x_n)}, \quad n \geq 0$$

which is an iterative formula. (It was derived in class.)

Exercises:

1. The amount of investment is given by $A = P\left(1 + \frac{r}{n}\right)^{nt}$, also known as the compound interest formula. Note that n is the number of compounding per year, t is the time in years. Write a **Python function** and find the amount of investment for the following questions.

   (a) $P = 8000, r = 4\%, t = 10$, compounded monthly (n=12).

   (b) $P = \$5,000$, $r = 2.5\%$, $t = 5$ years, compounded quarterly.

2. Recall that the Fibonacci numbers are defined as follows:

$$\begin{aligned} F_1 &= 1, \quad F_2 = 1, \\ F_i &= F_{i-1} + F_{i-2}, \quad i \geq 3 \end{aligned}$$

   Write a *Python function* to calculate the nth Fibonacci number, F_n. Use the function to find F_{25} and F_{35}.

3. Economic formulas are available to compute annual payments for loans. Suppose that you borrow an amount of money P and agree to repay it in n annual payments at an interest rate i. The formula to compute the annual payments A is

$$A = P\frac{i(1+i)^n}{(1+i)^n - 1}.$$

   Write a *function* to compute A. Then use the function to compute results for $n = 1$, 2, 3, 4, and 5 using $P = \$35,000$ and $i = 0.076$ (7.6%). .

4. Create a function for the Newton's method and use it with the specified initial approximation x_0 to find x_{10}. Round your answer to 6 decimal places. (compare this with Lab 4)

   (a) $x^3 - 2 = 0, \qquad x_0 = 2$

   (b) $x^5 - 17 = 0, \qquad x_0 = 2.1$

   (c) $\sin x + x - 1 = 0, \qquad x_0 = 1.5$

   (d) $\ln(x + 1) = 1, \qquad x_0 = 1.7$

5. Repeat problem #4 using Modified Secant Method (given that $\delta = 0.001$).