PHYS 3142 Spring 2021
Computational Methods in Physics
Assignment 1
Due: 11:59 p.m. 11th Feb 2021

Before you submit your assignment, do remember:

1. the due day

2. submit a report which contains your figures and results along with your code

3. make sure your code can run

4. do not forget to write comments in your codes.

The basic scoring rubric is :

1. **If you submit the assignment after the deadline or do not submit the report, you can only get up to 80% of grade**

2. **If there is any kind of plagiarism, all of the student involving will get zero mark! (except that the one can really prove the code is written by himself or herself and others copied it without telling him or her)**

1. **Plot the d orbital angular wave function (20 points)**

$$
\begin{aligned}
Y_{4d_{x^2-y^2}} &= \sqrt{15/4} \times (x^2 - y^2)/r^2 \times \sqrt{1/4\pi}, &&(1)\\
r^2 &= x^2 + y^2 + z^2 &&(2)
\end{aligned}
$$

We have the angular wave function for the 4d orbitals as shown in the slides. Please use the contourf function in matplotlib to plot the function in the range of (-3, 3) for both x and y (we set z = 0 for this function)

2. Prime number (20 points)

Please define a function to figure out whether a number is a prime number.
a. First use the "input" command to enter a number(at least four digits) and find out whether it is a prime number.
b. Install and import module 'sympy' and use module function 'isprime()' to check whether your answer is correct.

Ps. Please show a result as an example in your report!

3. Draw the trajectories (20 points)

A projectile is throwed out with initial speed $100m/s$. The earth gravity is 9.8 m/s^2 and the air resistance is neglected. Please draw the trajectories of the projectile with different initial launch angle $30°, 45° and 60°$ in one figure. Please set different trajectories with different colors, markers and line styles. You also need to add legend, xlabel, ylabel, title in the figure.

4. Dictionary practice (20 points)

Write a Python program to create three dictionaries of Atomic_number, Melting_point and Density include keys "Au","Cu","Fe", "Ag" and "Zn" whose values are corresponding physical property. (You could find the required information simply from Wikipedia) Print the value of each key from the dictionary.

5. Bubble Sort (20 points)

Please define a function to arrange a list of numbers from the biggest to the smallest. Then use this function to sort the values in dictionaries created in question 4 and print out the largest number for each dictionary.

Ps. Please show the result as an example in your report and DO NOT use the function in python like numpy.sort()!

The following questions are optional, just for exercise and will not be marked.

6. Print the Triangle pyramid patterns with '*' marker

Please write the Python code to print the triangle pyramid with the marker: *. The number of rows should be 9.

7. Continued fraction

The continued fraction defines as :

$$b = 1 + \cfrac{1}{2 + \cfrac{1}{2 + \cfrac{1}{2 + \cfrac{1}{2 + \cdots}}}} \tag{3}$$

Please first calculate the result by using the for loop function and then by changing the number of loops from 10 to 100 and plot the 2-d figure of the results(y-axis) & number of loop(x-axis). Then plot the absolute error & number of loop(analytic result if $sqrt2$). Please label the caption(include the xlabel, ylabel, ticks, and title clearly).

8. Insert string

Please Write a function to insert a string in the middle of the string.
e.g :
str_in = INSERT , str = String
Result : StrINSERTing (Type: str)
Ps. Please show a result as an example and the method you use in your code and your report!

9. How many 5-digit palindromes are there ?

Please write a program to determine how many 5-digit palindromes there are.

10. Reproduce an animation

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Please reproduce the animation showed in HW1. You can refer the code in example_Lec2.zip.