國立清華大學
NATIONAL TSING HUA UNIVERSITY

11110PHYS401300
Computational Physics Lab
計算物理實作

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Due: 2022.10.17
(submit to google classroom)

Homework 1

Reading Assignments

1. Read the article "The Linux command line for beginners" (https://ubuntu.com/tutorials/command-line-for-beginners#1-overview)
2. Read the article "Getting Started with Python in VS Code" (https://code.visualstudio.com/docs/python/python-tutorial)
3. Read the article "Working with Visual Studio Code on Ubuntu on WSL2" (https://ubuntu.com/tutorials/working-with-visual-studio-code-on-ubuntu-on-wsl2#1-overview).
4. Read the article "Jupyter Notebooks in VS Code" (https://code.visualstudio.com/docs/datascience/jupyter-notebooks)
5. Read the articles "Learn LaTeX in 30 minutes" (https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes)

(no need to submit your homework "solutions" for reading assignments. I trust you.)

Programming Assignments

1. Redo the "π calculation" we developed in class with $N = 10000, 100000$ and 1000000. Use the `%timeit` command in a jupyter notebook to evaluate the performance. Compare the performance of the same π calculation with (a) a hand writing for loop to evolute the area sum of each rectangle, (b) the default python `sum`, and (c) the `numpy.sum`.
2. During the lecture, we have learned a simple numerical integrator to evaluate π.

   Modify your source code to calculate the Stefan-Boltzmann constant σ_B by verify the below integration,

$$\frac{\sigma_B T^4}{\pi} = \int_0^\infty B_\nu(T) d\nu, \tag{1}$$

where

$$B_\nu(T) = \frac{2h\nu^3}{c^2}\frac{1}{e^{\frac{h\nu}{kT}} - 1}, \tag{2}$$

is the Planck function (assume $T = 6000$ K).

Hints: how to integrate a function that has an upper bound equal to infinity? Since when ν approaches infinity $B_{\nu\sim\infty}(T) = 0$, we could use a high value of ν as an upper bound to approximate the true upper bound.

3. Modify your angry bird program to include the drag force, $F = -K\eta v$, in your simulation, where K is the drag coefficient and η is the coefficient of viscosity. We could approximate your angry bird as a moving sphere, then the drag coefficient $K = 6\pi R$, where R is the radius of the sphere. Assuming the angry bird is 5 kg, $R = 30$ cm, and your target (the pig) is 20 meter away, find at least two different pairs of solutions with different initial velocity and inclination angle that could hit your target in (a) air, $\eta = 2 \times 10^{-4}$ (mks unit), and in (b) water $\eta = 0.01$ (mks unit).

   Hints: You could decompose the drag force into F_x and F_y components. In this homework. In this homework, the accuracy of the solution is not our main topic, first order Euler method is enough (though inaccurate).