CIS 4930 - 001: summer 2018
Homework 6

Total Points: 100
Due: Friday 07/27/2018

1 Objective

The objective for this assignment is to make sure

- You have a working setup for Python on your computer. From this assignment onward, you would probably be able to use linprog, but it is not a guarantee.
- You can write small to medium level programs in Python, using certain libraries.
- You can use the standard library to use parallel programming to solve certain numeric problems.

Please turn in your file `pancakes.py` and the report in a tarball `FSUID_HW5.tar` on Canvas.

2 Geometric Pancakes

Welcome to your new job at the House of Geometric Pancakes, where we serve artisan pancakes of only the most abstract 3-dimensional design. Each pancake is a one-of-a-kind work of art, and can be expressed as a series of overlapping rectangular prisms in 3-dimensional space.

While we do employ a large staff of pancake-artists, your position is more computational than artistic; you are tasked with determining how many cubic units of batter (to some given degree of accuracy) is required to create a given artisan 3D pancake defined by a given blueprint, where each blueprint consists of

1. How many rectangular prisms are needed to describe their artisan 3D pancake
2. The desired degree of accuracy with respect to how many cubic units of batter are required
3. Several lines, each consisting of 6 floating point numbers, each defining a single rectangular prism in 3D space

For example, consider the following blueprint:

```
5       0.31
-1.65   1.51    0.05    -0.70   -0.84   -0.21
-1.16   1.04    -0.09   1.71    0.03    1.87
1.64    0.76    0.57    1.42    1.86    -0.68
-1.44   0.83    -0.05   -0.99   -0.13   -1.71
1.64    1.27    0.25    1.91    -1.02   1.46
```

1. The first value, “5”, is the number of rectangular prisms required to describe the pancake.

2. The second value, "0.31", is the desired degree of accuracy (DegAcc). We ask that you round your answer down to the nearest multiple of DegAcc (e.g. in this case were the actual volume 7.992 cubic units, you would reply with "7.750").

3. We ask that you always reply with 3 decimal places.

4. The latter 5 lines each define one rectangular prism by describing two vertices, each line taking the form "x1 y1 z1 x2 y2 z2". All edges of the rectangular prisms are parallel to one of the major axis (X, Y, or Z), so you may assume that the volume of any individual rectangular prism is simply $\Delta x * \Delta y * \Delta z$.

5. Considering that our menu only lists individual artisan-pancakes for each platter, no blueprint will ever produce multiple disjoint pancakes. That is to say, you should assume that every rectangular prism at least partially overlaps with at least one other rectangular prism. As we are an eco-friendly pancake house, we ask that you remember not to incorrectly count overlapping regions multiple times, thus wasting pancake batter.

2.1 Specifications

You will be using a Hit/Miss Monte Carlo algorithm to solve this problem.

- Read in the prisms and their dimensions. (10 points)
- Use a data structure of your choice to store the boundary lines/points of the overall pancake and a 3-D rectangular bounding box that contains the pancake. (10 points)
- Set up a pool of 150 "threads". (15 points)
- For each "thread", generate 10000 random 3D points inside the bounding box. Now, if the generated point is also inside the pancake, count this point. (25 points)
- Calculate volume as a ratio of points in the pancake to the number of points generated (by collating information from all "threads". Express the volume as a multiple of the degree of accuracy. (20 points)

2.2 Report

You are also required to write a report (about 250 words) on how you would solve this problem if you were not allowed to use a Monte Carlo algorithm and list the anticipated difficulties, and explain how using the Monte Carlo approach helps you avoid those pitfalls. (20 points)

2.3 Assumptions

1. You may assume every floating point number given to you may be stored in a double precision float, and every integer value given may be stored in a standard int.

2. All values in the same line are tab separated.

3. A point on the boundary line is considered to be a part of the pancake.

2.4 Sample Run

Input						Output
5	0.31					7.750
-1.65	1.51	0.05	-0.70	-0.84	-0.21	
-1.16	1.04	-0.09	1.71	0.03	1.87	
1.64	0.76	0.57	1.42	1.86	-0.68	
-1.44	0.83	-0.05	-0.99	-0.13	-1.71	
1.64	1.27	0.25	1.91	-1.02	1.46	

2.5 Generic Guidelines

- The only libraries allowed are `numpy` and standard Python Built-ins.
- You are NOT allowed to get code off the internet for this project.

Thanks to Steven Rohr, for letting us use his intellectual property for this project.