2014 Summer Entrance Examination

Department of Creative Informatics Graduate School of Information Science and Technology The University of Tokyo

Programming

INSTRUCTIONS

- 1. Do not open this problem brochure until the signal to begin is given.
- 2. Write your examinee ID number below on this cover page.
- 3. An answer sheet and a draft sheet accompany this brochure. Write down your examinee ID number on these sheets.
- 4. You may choose any programming language to answer.
- 5. You may consult only one printed manual of a programming language during the examination. You can use or copy any libraries or program fragments stored in your PC, but you may not connect to the Internet.
- 6. By the end of the examination, make a directory/folder on your PC, whose name is the same as your examinee ID number, and put your program files and related files into the directory/folder. Copy the directory/folder onto the delivered USB flash drive.
- 7. At the end of the examination, the USB flash drive, the answer sheet and the draft sheet are collected.
- 8. After these are collected, stay at your seat, until all the examinee program results have been checked briefly by the test supervisor.
- 9. After the brief check, try to save your program execution environment on the PC so that you can run your program as soon as possible during the oral examination in the afternoon.
- 10. Leave your PC and this brochure together in the room for the oral examination and stay out of the room until you are called.

| Examinee 1 | ID | |
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Programming

The d-points are the set of points given as $\{(dp,dq) \mid p \in Z, q \in Z\}$ where Z is the set of integers including negative integers. A(d,R) is the number of the points that are in the d-points and are contained in the given region R. Suppose that a point (x,y) contained in the region R_0 satisfies the following inequality:

$$R_0: 0 \le x \le 10$$
 and $0 \le y \le 10$.

Then $A(1, R_0)$ is 121 as shown in Figure 1.

- (1) Write a program that computes $A(d, R_0)$ for a given floating-point number d.
- (2) A point (x, y) in the region R_1 satisfies the following inequality:

$$R_1: (x-5)^2 + (y-5)^2 \le 5^2.$$

Write a program that computes this expression:

$$\frac{A(d,R_1)}{A(d,R_0)} \times \frac{1}{4}$$

for a given floating-point number d.

- (3) The Koch snowflake (Figure 2) can be constructed by starting with an equilateral triangle, then recursively altering each line segment as follows:
 - 1. divide the line segment into three segments of equal length.
 - 2. draw an equilateral triangle that has the middle segment from step 1 as its base and points outward.
 - 3. remove the line segment that is the base of the triangle from step 2.

(from Wikipedia, http://en.wikipedia.org/wiki/Koch_snowflake)

The region K_n is the inside of the shape obtained from the triangle with vertices (0,0), (10,0), $(5,5\sqrt{3})$ and after *n*-iterations of the steps shown above. The boundary of the shape is included in K_n .

Write a program that prints the area of K_2 . The answer must be a floating-point number.

- (4) Write a program that computes the area of K_n for a given positive integer n. The answer must be a floating-point number.
- (5) Write a program that computes $A(d, K_2)$ for a given floating-point number d.
- (6) Write a program that computes $A(d, K_n)$ for a given floating-point number d and a positive integer n.

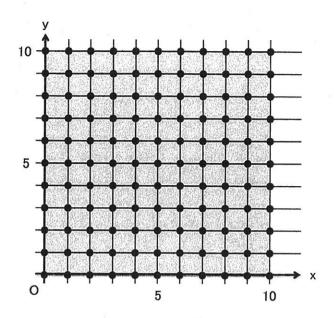


Figure 1: The region R_0 and the 1-points in R_0 .

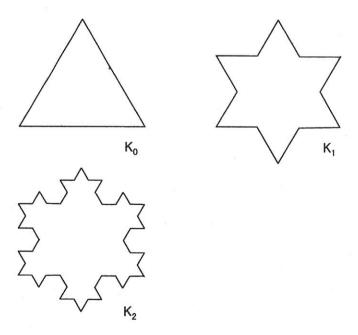


Figure 2: The Koch snowflake.



