2012 Winter Entrance Examination

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Programming

INSTRUCTIONS

1. Do not open this problem brochure until the signal to begin is given.
2. Write your examinee ID below on this cover.
3. An answer sheet and a draft sheet is provided. Write down your examinee ID on these sheets.
4. The USB memory delivered beforehand to each examinee contains ASCII text files: `data1.txt` and `data2.txt`. Newline is represented by carriage return (CR) followed by line feed (LF) in the file.

   Before the examination starts, copy these files to your PC and browse them. Make sure you can see text files and keep your hands away from your PC. If you cannot read the files properly, consult the test supervisor. The contents of the USB memory are common to all examinees.
5. You may choose your favorite programming languages.
6. You may consult only one printed manual of a programming language during the examination. *You can use or copy any libraries or program segments existing in your PC, but you cannot connect to the Internet.*
7. By the end of the examination, make a directory/folder on your PC, whose name is the same as your examinee ID, and put your program files and related files into the directory/folder. Copy the directory/folder onto the delivered USB memory.
8. At the end of the examination, the USB memory, the answer sheet and the draft sheet are collected.
9. After these are collected, stay at your seat, until all examinee program results have been checked briefly by the test supervisor.
10. 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.
11. *Leave your PC and this brochure together in the room* for the oral examination and leave the room until you are called.

Examinee ID _____

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Programming

Make a program that shows a graph of N data elements and that calculates Least Squares approximation.
A data tuple is represented as (x, y) , x, y are integers where $0 \leqq x < 30$, $0 \leqq y < 30$.
The USB memory distributed contains two sets of data each with 30 data tuples where the data format is as follows:

(2, 10)
(23, 1)
. . .
(15, 23)

(1) The USB memory contains data1.txt that has 30 data tuples. Make a program that reads all the data of data1.txt and outputs the (x, y) tuple that has the maximum y value.

(2) Draw all the data in data1.txt in the USB memory in a graph (c.f. Figure 1).

(3) Make a program that shows a graph of a linear equation $y = ax + b$ where $0 \leqq x < 30$, $0 \leqq y < 30$, using ASCII characters. Then show a graph of a=0.5, b=10 as a test case.
Characters for drawing the graph are arbitrary selected (c.f. Figure 2).

(4) Obtain a linear equation $y = ax + b$ that is the Least Squares approximation of data in data1.txt in the USB memory. Then draw the obtained equation on the graph (c.f. Figure 3).

Here, coefficients a, b of the linear equation are computed as

$$a = \frac{N\sum_{k=0}^{N-1} x_k y_k - \sum_{k=0}^{N-1} x_k \sum_{k=0}^{N-1} y_k}{N\sum_{k=0}^{N-1} x_k^2 - \left(\sum_{k=0}^{N-1} x_k\right)^2} \qquad b = \frac{\sum_{k=0}^{N-1} x_k^2 \sum_{k=0}^{N-1} y_k - \sum_{k=0}^{N-1} x_k y_k \sum_{k=0}^{N-1} x_k}{N\sum_{k=0}^{N-1} x_k^2 - \left(\sum_{k=0}^{N-1} x_k\right)^2}$$

from input $(x_k, y_k,)$, where $k = 0, \cdots, N-1$.

(5) Make a program that computes two sets of coefficients a_1, b_1, a_2, b_2, and x_m where two linear equations $y = a_1x + b_1$, $0 \leqq x < x_m$

and $y = a_2x + b_2$, $x_m \leqq x < 30$ gives the minimum sum of square errors of data in data2.txt file in the USB memory. Note that two linear equations must be connected at x_m. Here, sum of square errors of data is defined as:

$$F(x) = \begin{cases} a_1x + b_1 & 0 \leqq x < x_m \\ a_2x + b_2 & x_m \leqq x < 30 \end{cases}$$

$$a_1x_m + b_1 = a_2x_m + b_2$$

$$E = \sum_{k=0}^{N-1} (y_k - F(x_k))^2$$

where $F(x_k)$ denotes the y value of the approximated linear equation at x_k.

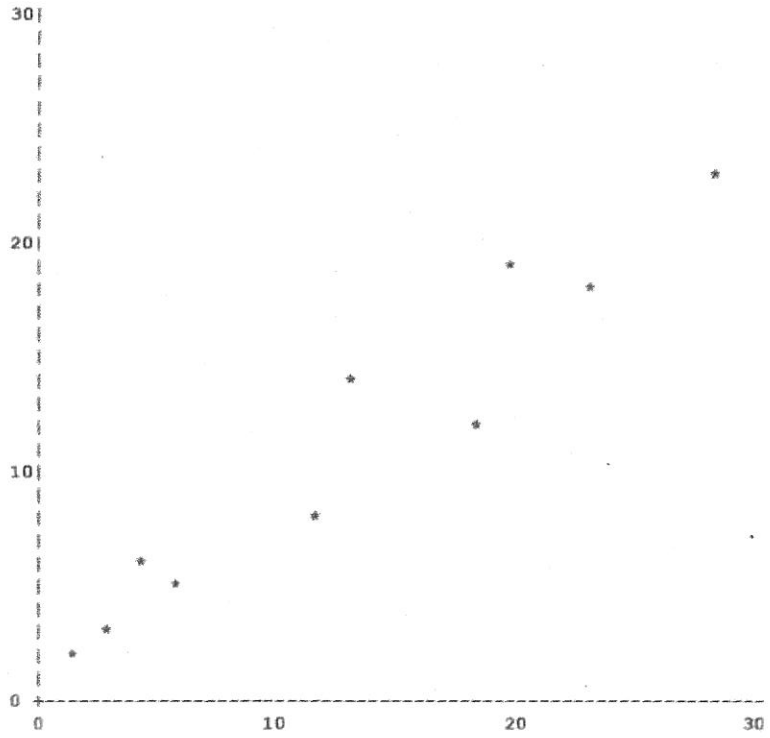

Figure 1. An example of a graph of data from a file

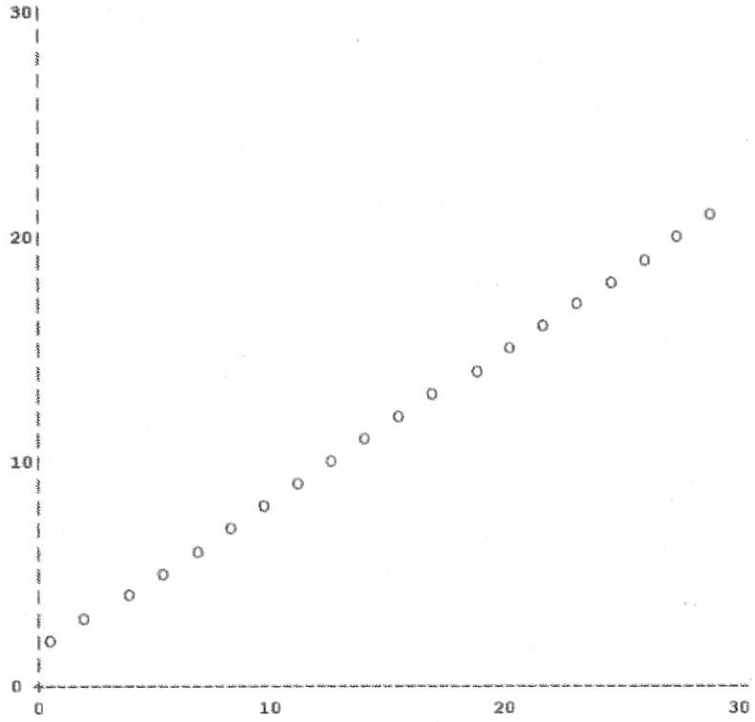

Figure 2. An example of a graph of a liner equation y=ax+b, a=0.8, b=2.0

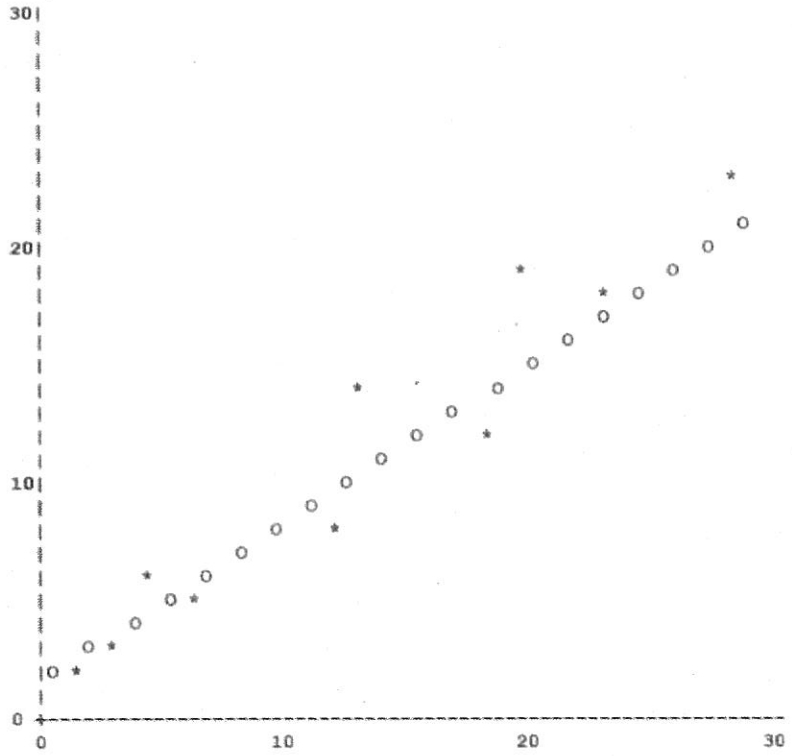

Figure 3. An example of a Least Squares fit

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