Indian Statistical Institute

Semester-I 2024–2025

M.Tech.(CS) - First Year

Lab Test 1 (25 September, 2024)

Subject: Computing Laboratory

Total: 60 marks Duration: 4 hrs.

INSTRUCTIONS

1. You may consult or use slides / programs provided to you as course material, or programs that you have written yourself as part of classwork / homework for this course, but please **do not** consult or use material from other Internet sources, your classmates, or anyone else.
2. Unless otherwise specified, all programs should take the required inputs from stdin, and print the desired outputs to stdout. Please make sure that your programs adhere strictly to the specified input and output format. **Your program may not pass the test cases provided, if your program violates the input and output requirements.**
3. Submissions from different students having significant match will **not be evaluated**.
4. To avoid mismatches between your output and the provided output, please store all floating point numbers in `double` type variables.

PART A

Q1. (15 marks)

Consider the following 2-player game. In **Round 1**, player A thinks of a string `S` consisting only of letters, digits and the underscore character (`_`). Player B has to guess the string `S`. At each turn, B guesses either a letter or a digit or the underscore. Suppose B guesses `'a'` during her first turn. Player A then ticks off any and all occurrences of `'a'` or `'A'` in `S`.[1]

B then guesses another character. This process continues until all characters in `S` have been ticked off (in this case, B is said to have **won** the round), or B gives up. If B wins after m guesses, then $1/m$ is added to B's score, A's score does not change. If B gives up, $\frac{1}{37}$ is added to A's score. The players then switch roles and play **Round 2**. This continues for some number of rounds (not necessarily even).

Write a program that reads a transcript of the game, and prints the final scores of A and B.

Input format: The first line of input will be a positive integer N, specifying the number of rounds. The transcript of each round will consist of one line, containing `S`, whitespace, and the sequence of guesses. If a character that is not a letter, digit or the underscore is encountered in the sequence, the guesser is presumed to have given up. Note that the guesser may win before all her guesses are considered. In such cases, the remaining guesses are ignored when computing the guesser's score. You may assume that `S` and the sequence of guesses are no longer than 125 and 50 characters, resp.

[1] Note that if B guesses either a lowercase letter, or an uppercase letter, **all** occurrences of that letter are ticked off, irrespective of whether its case in `S` matches the case of the guess.

Output format: Your program should print two floating point numbers, corresponding to the scores of A and B, correct to 6 decimal places.

PART B

Let A be a $10^m \times 10^n$ matrix. Each entry of the matrix is a non-negative, $(m+n)$-digit integer; if the value of $A[i,j]$ $(0 \leq i < 10^m,\ 0 \leq j < 10^n)$ is less than 10^{m+n-1} (i.e., $A[i,j]$ consists of fewer than $m+n$ significant digits), then it is assumed to be padded with enough leading zeros so that it has exactly $m+n$ digits. If K denotes the integer stored in $A[i,j]$, then K should be interpreted as a *pair of integers* (x,y) where x corresponds to the higher order m digits of K, and y corresponds to the lower order n digits of K.

If the integer in $A[i,j]$ corresponds to the tuple (i,j), then $A[i,j]$ is said to hold **treasure**.

Input format: The input will consist of the integers m and n, followed by the 10^{m+n} entries of A in row-major order. You may assume that $m+n$ is small enough that (i) A can be stored in memory, and (ii) an integer with $m+n$ digits can be stored in an `unsigned int` type variable.

Q2. (10 marks)

Write a program to print the coordinates of all cells containing treasure. If none of the cells contain treasure, you program should print the string "No treasure found."

Output format: The coordinates of cells that hold treasure should be printed in row-major order, with each pair appearing on a separate line.

Q3. (10 marks)

Write a program to simulate a "treasure hunt". Your program should start from $A[0,0]$. Suppose your program is currently at $A[i,j]$; let the integer stored in $A[i,j]$ correspond to the pair (x,y) as described above. Your program should then move to $A[x,y]$ in the next step. The hunt stops either when the first treasure-bearing cell is reached, or your program reaches a cell that it has already visited before.

Output format: Your program should print the coordinates of cells that it visits (starting with $(0,0)$). Each pair of coordinates should appear on a separate line. Depending on the outcome of the hunt, the last line of your program's output should be either "Treasure found", or "Going round in circles".

PART C

Let $f : \mathbb{R} \to \mathbb{R}$ and $g : \mathbb{R} \to \mathbb{R}$ be two piecewise linear functions. We say f and g are *separable* in the interval $[a,b] \subseteq \mathbb{R}$ if f and g are both defined in the interval $[a,b]$ and either $f(x) > g(x)$ for all $x \in [a,b]$ or $f(x) < g(x)$ for all $x \in [a,b]$. For example, in Figures 1 (a) and (b), functions f and g are separable in the interval $[a,b]$, but in Figure 1 (b), f and g are not separable in the interval $[a',b']$.

Input format: The input to your program will comprise 3 lines.

The first line will specify the function f: it will consist of a positive integer $m \geq 2$, followed by the x and y coordinates of m points, $F_1(x_1^{(f)}, y_1^{(f)}), F_2(x_2^{(f)}, y_2^{(f)}), \ldots, F_m(x_m^{(f)}, y_m^{(f)})$. **The points will be listed in increasing order of their x coordinates,** i.e., $x_1^{(f)} < x_2^{(f)} < \cdots < x_m^{(f)}$. In the interval $[x_i^{(f)}, x_{i+1}^{(f)}]$, the function f corresponds to the line segment joining F_i and F_{i+1}; f is not defined if $x \notin [x_1^{(f)}, x_m^{(f)}]$.

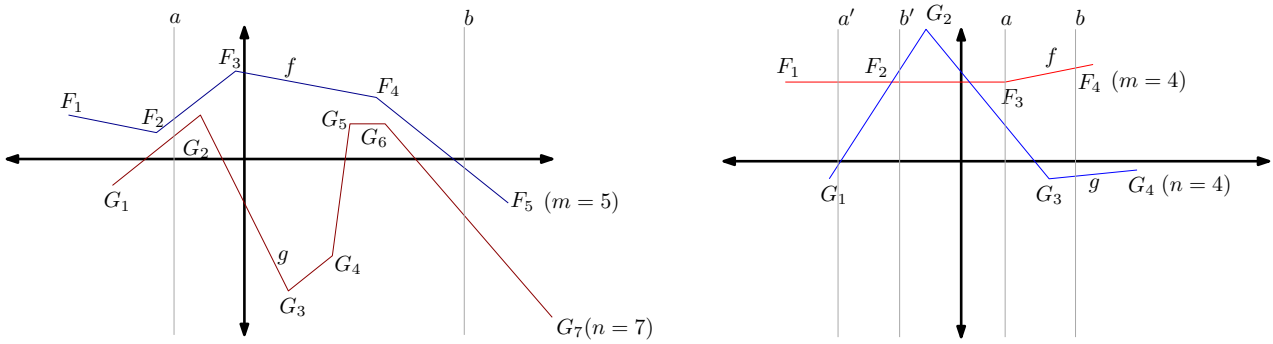

Figure 1: Separable and non-separable piecewise linear functions

The second line will specify the function g in the same format, i.e., it will consist of a positive integer $n \geq 2$, followed by the x and y coordinates of n points. As for f, the points will be listed in increasing order of their x coordinates.

The third line will specify the two numbers a and b defining the interval for which separability has to be determined.

Q4. (5 marks)

Write a program to determine the largest interval $[a_0, b_0]$ in which f and g are both defined.

Output format: Your program should print two floating point numbers a_0 and b_0 such that $[a_0, b_0]$ is the largest interval in which f and g are both defined. If no such interval exists, your program should print `None`.

Q5. (20 marks)

Write a program that determines whether f and g are separable in the specified interval $[a, b]$.

Output format: Your program should print either SEPARABLE or NOT SEPARABLE, depending on whether the given functions are separable or not in the given interval.