Islamic University of Technology
Department of Computer Science and Engineering

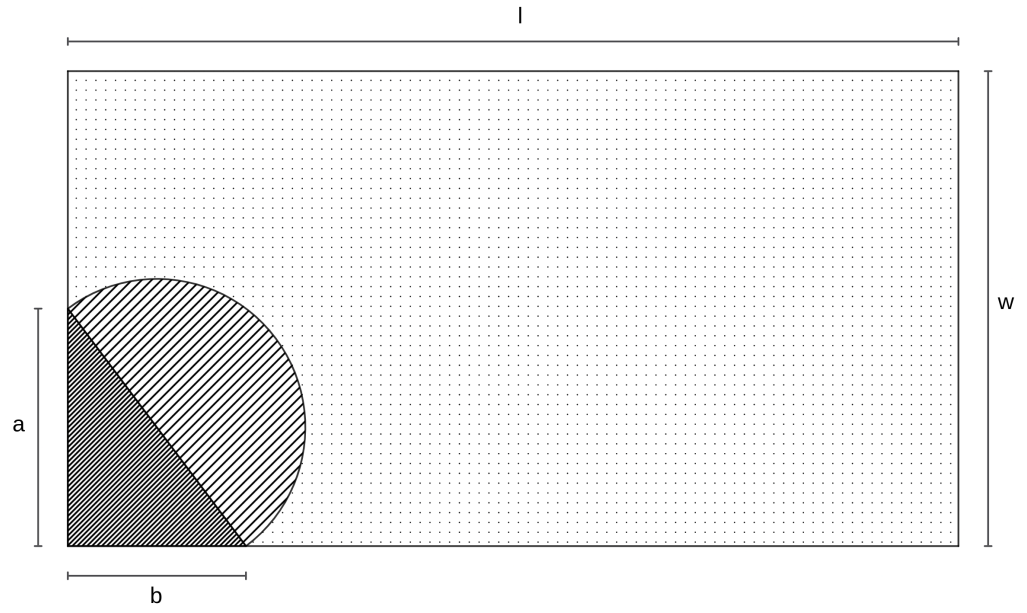
Lab 1: Introduction

CSE 4404: Algorithms Lab
Summer 2023-24

Task A. Simple Mensuration Problem

Time Limit: 1 second | *Memory Limit: 256 MB*

Find the area of the dotted zone in the following figure:



Input Format

The input consists of four space-separated integers in a line $l\,(2 \leq l \leq 100)$, $w\,(2 \leq w \leq 100)$, $a\,(1 \leq a \leq \min(\frac{l}{2}, \frac{w}{2}))$ and $b\,(1 \leq b \leq \min(\frac{l}{2}, \frac{w}{2})))$ — the length of the rectangle, the width of the rectangle and the two side lengths of the triangle respectively.

Output Format

Output a single number — the area of the dotted zone rounded to *exactly* two decimal places.

Examples

Sample Input	Sample Output
15 8 4 3	104.18

Notes

Area of a rectangle = $length \times width$
Area of a triangle = $\frac{1}{2} \times base \times height$
Area of a circle = $\pi \times radius^2$
Hypotenus of a right triangle = $\sqrt{base^2 + height^2}$
$\pi = 3.14159$

Task B. Implementation Problem

Time Limit: 1 second | Memory Limit: 256 MB

You are given two integers. Your task is to *swap their values* by implementing a function named `customSwap`. The swap must be done by reference.

Input Format

The input consists of two space-separated integers a and b ($-2 \times 10^9 \leq a, b \leq 2 \times 10^9$).

Output Format

Output the two integers after swapping, separated by a space.

Examples

Sample Input	Sample Output
6 9	9 6

Notes

- You must implement the function `customSwap` with the following signature:

```
void customSwap(int& a, int& b);
```

- You are not allowed to use the built-in `swap` function from the Standard Library.
- You will be provided with a partially completed code file in the folder: `Lab 1/Task 2/submission`.
- Your only task is to implement the `customSwap` function. Please do not make any changes outside the function.
- The function should swap the values of `a` and `b` by reference.

Task C. Triple Sort

Time Limit: 5 minutes | *Memory Limit: 512 MB*

Given an array a of integers, you need to sort and print it in three different ways:

1. Ascending order.
2. Descending order.
3. Ascending order based on absolute values (if two numbers have the same absolute value, the negative one should come first).

Input Format

The first line of the input contains an integer n ($1 \leq n \leq 100000$) — the size of the array.

The second line contains n space-separated integers $a_1, a_2, \ldots, a_n$ ($-100 \leq a_i \leq 100$) — the elements of the array.

Output Format

Output three lines:

- First line: the array sorted in ascending order.
- Second line: the array sorted in descending order.
- Third line: the array sorted in ascending order of absolute values.

Examples

Sample Input	Sample Output
5 1 -3 5 0 -2	-3 -2 0 1 5 5 1 0 -2 -3 0 1 -2 -3 5

Notes

For this task, make 4 submissions with 4 different sorting algorithms:

1. Selection Sort
2. Bubble Sort
3. Insertion Sort
4. Merge Sort (using the `sort` function in C++ STL)

Afterwards, run the local judge to execute the submissions. Test 1 has an array of 10000 elements, Test 2 has 20000 elements, ... up to Test 10, which has 100000 elements.

Record the runtime for each test case in the sheet provided in Google Classroom assignment and observe the shape of the runtime vs. input size graphs.

Task D. Count Values in Range

Time Limit: 2 seconds | *Memory Limit: 512 MB*

You are given an array of n integers. You also have to answer q queries.

For each query, you are given two integers l and r, and you must determine how many indices i ($1 \leq i \leq n$) satisfy the condition $l \leq a_i \leq r$.

Input Format

The first line contains two space-separated integers n and q ($1 \leq n, q \leq 10^5$) — the size of the array and the number of queries.

The second line contains n space-separated integers $a_1, a_2, \ldots, a_n$ ($-10^9 \leq a_i \leq 10^9$) — the elements of the array.

Each of the next q lines contains two space-separated integers l and r ($-10^9 \leq l \leq r \leq 10^9$) — describing a query.

Output Format

For each query, print a single integer — the number of indices i ($1 \leq i \leq n$) such that $l \leq a_i \leq r$.

Examples

Sample Input	Sample Output
5 3 1 5 2 7 3 1 5 2 6 8 10	4 3 0

Notes

In the first query, the indices satisfying $1 \leq a_i \leq 5$ are $i = 1$, 2, 3, and 5 — a total of 4 indices.

In the second query, the indices satisfying $2 \leq a_i \leq 6$ are $i = 2$, 3, and 5 — a total of 3 indices.

In the third query, no index satisfies $8 \leq a_i \leq 10$.

Marks Distribution

Everyone gets 100% marks for this lab.

Practice Problems

Problem	**Links**
Game	Codeforces: https://codeforces.com/contest/984/problem/A Vjudge: https://vjudge.net/problem/CodeForces-984A
Gravity Flip	Codeforces: https://codeforces.com/contest/405/problem/A Vjudge: https://vjudge.net/problem/CodeForces-405A
Valid Anagram	LeetCode: https://leetcode.com/problems/valid-anagram/
Jagged Swaps	Codeforces: https://codeforces.com/contest/1896/problem/A Vjudge: https://vjudge.net/problem/CodeForces-1896A
Unforgivable Curse (Easy)	Codeforces: https://codeforces.com/contest/1800/problem/E1 Vjudge: https://vjudge.net/problem/CodeForces-1800E1
Unforgivable Curse (Hard)	Codeforces: https://codeforces.com/contest/1800/problem/E2 Vjudge: https://vjudge.net/problem/CodeForces-1800E2