A. Requirements

Code (90%)

You can write your code in Java, Python, C, or C++. The *time limit* may vary among different languages, depending on the performance of the language. Your code must be a complete excutable program instead of only a function. We guarantee test data strictly compliance with the requirements in the description, and you do not need to deal with cases where the input data is invalid.

Libraries in this assignment:

- For C/C++, you can only include standard library.
- For Java, you can only `import java.util.*`
- For Python, you can only import standard library. In other words, you cannot import libraries such as `numpy`.

Report (10%)

You also need to write a report in `pdf` type to explain the following:

- What are the possible solutions for the problem?
- How do you solve this problem?
- Why is your solution better than others?

Please note that the **maximum** number of pages allowed for your report is **5 pages**.

Remember that the report is to illustrate your thinking process. Keep in mind that your report is supposed to show your ideas and thinking process. We expect clear and precise textual descriptions in your report, and we do not recommend that you over-format your report.

B. Example Problem: A + B Problem

Description

Given 2 integers A and B, compute and print A + B

Input

Two integers in one line: A, and B

Output

One integer: A + B

Sample Input 1   Sample Output 1

1 2

3

Problem Scale & Subtasks

For 100% of the test cases, $0 \leq A, B \leq 10^6$

Solutions

Java

```java
import java.util.*;

public class Example {
    public static void main(String[] args) {
        int a, b;
        Scanner scanner = new Scanner(System.in);
        a = scanner.nextInt();
        b = scanner.nextInt();
        scanner.close();
        System.out.println(a + b);
    }
}
```

Python

```python
AB = input().split()
A, B = int(AB[0]), int(AB[1])
print(A + B)
```

C

```c
#include <stdio.h>

int main(int argc, char *argv[])
{
  int A, B;
  scanf("%d%d", &A, &B);
  printf("%d\n", A + B);
  return 0;
}
```

C++

```cpp
#include <iostream>

int main(int argc, char *argv[])
{
  int A, B;
  std::cin>> A >> B;
  std::cout<< A + B << std::endl;
  return 0;
}
```

C. Submission

After finishing this assignment, you are required to submit your code to the Online Judge System (OJ), and upload your `.zip` package of your code files and report to BlackBoard.

C.1 Online Judge

Once you have completed one problem, you can submit your code on the page on the Online Judge platform (oj.cuhk.edu.cn, campus only) to gain marks for the code part. You can submit your solution of one problem for **no more than 80 times**.

After you have submitted your program, OJ will test your program on all test cases and give you a grade. The grade of your latest submission will be regarded as the final grade of the corresponding problem. Each problem is tested on multiple test cases of different difficulty. You will get a part of the score even if your algorithm is not the best.

Note: The program running time may vary on different machines. Please refer to the result of the online judge system. OJ will show the time and memory limits for different languages on the corresponding problem page.

If you have other questions about the online judge system, please refer to OJ wiki (campus network only). If this cannot help you, feel free to contact us.

C.2 BlackBoard

You are required to upload your **source codes and report** to the BlackBoard platform. You need to name your files according to the following rules and compress them into `A1_<Student ID>.zip` :

```
A1_<Student ID>.zip
|-- A1_P1_<Student ID>.java/py/c/cpp
|-- A1_P2_<Student ID>.java/py/c/cpp
|-- A1_Report_<Student ID>.pdf
```

For Java users, **you don't need to consider the consistency of class name and file name**.

For example, suppose your ID is 123456789, and your problem 1 is written in `Python`, problem 2 is written in `Java` then the following contents should be included in your submitted `A1_123456789.zip`:

```
A1_123456789.zip
|-- A1_P1_123456789.py
|-- A1_P2_123456789.java
|-- A1_Report_123456789.pdf
```

C.3 Late Submissions

Submissions after Mar 27, at 23:59 PM (UTC+8) would be considered as LATE. A late submission contest will open after deadline.

Submisson time = max{latest submisson time for every problem, BlackBoard submisson time}

There will be penalties for late submission:

- 0–24 hours after deadline: final score = your score×0.8

- 24–72 hours after deadline: final score = your score×0.5

- 72+ hours after deadline: final score = your score×0

FAQs

Q: I cannot access to Online Judge.

A: First, please ensure that you are using the campus network. If you are not on campus, please use the university VPN. Second, please delete cookies and refresh browser or use other browser. If you still cannot access to Online Judge, try to visit it via the IP address `10.26.200.13`.

Q: My program passes samples on my computer, but not get AC on OJ.

A: Refer to OJ Wiki Q&A

Authors

If you have questions for the problems below, please contact:

- Problem 1. The 2023 Programming Contest of CUHK-Shenzhen (official)

- Problem 2. The 2023 Programming Contest of CUHK-Shenzhen (official)

- Problem 3. Yige Jiang: yigejiang@link.cuhk.edu.cn

CSC3100 Data Structures Spring 2024

Programming Assignment 3

Due: Apr 16 2024 23:59:00

Assignment Link: http://oj.cuhk.edu.cn/contest/csc310024spa3

Access code: flute

Question 1, question 2, and question 3 weigh 25%, 25%, and 40% of the total grade, respectively.

Please note that you are not recommended to use AI tools such as chatGPT to complete your assignment for potential plagiarism issue.

1 PigCup Final (25% of this assignment)

1.1 Description

Football is a favorable sport in Pigeland, and PigCup is considered the most prestigious football game in the country.

The final of the 2023 PigCup was played between Team A and Team B. Piggy, a rising star in the sport, was selected to represent Team A in the final. Sadly, Piggy fell ill and overslept, causing him to miss the game. Nevertheless, as the team captain, Piggy is eager to learn about the outcome of the 2023 PigCup final.

In PigCup, the team with a higher number of scores will win the game; the game will result in a tie if the two teams get the same number of scores. The events in the 2023 PigCup final are represented by a string S consisting of the letters 'A' or 'B', where each 'A' indicates a score for Team A and each 'B' indicates a score for Team B. In particular, in the case where no team scores, i.e. the final result is 0:0, S will only contain a single letter 'O'.

Now, Piggy gives you the string S. Your task is to help Piggy determine the winning team or whether the game results in a tie.

1.2 Input

The inputs consist of a single line that contains a string S of at most 20 letters. Each letter in S is either of 'A', 'B' or 'O', where 'A' means Team A scores, 'B' means Team B scores, while 'O' means no team scores in the 2023 PigCup final.

1.3 Output

Output the scores of Team A and Team B on the first two lines, respectively, with the format "A:X" and "B:Y", where X is the score of Team A and Y is the score of Team B.

On the third line, output the result of the game. If Team A wins, output "A wins!". If Team B wins, output "B wins!". If the game results in a tie, output "Draw!". The detailed output format can be found in the example.
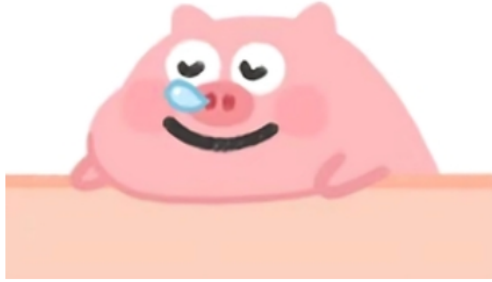
Figure 1: Enter Caption

Sample Input 1

```
BAA
```

Sample Output 1

```
A: 2
B: 1
A wins!
```

You can find more samples in the attached file on BB.

1.4 Problem Scale & Subtasks

There are 10 testcases in total, the length of the given string is at most 20 letters.

2 Watermelon (25% of this assignment)

2.1 Description

In Pigeland, watermelon is the most renowned fruit among pigs. There is an ancient saying: the larger the watermelon, the larger the watermelon rind.

Small Piggy is Piggy's sister, a critically-minded girl. She thinks this idiom is incorrect in some special situations. In order to support her, you want to find such an example.

You found two round watermelons. The smaller one has a radius r_1, you cut it apart and figured out that its rind has thickness d. The larger one has a radius r_2. Before cutting it open, you want to know the maximum thickness of the second rind to let the volume of the second watermelon rind be smaller than the volume of the first watermelon rind.

Note that the watermelons are perfectly ball-shaped. A watermelon has two parts — watermelon pulp and watermelon rind. The watermelon pulp is also ball-shaped and it is concentric with the watermelon itself.

2.2 Input

Each test contains multiple test cases. The first line contains a single integer T ($1 \leq T \leq 30\,000$) — the number of test cases. A description of the test cases follows.

The only line for each test case contains three integers in one line, r_1, r_2, d ($1 \leq d < r_1 < r_2 \leq 1\,000$).

2.3 Output

For <mark>each testcase, output one real number in a line</mark>, representing the <mark>maximum thickness of the second watermelon rind.</mark>

Your answer will be considered correct if its absolute or relative error does not exceed 10^{-4}.

Sample Input 1	Sample Output 1
2 2 3 1 5 7 1	0.2855823834 0.4423278138

You can find more samples in the attached file on BB.

2.4 Problem Scale & Subtasks

There are 10 testcases in total.

For the all given testcases, $1 \le T \le 3 \times 10^4, 1 \le d < r_1 < r_2 \le 1000$.

3 Tree Problem (40% of this assignment)

3.1 Description

Given an unrooted tree with n nodes, where each node is either black or white, and the tree has edge weights.

For positive integers $u, v \in [1, n]$, define $dis(u, v)$ as the distance between nodes u and v on the tree.

Define:

$$ans_i = \left[\sum_{j=1, j \ne i, j \in black\ nodes}^{n} dis(i, j) \right] \% mod$$

Output the array $\{ans_i\}, i \in [1, n]$, where $mod = 10^9 + 7$.

3.2 Input

The first line contains an integer n.

The second line contains n numbers, where the i-th number represents the color of node i (1 for black, 0 for white).

The following $n - 1$ lines, each line contains three integers u, v, w, representing an edge connecting node u and node v with a distance of w. Note that $n, u, v, w > 0$.

3.3 Output

Output n lines, the i-th line represents ans_i.

Sample Input 1	Sample Output 1
5 1 0 1 1 1 1 2 3 1 3 2 2 4 1 2 5 1	10 10 14 12 12

You can find more samples in the attached file on BB.

3.4   Problem Scale

$1 \leq u, v \leq n, 1 \leq w \leq 1000$

Test Data Scale.	Constraints
30% data	$1 \leq n \leq 100$
70% data	$1 \leq n \leq 2000$
100 % data	$1 \leq n \leq 100000$

3.5   Hint

For Python users, if there occurs a `RecusrionError`, see here.