Problem A
Spray on Surface

Time Limit: 2 seconds

Consider an $N \times N \times N$ region with opposite corners at $(0, 0, 0)$ and (N, N, N).

Within this region, an object is built from $1 \times 1 \times 1$ blocks. Each block occupies exactly the unit cube $[i, i+1] \times [j, j+1] \times [k, k+1]$ for some integers $0 \le i, j, k < N$. It is guaranteed that this object is connected and that it contains no cavities (i.e., every empty cell is connected to the exterior of the $N \times N \times N$ region).

You want to know the amount of spray paint required to paint the surface of this object. Compute the surface area of the object.

Input

The input consists of multiple test cases.

The first line contains an integer T $(1 \le T \le 100)$, representing the number of test cases.

T test cases follow. Each test case is given in the following format.

N
$S_{1,1}$
$S_{1,2}$
$\vdots$
$S_{1,N}$
$S_{2,1}$
$\vdots$
$S_{N-1,N}$
$S_{N,1}$
$\vdots$
$S_{N,N}$

For each test case, the first line contains an integer N $(1 \le N \le 10)$, representing the side length of the region containing the object.

The following N^2 lines each contain a string $S_{i,j}$ of length N, representing the shape of the object.

If the k-th character of $S_{i,j}$ is '#', then there is a block in the region $[i, i+1] \times [j, j+1] \times [k, k+1]$. If it is '.', there is no block in that region. The object satisfies the conditions in the problem statement.

Output

For the T test cases, output the answers on separate lines. For each test case, output the surface area of the object on a single line.

Sample Input	Sample Output
2 2 ## #. #. .. 3 ### #.# ### ### #.# ### ### #.# ###	18 64

Problem B
Funini Adventure

Time Limit: 2 seconds

Funini Adventure is a very popular game. In this game, you can raise Funini by performing the following three actions.

Action 1: Climb a mountain to build stamina

Action 2: Participate in a programming contest

Action 3: Learn a new algorithm

You want to perform these actions several times, but each action has a cost. For $i = 1, 2, 3$, the cost of performing Action i is defined as follows: if you have already performed Action i exactly x_i times, then the cost is $a_i + b_i x_i$.

Initially, you have performed each action 0 times. Find the minimum total cost required to perform N actions in total.

Input

The input consists of multiple test cases.

The first line contains an integer T ($1 \le T \le 100\,000$), representing the number of test cases.

T test cases follow. Each test case is given in the following format.

N
a_1 b_1
a_2 b_2
a_3 b_3

For each test case, the first line contains an integer N ($1 \le N \le 10^6$), representing the number of actions you should perform.

The following 3 lines each contain two integers a_i and b_i ($1 \le a_i, b_i \le 10^6$). The i-th of these lines gives the coefficients for Action i.

Output

For each test case, output a line containing a single integer – the minimum total cost to perform N actions.

Sample Input	Sample Output
2 5 1 5 2 10 4 3 1000000 1000000 1000000 1000000 1000000 1000000 1000000	20 166667166667000000

In the first test case, you need to perform the three actions a total of 5 times. If you perform Actions $1, 3, 3, 2, 1$ in this order, then the costs are $1, 4, 7, 2$, and 6, for a total of 20. Since it can be shown that no sequence achieves a total cost less than 20, the answer is 20.

Problem C
Communication between islands

Time Limit: 2 seconds

Solve the following problem for $r = 1, 2, \ldots, N$.

There are N islands, and with $N - 1$ bridges it is possible to travel between any two islands.

When there is an announcement to be made to all islands, flyers are distributed in a somewhat unusual way. First, exactly one flyer is created on island r. After that, the following operation is repeated:

> Choose one flyer, and let u be the island that currently has it. Duplicate the flyer once, and deliver the original and the duplicate (exactly two flyers in total) to islands connected to u by a bridge. These two flyers may both be delivered to the same island or to two different islands.

Determine the minimum number of operations required until every island has at least one flyer.

Input

The input consists of a single test case in the following format.

N
u_1 v_1
$\vdots$
u_{N-1} v_{N-1}

The first line contains an integer N $(2 \leq N \leq 300\,000)$, representing the number of islands.

The following $N - 1$ lines each contain integers u_i, v_i $(1 \leq u_i, v_i \leq N,\ u_i \neq v_i)$, representing that the i-th bridge connects island u_i and island v_i.

It is guaranteed that one can travel between any two islands using bridges.

Output

Output N integers separated by spaces. The i-th integer should contain the minimum number of operations when $r = i$.

Sample Input 1	Sample Output 1
3 1 2 2 3	2 3 2

Sample Input 2	Sample Output 2
5 3 1 2 3 3 5 3 4	5 5 5 5 5

Problem D
Grid Painting

Time Limit: 2 seconds

There is an $H \times W$ grid, where initially every cell is painted white. Let $C_{i,j}$ $(1 \le i \le H, 1 \le j \le W)$ denote the color of the cell in the i-th row from the top and the j-th column from the left.

You can paint the grid by repeating the following two operations any number of times, in any order.

Operation 1: This operation may be applied only if the rightmost column of the grid is entirely white.
First, perform a cyclic right shift of the entire grid by one column (i.e., for all $1 \le i \le H, 1 \le j \le W$, replace $C_{i,(j \bmod W)+1}$ with $C_{i,j}$ simultaneously).
Then, choose $1 \le l \le r \le H$ and paint $C_{l,1}, C_{l+1,1}, \ldots, C_{r,1}$ black.

Operation 2: This operation may be applied only if the bottom row of the grid is entirely white.
First, perform a cyclic downward shift of the entire grid by one row (i.e., for all $1 \le i \le H, 1 \le j \le W$, replace $C_{(i \bmod H)+1,j}$ with $C_{i,j}$ simultaneously).
Then, choose $1 \le l \le r \le W$ and paint $C_{1,l}, C_{1,l+1}, \ldots, C_{1,r}$ black.

Given the final grid after performing some operations, determine the number of operation sequences that could result in it. Since the answer can be very large, output it modulo $998244353 = 119 \times 2^{23} + 1$.

Two operation sequences are considered different if they have different lengths, or if at any step either the shift direction or the segment painted black differs.

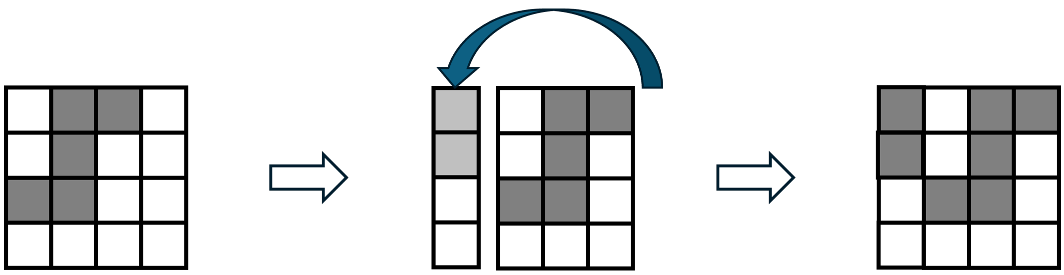

Figure D-1: Illustration of Operation 1.

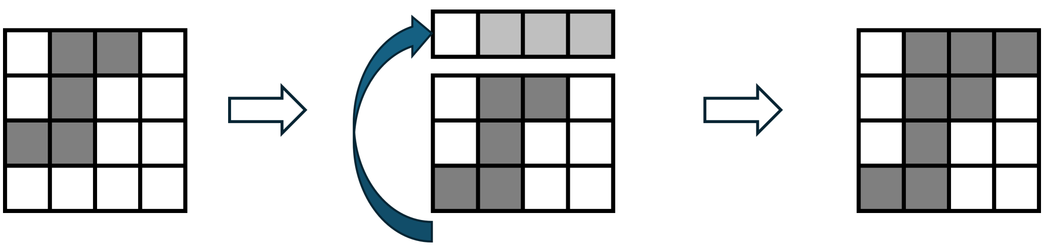

Figure D-2: Illustration of Operation 2.

Input

The input consists of multiple test cases.

The first line contains an integer T $(1 \le T \le 100)$, representing the number of test cases.

T test cases follow. Each test case is given in the following format.

H W
S_1
$\vdots$
S_H

For each test case, the first line contains integers H ($1 \leq H \leq 100$) and W ($1 \leq W \leq 100$), representing the height and width of the grid, respectively.

Each of the following H lines contains a string S_i of length W, representing the final grid, consisting only of the characters '#' and '.'. If the j-th character of S_i is '#', then $C_{i,j}$ is black, and if it is '.', then $C_{i,j}$ is white.

Output

Output one line per test case: the number of possible operation sequences modulo 998244353.

Sample Input	Sample Output
4 2 2 .# ## 2 3 ... ... 3 4 #.#. .#.# #.#. 6 5 ###.. ###.. ##.## ##.## ..### ..###	6 1 0 210

Problem E
Word Search

Time Limit: 2 seconds

You are given a word S written in an unfamiliar language. In this language, a *syllable* is known to be one of the following:

- A single uppercase English letter
- A single lowercase English letter
- An uppercase English letter followed by a lowercase English letter

For example, "`Ab`", "`A`", and "`c`" can each form a syllable, but "`IC`", "`pC`", and "`Jag`" cannot.

When dividing a word S into several contiguous substrings that are syllables, determine the minimum and maximum possible number of distinct syllables among them.

Input

The input consists of multiple test cases.

The first line contains an integer T $(1 \leq T \leq 10\,000)$, representing the number of test cases.

T test cases follow. Each test case is given in the following format.

S

For each test case, the only line contains a string S $(1 \leq |S| \leq 10^6)$, consisting of uppercase and lowercase English letters.

Additionally, the sum of the lengths of S over all test cases does not exceed 10^6.

Output

Output T lines. For each test case, output the minimum and maximum possible numbers of distinct syllables in S, in this order, separated by a space.

Sample Input	Sample Output
3 RaRa ICPCJAG BuRiShaBuShaBuRiBu	1 3 6 6 4 10

In the first test case, the word "`RaRa`" can be divided into syllables in the following ways: "`Ra`" + "`Ra`", "`Ra`" + "`R`" + "`a`", "`R`" + "`a`" + "`Ra`", and "`R`" + "`a`" + "`R`" + "`a`". Here, + denotes string concatenation. For each division, the number of distinct syllables is $1, 3, 3$, and 2, respectively. Therefore, the minimum is 1 and the maximum is 3.

Problem F
Ants Collision

Time Limit: 2 seconds

There are N ants on a number line. The i-th ant is initially at coordinate i and is stationary. Each ant faces either right (the positive direction) or left (the negative direction), but the initial directions are unknown.

At time 0, each ant starts moving at a speed of 1 per unit time. Whenever two ants collide (i.e., occupy the same position), they turn around and move in the opposite direction.

By time 10^{100}, the i-th ant has collided with other ants exactly A_i times.

Determine whether there exists an assignment of initial directions for the ants that is consistent with these collision counts. If such an assignment exists, construct one.

Input

The input consists of multiple test cases.

The first line contains an integer T ($1 \leq T \leq 10\,000$), representing the number of test cases.

T test cases follow. Each test case is given in the following format.

N
A_1 A_2 $\ldots$ A_N

For each test case, the first line contains an integer N ($1 \leq N \leq 300\,000$), representing the number of ants.

The next line contains N integers $A_1, A_2, \ldots, A_N$ ($0 \leq A_i \leq 10^9$), each representing the number of times the corresponding ant has collided with other ants by time 10^{100}.

Additionally, the sum of N over all test cases does not exceed $300\,000$.

Output

Output T lines. For each test case, determine whether there exists an assignment of initial directions for the ants that satisfies the conditions described in the problem.

- If no such assignment exists, output “`No`”.
- If an assignment exists, output a string of length N consisting of characters ‘`L`’ and ‘`R`’, where the i-th character is ‘`L`’ if the i-th ant initially faces left (the negative direction), and ‘`R`’ if it initially faces right (the positive direction).

If multiple assignments exist, any of them will be accepted.

Sample Input	Sample Output
3 3 1 2 1 5 3 1 4 1 5 4 0 0 0 0	RRL No LLLL

Problem G
Fireworks

Time Limit: 2 seconds

There are N apartment buildings equally spaced along a straight line. Building i $(1 \leq i \leq N)$ is located at coordinate $i \times L$ and has height H_i.

This year, a fireworks festival will be held, and the residents of each building want to watch the fireworks from its rooftop. However, depending on the launch position, their view may be blocked by other buildings. To avoid this, for each given launch coordinate X_j, determine the minimum height such that all residents can see the fireworks.

More formally, find the minimum **non-negative** real number h_j such that there do not exist indices a, b $(1 \leq a, b \leq N)$ for which the line segment connecting $(a \times L, H_a)$ and (X_j, h_j) (excluding endpoints) intersects with the line segment connecting $(b \times L, 0)$ and $(b \times L, H_b)$ (excluding endpoints).

Input

The input consists of a single test case in the following format.

N L Q
H_1 H_2 $\ldots$ H_N
X_1
$\vdots$
X_Q

The first line contains integers N $(1 \leq N \leq 300\,000)$, L $(1 \leq L \leq 1\,000)$, and Q $(1 \leq Q \leq 300\,000)$, representing the number of apartment buildings, the distance between adjacent buildings, and the number of candidate launch coordinates, respectively.

The next line contains N integers H_i $(1 \leq H_i \leq 10^9)$, representing the height of building i.

Each of the following Q lines contains an integer X_j $(-10^9 \leq X_j \leq 10^9$, $X_j \neq i \times L$ for $i = 1, \ldots, N)$, representing a candidate coordinate for launching the fireworks.

Output

For the Q queries, output the answers separated by newlines. On the j-th line, output the minimum launch height required when the fireworks are launched at coordinate X_j. The answer will be considered correct if the absolute or relative error is less than 10^{-6}.

Sample Input	Sample Output
3 7 3 5 9 13 10 -9 28	6.7142857143 0 17

Problem H
Max of Mod

Time Limit: 2 seconds

You are given a set of integers $S = \{L, L+1, \ldots, R\}$. As long as S does not contain 0, you can repeatedly perform the following operation:

> Choose a positive integer g less than or equal to the maximum value in S, and replace each element of S with its remainder when divided by g.

Determine the maximum number of operations that can be performed.

Input

The input consists of multiple test cases.

The first line contains an integer T $(1 \leq T \leq 100\,000)$, representing the number of test cases.

T test cases follow. Each test case is given in the following format.

> L R

For each test case, the only line contains integers L and R $(1 \leq L \leq R \leq 10^9)$, representing the minimum and maximum values of the set, respectively.

Output

For the T test cases, output the answers separated by newlines. For each test case, output the maximum number of operations that can be performed.

Sample Input	Sample Output
3 7 10 1 2718 20250913 20250915	2 1 23

Problem I
Copy, Reflect, and Paste

Time Limit: 2 seconds

You are given a polygon P with N vertices, which is not necessarily convex. Initially, let $Q = P$. You can perform the following operation on Q any number of times:

> Choose a line segment of positive length lying on the boundary of Q, and let Q' be the figure obtained by reflecting Q across the line containing this segment.
> If the interiors of Q and Q' intersect, the process ends immediately.
> Otherwise, update Q to the union of Q and Q'.

Determine whether the operation can be repeated indefinitely. In other words, determine whether it is possible to perform the operation at least M times for every positive integer M.

Figure I-1: Illustration of the first test case

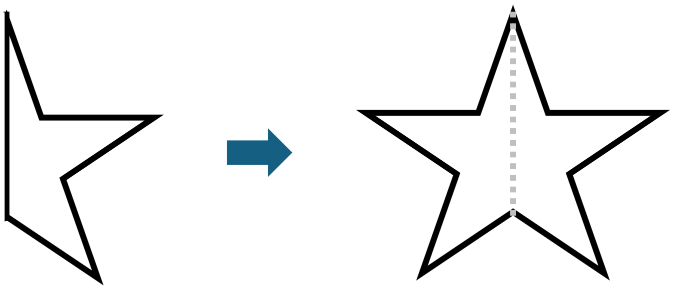

Figure I-2: Illustration of the second test case

Input

The input consists of multiple test cases.

The first line contains an integer T ($1 \le T \le 100$), representing the number of test cases.

T test cases follow. Each test case is given in the following format.

> N
> x_1 y_1
> $\vdots$
> x_N y_N

For each test case, the first line contains an integer N ($3 \le N \le 10\,000$), representing the number of vertices of the polygon.

Each of the following N lines contains two integers x_i and y_i, representing that the i-th vertex of polygon P has coordinates (x_i, y_i). These points satisfy the following conditions:

- $-10^9 \le x_i, y_i \le 10^9$
- The vertices of polygon P are given in counterclockwise order.
- P is a simple polygon; in particular, no interior angle equals 180°.

Output

Output T lines. For each test case, output "`Yes`" if it is possible to perform the operation infinitely many times, and "`No`" otherwise.

Sample Input

```
2
4
0 0
1 0
1 1
0 1
6
11 6
19 10
9 10
5 18
5 3
15 -2
```

Sample Output

```
Yes
No
```

Problem J
Flight Planning 2

Time Limit: 2 seconds

There are N airports in a certain country, and the Jag Airlines Group operates M flights connecting these airports. To reduce the number of airplanes required, they choose to rearrange the order of flights.

In each flight, an airplane departs from one airport and arrives at another, and each flight must be operated by exactly one airplane. We denote by $a \to b$ a flight that departs from airport a and arrives at airport b.

An airplane can operate a flight $x \to y$ only if one of the following holds:

- The airplane was initially placed at airport x and has not yet operated any flight.
- The destination of its most recent operation was airport x.

For example, suppose there are three flights: $a \to b$, $c \to a$, and $b \to d$. If they are ordered as $c \to a$, $b \to d$, and $a \to b$, then $c \to a$ and $a \to b$ can be operated by the same airplane, so the three flights can be operated by two airplanes.

You may reorder the M flights arbitrarily and choose the initial placements of the airplanes arbitrarily. What is the minimum number of airplanes required to operate all the flights?

Input

The input consists of multiple test cases.

The first line contains an integer T ($1 \le T \le 1\,000$), representing the number of test cases.

T test cases follow. Each test case is given in the following format.

$$
\begin{array}{l}
N\ M \\
a_1\ b_1 \\
\vdots \\
a_M\ b_M
\end{array}
$$

For each test case, the first line contains integers N ($2 \le N \le 300\,000$) and M ($1 \le M \le 300\,000$), representing the number of airports and the number of flights, respectively.

The following M lines each contain integers a_i and b_i, satisfying $1 \le a_i, b_i \le N$ and $a_i \ne b_i$. Each line describes the i-th flight $a_i \to b_i$.

Additionally, the sum of N over all test cases does not exceed $300\,000$, and the sum of M over all test cases does not exceed $300\,000$.

Output

For each of the T test cases, output the minimum number of airplanes required, one per line.

Sample Input	Sample Output
2 5 3 2 3 5 4 1 2 5 6 2 3 3 5 5 1 4 2 2 3 1 4	2 1

Problem K
Bomb Game

Time Limit: 2 seconds

There are N stones in a row, and each stone is colored either white or black.

Alice and Bob play the following game using these stones:

> The players alternate turns, and Alice goes first.
> On each turn, the current player must remove exactly one stone from either the left or right end.
> If the total number of black stones removed by the two players reaches M, the player who makes that move loses, and the other player wins.

Determine which player will win the game when both players play optimally. It is guaranteed that the number of black stones is at least M.

Input

The input consists of multiple test cases.

The first line contains an integer T ($1 \le T \le 1\,000$), representing the number of test cases.

T test cases follow. Each test case is given in the following format.

> N M
> S

For each test case, the first line contains integers N ($1 \le N \le 500\,000$) and M ($1 \le M \le N$), representing the total number of stones and the losing threshold, respectively.

The next line contains a string S of length N, consisting only of '`B`' and '`W`'. The i-th character of S represents the color of the i-th stone from the left: it is '`B`' if the stone is black, and '`W`' if the stone is white. It is guaranteed that the number of black stones is at least M.

It is guaranteed that the sum of N over all test cases does not exceed $500\,000$.

Output

For the T test cases, output the answers separated by newlines. For each test case, output the name of the player who will win.

Sample Input	Sample Output
3 5 1 WBBWB 5 2 WBBWB 5 3 WBBWB	Alice Alice Bob

In the first test case, if Alice removes the leftmost white stone, the remaining stones are "`BBWB`". No matter which side Bob chooses from, he will end up picking a black stone, so Bob loses.

In the second test case, Alice will win. For example, the game could proceed as follows:

1. Alice removes the black stone from the rightmost position.
2. Bob removes the white stone from the rightmost position.
3. Alice removes the white stone from the leftmost position.
4. Bob removes the black stone from the rightmost position.

Problem L
Broken Scale

Time Limit: 2 seconds

You are an airport receptionist at Jag Airlines Group. There are N passengers, and you have received one piece of baggage from each of them. From the check-in records, you know that the weight of passenger i's baggage is A_i kilograms.

However, you forgot to attach labels to the bags.

If you assign random labels to the bags, the probability of attaching the correct label to all baggage is $\frac{1}{N!}$, which is far too low. While thinking of ways to increase this probability, you find a slightly broken electronic scale in the warehouse.

After some investigation, you find that when items are placed on this scale, it displays the largest value among $B^0, B^1, B^2, \ldots$ (in kilograms) that does not exceed the actual total weight. Here, B is a given integer with $B \geq 2$.

You may place any non-empty subset of the bags on the scale, and you may repeat this as many times as you like. Find the maximum probability of attaching the correct label to all baggage if you act optimally, and output it modulo $998244353 = 119 \times 2^{23} + 1$.

What is probability modulo 998244353?

It can be proved that the sought probabilities will always be rational numbers. Under the constraints of this problem, it can also be proved that when expressing the value as $\frac{P}{Q}$ using two coprime integers P and Q, there is exactly one integer R satisfying $R \times Q \equiv P \pmod{998244353}$ and $0 \leq R < 998244353$. Find this R.

Input

The input consists of multiple test cases.

The first line contains an integer T $(1 \leq T \leq 10)$, representing the number of test cases.

T test cases follow. Each test case is given in the following format.

> N B
> A_1 A_2 $\ldots$ A_N

For each test case, the first line contains integers N $(1 \leq N \leq 300)$ and B $(2 \leq B \leq 1\,500)$, representing the number of pieces of baggage and the parameter of the electronic scale, respectively.

The next line contains N integers A_i $(1 \leq A_1 \leq A_2 \leq \cdots \leq A_N \leq 1\,500)$, representing the weight of passenger i's baggage.

Additionally, the sum of N over all test cases does not exceed 300.

Output

For the T test cases, output the answers separated by newlines. For each test case, output the maximum probability of attaching the correct label to all baggage if you act optimally.

Sample Input	Sample Output
3 3 3 9 15 17 5 23 41 41 41 41 41 14 10 101 102 103 104 105 106 107 108 109 110 111 112 113 114	499122177 856826403 314148269

In the first test case, if you place one bag at a time, the scale always shows $3^2 = 9$ (kilograms), so you cannot distinguish any of them. However, if you place two bags at a time, only the combination $15 + 17$ yields $3^3 = 27$ (kilograms). Therefore, the bag not placed on the scale at that moment must be the one labeled 1 (9 kilograms). Since the bags labeled 2 and 3 cannot be distinguished by any sequence of weighings, the maximum probability is $\frac{1}{2}$.

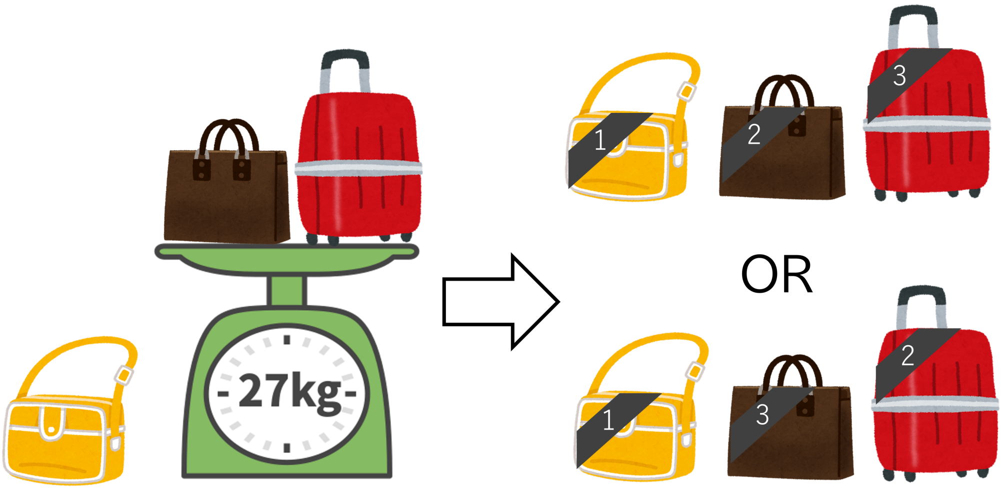

Figure L-1: Illustration of the first test case