BINUS University

Academic Career:	Class Program:
*Undergraduate / ~~Master~~ / ~~Doctoral~~ *)*	*~~International~~ / Regular / ~~Smart Program~~ / ~~Global Class~~ / ~~BINUS Online Learning~~ *)*

		Term : Odd / ~~Even~~ / ~~Compact~~ *)
☐ Mid Exam	☐ Compact Term Exam	
☑ Final Exam	☐ Others Exam : _____	Period (Only for BOL) : ~~1~~ / ~~2~~ *)

			Academic Year :
☑ Kemanggisan	☐ Senayan	☐ Semarang	
☑ Alam Sutera	☐ Bandung		
☑ Bekasi	☐ Malang		2022 / 2023

Exam Type*	:	Onsite / Online	Faculty / Dept.	:	School of Computer Science
Day / Date**	:		Code - Course	:	-
Time**	:		Code - Lecturer	:	Team Teaching
Exam Specification***	:	☐ Open Book ☐ Open Notes	BULC (Only for BOL)	:	-
		☐ Close Book ☐ Submit Project	Class	:	
		☐ Open E-Book ☐ Oral Test			
Equipment***	:		Student ID ***	:	
☐ Exam Booklet ☐ Laptop ☐ Drawing Paper – A3			Name ***	:	
☐ Calculator ☐ Tablet ☐ Drawing Paper – A2			Signature ***	:	
☐ Dictionary ☐ Smartphone ☐ Notes					

*) *Strikethrough the unnecessary items*   ****)** *For Online Exam, this is the due date*   *****)** *Only for Onsite Exam*

Please insert the test paper into the exam booklet and submit both papers after the test.

The penalty for CHEATING is DROP OUT!

Learning Outcomes:

LO1: (C3) Application : apply algorithm techniques and methods
LO2: (C4) Analysis : calculate processing time and memory space of algorithms.
LO3: (C5) Synthesis : Create good and correct algorithm for problem solving

Dokumen ini berisi deskripsi dari semua soal. Total terdapat 3 soal utama dan 1 soal tambahan. Ketiga soal utama memiliki total 100 poin, dan soal tambahan juga bernilai 100 poin. Nilai Anda tetap tidak bisa lebih dari 100 poin. Oleh karena itu, silakan pilih dengan bijaksana, soal mana yang ingin Anda kerjakan.

Perhatikan bahwa untuk soal tambahan, mungkin saja membutuhkan algoritma/struktur data/teknik yang belum pernah diajarkan di kelas. **Anda disarankan untuk mengerjakan 3 soal utama terlebih dahulu**.

Anda diperbolehkan membawa cheatsheet (reference document) tidak lebih dari 25 halaman A4.

Selamat mengerjakan!

Verified by,
[Lecturer Name] (Lecturer ID) and sent to Department/Program on MMM DD, YYYY

A. Jojo and Knapsack (30 points)

Jojo has a bag with a capacity of M. There are N items, numbered from 1 to N. Item i has a weight of W_i and a value of V_i. Find the maximum total value of items that Jojo can take such that the total weight of items that Jojo takes does not exceed M. Denote this value as the original answer.

That is just a regular Knapsack problem. In this problem, there is an additional restriction k, such that Jojo can only take at most k items. Determine the minimum value of k such that the total value of items is exactly the same as the original answer.

Subtasks

No	Constraints	Points
1	$1 \leq N, M \leq 100$ $W_i = V_i = 1$, for $1 \leq i \leq N$	5
2	$1 \leq N, M \leq 100$ $1 \leq W_i, V_i \leq 100$, for $1 \leq i \leq N$	15
3	$1 \leq N, M \leq 1000$ $1 \leq W_i, V_i \leq 1000$, for $1 \leq i \leq N$	10

Input Format
The first line consists of two integers N and M. The next N lines consist of two integers W_i and V_i.

Output Format
A single line consisting of an integer that represent the minimum value of k.

Sample Input	Sample Output
5 12 6 2 6 1 4 1 4 1 4 1	2
2 10 6 3 6 5	1

Explanation
In the first sample, the original answer is 3, which can be achieved by either taking item 1 and 2; or item 3, 4, and 5. If a restriction of $k = 2$ is given, then the total value is still 3. If a restriction of $k = 1$ is given, then the total value changes to 2, by taking the first item.

In the second sample, the original answer is 5, which can be achieved by taking item 2. If a restriction of $k = 1$ is given, then the total value does not change.

B. Lili and Numbers (40 points)

Lili has an integer A. She wants to change her integer to B. In order to change her integer, Lili can perform one of the following actions in one operation:
- Decrease the value of her integer by 1, or
- Multiply the value of her integer by 2.

Determine the minimum number of operations in order to change her integer to B.

Subtasks

No	Constraints	Points
1	$1 \le A \le 100\,000$ $B = 1$	5
2	$1 \le A, B \le 100\,000$	15
3	$1 \le A, B \le 10^9$	20

Input Format
A single line consisting of two integers A and B.

Output Format
A single line consisting of an integer that represent the minimum number of operations.

Sample Input	Sample Output
1 5	5
5 1	4
5 17	4
4 4	0
100 101	51

Explanation
In the first sample, Lili can do the following steps: $1 \to 2 \to 4 \to 3 \to 6 \to 5$, which requires 5 operations. It can be shown that there is no better solution than 5.

In the second sample, Lili can decrease the value of A by 4 times.

In the third sample, Lili can do the following steps: $5 \to 10 \to 9 \to 18 \to 17$, which requires 4 operations. It can be shown that there is no better solution that 4.

In the fourth sample, Lili does not need to do any operation.

In the fifth sample, Lili can do the following steps. First, decrease her integer 49 times to make her integer 51. Then, multiply it by 2 to make her integer 102. Finally, decrease her integer to make it 101. It requires 51 operations, which can be shown that there is no better solution that this.

C. Bibi and Query (30 points)

Bibi has N integers, numbered from 1 to N. Integer i has a value of A_i.

Define $f(l,r) = \sum_{i=0}^{r-l} \left(A_{l+i} \times (-1)^i \right)$. In other words, is the sum from A_l to A_r, but the signs are alternating. For example, $f(3,5) = A_3 - A_4 + A_5$, $f(4,7) = A_4 - A_5 + A_6 - A_7$, and $f(5,5) = A_5$.

Bibi asks Q queries. In each query, Bibi gives you L and R. You need to determine the value of $f(L,R)$ of each query.

Subtasks

No	Constraints	Points
1	$1 \le N, Q \le 1000$ $1 \le A_i \le 10^9$, for $1 \le i \le N$ $1 \le L, R \le N$ and $L = R$, for each query.	5
2	$1 \le N, Q \le 1000$ $1 \le A_i \le 10^9$, for $1 \le i \le N$ $1 \le L \le R \le N$, for each query.	10
3	$1 \le N, Q \le 30\,000$ $1 \le A_i \le 10^9$, for $1 \le i \le N$ $1 \le L \le R \le N$, for each query.	15

Input Format
The first line consists of two integers N and Q. The second line consists of N integers A_i. The next Q lines consist of two integers L and R of each query.

Output Format
For each query, print an integer in a single line, representing the value of $f(L,R)$ of that query.

Sample Input	Sample Output
4 5 3 5 2 7 1 4 2 4 3 4 4 4 1 3	-7 10 -5 7 0

Explanation
In the first sample, the followings are the value of each query:
- $f(1,4) = 3 - 5 + 2 - 7 = -7$
- $f(2,4) = 5 - 2 + 7 = 10$
- $f(3,4) = 2 - 7 = -5$
- $f(4,4) = 7$
- $f(1,3) = 3 - 5 + 2 = 0$

X. Easy Problem (100 points)

You are given N integers, numbered from 1 to N. Integer i has a value of A_i. You are also given a variable x, which is initially set to 0. The following operation repeats K times.

First, choose an index j from 1 to N uniformly at random. Increase the value of x by the product of all A_i such that $1 \leq i \leq N$ and $i \neq j$ (or in another words, the product of all of your integers except A_j). Finally, subtract A_j by 1.

Find the expected value of x at the end of all operations. It can be proved that the answer can be represented as an irreducible fraction $\frac{p}{q}$. You have to find $P \cdot Q^{-1} \bmod 998\,244\,353$.

Subtasks

No	Constraints	Points
1	$1 \leq N \leq 50\,000$ $1 \leq K \leq 10^8$ $0 \leq A_i \leq 10^8$, for $1 \leq i \leq N$	100

Input Format
The first line consists of two integers N and K. The second line consists of N integers A_i.

Output Format
Output an integer in a single line which represent the answer.

Sample Input	Sample Output
2 1 5 5	5
1 10 80	10
2 2 0 0	499122176
9 4 0 11 12 9 20 7 8 18 2	572996891