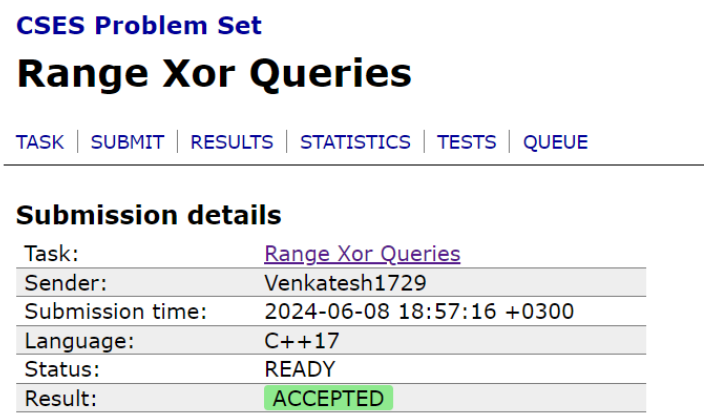
ACA - Mastering Algorithms

Final Assignment

Due Date: 16^{th} July 11:59 pm, 2024

Instructions

1. Solve and submit your code on the provided links which can be accessed from the question heading.
2. You should upload your C++ solutions as .cpp files with appropriate file names on your Github repository.
3. Along with the code, upload a screenshot of the submission on the respective websites, showing it is accepted for each question. A similar image for a CSES submission is shown :



CSES Problem Set

Range Xor Queries

TASK | SUBMIT | RESULTS | STATISTICS | TESTS | QUEUE

Submission details

Task:	Range Xor Queries
Sender:	Venkatesh1729
Submission time:	2024-06-08 18:57:16 +0300
Language:	C++17
Status:	READY
Result:	ACCEPTED

4. Solve and upload at least 3 questions out of the given 5. However, it is recommended that you solve all the questions.
5. Do not waste your time using external resources such as Google or Chat GPT to answer the questions.
6. Allowed Languages for challenge code submission: C/C++
7. Your codes will be checked for possible plagiarism of any sort. If we find such cases, we will possibly deratify you.

Coin Combinations

Problem 1.

Consider a money system consisting of n coins. Each coin has a positive integer value. Your task is to calculate the number of distinct ordered ways you can produce a money sum x using the available coins.

For example, if the coins are {2,3,5} and the desired sum is 9, there are 3 ways:

```
2+2+5
3+3+3
2+2+2+3
```

Input Format:

- The first input line has two integers n and x: the number of coins and the desired sum of money.
- The second line has n distinct integers c_1,c_2,...,c_n: the value of each coin.

Output Format:

- Print one integer: the number of ways modulo $10^9 + 7$

Constraints

- $1 \leq n \leq 100$
- $1 \leq x \leq 10^6$
- $1 \leq c_i \leq 10^6$

Sample Input

```
3 9
2 3 5
```

Sample Output

```
3
```

Course Schedule

Problem 2.

There are n different online courses numbered from 1 to n. You are given an array courses where courses[i] = [duration$_i$, lastDay$_i$] indicate that the i^{th} course should be taken continuously for duration$_i$ days and must be finished before or on lastDay$_i$.
You will start on the 1st day and you cannot take two or more courses simultaneously.
Return the maximum number of courses that you can take.

Input Format:

- courses array with courses[i] = [duration$_i$, lastDay$_i$]

Output Format:

- You have to give a single line output for what is the maximum number of courses that you can take.

Examples

Example 1:
Input: courses = [[100,200],[200,1300],[1000,1250],[2000,3200]]
Output: 3

Example 2:
Input: courses = [[1,2]]
Output: 1

Example 3:
Input: courses =[[3,2],[4,3]]
Output: 0

Constraints

- $1 \leq$ courses.length $\leq 10^4$
- $1 \leq$ duration$_i$, lastDay$_i$ $\leq 10^4$

Walk

Problem 3.

Given a simple directed graph G with N vertices, numbered $1, 2, \ldots, N$, and an $N \times N$ matrix A where a_{ij} represents whether there is a directed edge from vertex i to vertex j. If a_{ij} =1, there is a directed edge from Vertex i to vertex j, if a_{ij} =0, there is not.
Find the number of different directed paths of length K in G, modulo $10^9 + 7$. We will also count a path that traverses the same edge multiple times.

Input format

- The first line contains two space-separated integers N and K, denoting the number of vertices and the path length.
- The Next lines contain N space-separated integers denoting elements of the array a_{ij}.

Output format

- Print the number of different directed paths of length K in G, modulo $10^9 + 7$.

Constraints

- All values in input are integers.
- $1 \leq N \leq 50$
- $1 \leq K < 10$

Sample Input

```
4 2
0 1 0 0
0 0 1 1
0 0 0 1
1 0 0 0
```

Sample Output

```
6
```

Building Roads

Problem 4.

Byteland has n cities, and m roads between them. The goal is to construct new roads so that there is a route between any two cities. Your task is to find out the minimum number of roads required, and also determine which roads should be built.
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Input format

- The first input line has two integers n and m: the number of cities and roads. The cities are numbered 1,2,..., n.
- After that, there are m lines describing the roads. Each line has two integers a and b: there is a road between those cities.

A road always connects two different cities, and there is at most one road between any two cities.

Output format

- First print an integer k: the number of required roads.
- Then, print k lines that describe the new roads. You can print any valid solution.

Constraints

- $1 \leq n \leq 10^5$
- $1 \leq m \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

Sample Input

```
4 2
1 2
3 4
```

Sample Output

```
1
2 3
```

Shortest Route

Problem 5.

There are n cities and m flight connections between them. Your task is to determine the length of the shortest route from Syrjälä to every city.

Input format

- The first input line has two integers n and m: the number of cities and flight connections. The cities are numbered 1,2,...,n, and city 1 is Syrjälä.
- After that, there are m lines describing the flight connections. Each line has three integers a, b, and c: a flight begins at city a, ends at city b, and its length is c. Each flight is a one-way flight.

You can assume that it is possible to travel from Syrjälä to all other cities.

Output format

- Print n integers: the shortest route lengths from Syrjälä to cities 1,2,..., n.

Constraints

- $1 \le n \le 10^5$
- $1 \le m \le 2 \cdot 10^5$
- $1 \le a, b \le n$
- $1 \le c \le 10^9$

Sample Input

```
3 4
1 2 6
1 3 2
3 2 3
1 3 4
```

Sample Output

```
0 5 2
```