

# CS F211

## Data Structures and Algorithms

### Assignment - 5

#### Singly and Doubly Linked Lists

Allowed Language: C

February 7, 2024

#### General Tips

- Try to use functions as much as possible in your code. Functions increase reusability and the pass-by-value feature provides a significant help sometimes. Modularizing your code also helps you to debug efficiently.
- Use `scanf` to read characters/strings from STDIN. Avoid using `getchar`, `getc` or `gets`. Try to read up about character suppression in `scanf` as it will be very helpful in some of the problems.
- Use `printf` instead of `putc`, `putchar` or `puts` to print character/string output on STDOUT.
- Indent your code appropriately and use proper variable names. These increase readability and writability of the code. Also, Use comments wherever necessary.
- Use a proper IDEs like Sublime Text or VSCode as they help to run and test your code on multiple test-cases easily.
- **Note:** Kindly try to do all of these questions by yourself at least once. Spend some time thinking about it, or trying to code it instead of directly asking help of your friends or searching it up online. This helps you understand the question, allowing you to solve further questions which are not in the scope of this Assignment yourself.
- **Important:** Every submission on Mooshak will be checked offline after your respective labs, and if you have not used linked lists, then regardless of the testcases passed during the lab, you will fetch 0 marks.

## A: Breaking Add

Walter White in the parallel universe loved math. In search of hefty questions and complex equations, he walked across the huge valleys of New Mexico. While travelling, he found a boundless gate. In order to cross the gate, he was supposed to enter a password. He found 3 scrolls lying on the side of the gate. Two scrolls had some numbers written on them and the third one had some instructions:

*In order to open the door,  
These rules you must adore;  
And if you do not pass,  
You shall not be allowed to explore.*

*There are two scrolls in which verse,  
Two numbers in reverse;  
And for passing through the gate,  
The sum of the original numbers you must rehearse.*

*Past the gate is a fog of mist,  
Which is achievable only through the use of Linked List;  
The sum should be in a new one although, reversed,  
And that's all there is to this valley's twist.*

Help Walter White find the formula to decipher the scrolls and go past the boundless door in order to cultivate his love for math.

### Input

The first line contains 2 positive integers  $n$  and  $m$  ( $1 \leq n, m \leq 10^6$ ) - the number of digits in the two scrolls respectively.

The second line contains  $n$  digits of an integer  $a$  in reverse order, where each digit in  $a$  is from 0 to 9, both inclusive.

The third line contains  $m$  digits of an integer  $b$  in reverse order, where each digit in  $b$  is from 0 to 9, both inclusive.

**Note:** The last digit in each of the inputs of second and third line will NOT be 0.

### Output

A linked list, consisting of the the sum of the original numbers, but in reverse.

**Note:** There should be no extra zeros in the end.

---

input  
4 5  
3 4 5 2  
2 9 1 0 2

output  
5 3 7 2 2

---

input  
2 2  
4 6  
6 3

output  
0 0 1

---

input  
9 7  
8 5 2 6 2 1 0 0 7  
3 2 2 2 0 0 9

output  
1 8 4 8 2 1 9 0 7

---

## B: Noine Noine!

Jake Peralta and Amy Santiago were on a mission to see who could catch more criminals. Jake caught  $n$  criminals and Amy caught  $m$  criminals. Since Amy is smart, she of course won, i.e.,  $m$  is strictly greater than  $n$ . Now, they brought in their perps (criminals) in the precinct, and made them stand in a line each (Jake made his own line of perps, and Amy her own), in ascending order of the number on their t-shirts. Now Captain Holt was furious and wanted all of them in one single line in ascending order of their t-shirt numbers, but without any commotion.

You are given two linked lists with the t-shirt numbers of the perps and are required to find an optimal way to help Peraltiago to make them stand in one single line. You are supposed to do this without allocating new memory.

### Input

The first line contains two integers  $n$  and  $m$  ( $1 \leq n < m \leq 10^6$ ) - the number of perps caught by Jake and Amy respectively.

The second line contains  $n$  integers  $a_1 < a_2 < \dots < a_n$  ( $0 \leq a_i \leq 10^9$ ) - t-shirt numbers of perps caught by Jake.

The third line contains  $m$  integers  $b_1 < b_2 < \dots < b_m$  ( $0 \leq b_i \leq 10^9$ ) - t-shirt numbers of perps caught by Amy.

**Note:** Two or more perps can have the same t-shirt numbers.

### Output

A single linked list consisting of all the perps in order as described above.

---

input

3 4

33 345 346

1 22 333 4444

output

1 22 33 333 345 346 4444

---

input

1 4

4

2 4 54 445

output

2 4 4 54 445

---

## C: Jethalal's Loss

Sunderlal is recently investing a lot in stocks. One day he got some insider information on  $n$  stocks, but did not have the capital to invest. So, he decided to ask Jethalal for the money. Although Jethalal was pretty suspicious about the plan, he had no choice but to give him 1 crore rupees to invest otherwise Daya would not talk to him.

Now Sunderlal being Sunderlal, he read the stocks' list in reverse order and invested accordingly. This led to a huge loss of Jethalal's money. Jethalal was disappointed and angry. But since he has lots of connections in the stock market, he knows that his money would be recovered in no time. All he has to do is to find out the original order of the stocks, which Sunderlal read wrong.

The stocks are given to you as a linked list in the way Sunderlal read it and you have to obtain the original list by changing the links of the linked list, as required.

**Note:** You are allowed to use only constant extra space and a singly linked list.

### Input

The first line contains a single positive integer  $n$  ( $1 \leq n \leq 10^6$ ) - the number of stocks.

The second line contains  $n$  stocks  $a_1, a_2, \dots, a_n$  ( $1 \leq a_i \leq 10^9$ ) - where  $a_i$  is the number of the  $i$ -th stock.

### Output

Find the original list of stocks.

---

input

5

1 2 6 23 3

output

3 23 6 2 1

---

input

6

1 5 2 9 11 4

output

4 11 9 2 5 1

---

## D: Sheldon's Rotations

Sheldon made a list of  $n$  problems he solved of Quantum Astrophysics. But Leonard jumbled his problems and ran away. Now Raj saw all that and told Sheldon that if he \*rotates his list  $k$  times to the left, then he will get his original order of problems back. Help Sheldon get the original order of problems.

The jumbled list of problems will be given to you as a linked list and you have to make modifications in the same linked list.

\*A left rotation is defined when every element moves to its immediate left and the 1st element moves to the last.

### Input

The first line contains two integers  $n$  and  $k$  ( $1 \leq n \leq 10^6$ ;  $0 \leq k \leq 10^6$ ) - number of problems and number of rotations respectively.

The second line contains  $n$  problems  $a_1, a_2, \dots, a_n$  ( $1 \leq a_i \leq 10^9$ ) - as changed by Leonard, where  $a_i$  is the problem number.

### Output

A single linked list which Sheldon originally made.

---

input

3 4  
3 2 1

output

2 1 3

---

input

7 2  
93 2 34 23 9 1 11

output

34 23 9 1 11 93 2

---

## E: Berlin

Berlin caught  $n$  people numbered from 1 to  $n$  who deceived him over the years. In order to punish them, he decided to play a little game in which only one person will survive. He made them sit in clockwise order in which on moving clockwise  $i$ -th person will lead you to the  $(i+1)$ -th person ( $1 \leq i < n$ ), and moving from the  $n$ -th person leads you to the 1st person.

This new game had some rules as follows:

- Berlin starts at the 1st person.
- He counts  $k$  people in clockwise order including the person he started with and sends the  $k$ -th person from the start to Alcatraz. If  $k$  is more than the number of people remaining, he circles around.
- After throwing that person, he starts the process again with the next person in clockwise order and continues this process till only 1 person remains.

Since every single one of them had deceived him, Berlin mysteriously disappears the last one instead of sending him to Alcatraz. Find the person which Berlin made to disappear.

**Note:** You are supposed to solve this problem by using a singly linked list.

### Input

The first line contains two integers  $n$  and  $k$  ( $1 \leq k \leq n \leq 500$ ).

### Output

Number of the person Berlin made to disappear.

---

input  
5 2

output  
3

---

input  
6 5

output  
1

---

## F: Monica's Arrangements

Monica loves organizing things. One day, she told Chandler to get her copies of  $n$  different magazines. But Chandler got some duplicates instead. Monica got furious and first organized the duplicates of each magazine such that they would occur together (not necessarily in sorted order). Then she kicked Chandler out of the house with the magazines and told him to remove all the duplicates but one, and come back and give the magazines to her in the same order.

Help Chandler remove the duplicates of the magazines and keeping one of each so that he can return it to Monica.

**Note:** You are given the magazine numbers in the form of a linked list and you are supposed to make the modifications in the same list.

### Input

The first line contains a single integer  $n$  ( $1 \leq n \leq 10^6$ ) - number of magazines Chandler got.  
The second line contains  $n$  integers  $a_1, a_2, \dots, a_n$  ( $1 \leq a_i \leq 10^9$ ) - magazine numbers.

### Output

The linked list without duplicate magazine numbers.

---

input

7

1 1 1 2 3 4 5

output

1 2 3 4 5

---

input

2

1 1

output

1

---

input

10

1 1 23 23 23 4 5 5 5 5

output

1 23 4 5

---



## G: Where is Jim?

Dwight needs to meet Jim urgently but Jim is running on a circular track. Dwight goes there and finds Jim standing on some block of the track. The blocks on the track are numbered 1 to  $n$  clockwise (on moving clockwise from block  $n$ , you reach block 1). Dwight and Jim start at 2 random positions  $a$  and  $b$  respectively. For each step that Jim takes clockwise, Dwight takes 2 steps clockwise. Find out at which numbered block will Dwight catch up with Jim (in order to catch up, they have to be on the same block).

**Note:** You are supposed to solve this problem by using a singly linked list.

### Input

The first line contains 3 integers  $n$ ,  $a$  and  $b$  ( $2 \leq n \leq 10^6$ ;  $1 \leq a, b \leq n$ )

### Output

A single integer - the block where they meet.

---

input

6 1 2

output

3

---

input

6 2 1

output

6

---

input

10 2 9

output

6

---

## H: Deque

Nom was sleeping peacefully, when he suddenly woke up from the smell of Peanut Butter. There was a HUUUGE Linked List of Peanut Butter Jars. All he has to do is perform some operations correctly to disable the Linked List and get all the Peanut Butter he wants.

He is supposed to perform  $q$  operations of these 6 operations below:

1. Insert element at the front of the List.
2. Insert element at the back of the List.
3. Delete element from the front of the List.
4. Delete element from the back of the List.
5. Print the List forward.
6. Print the List backward.

Help Nom embrace his Peanut Butter Jars and eat them and return to his peaceful slumber.

**Note:** You are supposed to solve this problem using a doubly linked list.

### Input

The first line contains two integers  $n$  and  $q$  ( $1 \leq n, q \leq 10^3$ ) - number of jars in the initial list and the number of operations respectively.

The second line contains  $n$  integers  $a_1, a_2, \dots, a_n$  ( $1 \leq a_i \leq 10^9$ ) - the elements in the initial list, i.e., the weights of the jars.

Consequent  $q$  lines contain two integers for operations 1 and 2 - operation number and the element to be inserted (same constraints as  $a_i$ ), and a single integer for operation 3-6 - operation number.

### Output

A list of jars for operations 5 and 6, with the output of each operation being in a new line. While the list is empty, print -1 in case of print operations.

---

input

~~3 5~~  
3 4 5 2  
2 3  
4  
4  
6

output

5 4 3

---

---

```
input
3 10
2 10 11
2 10
3
4
6
5
4
4
5
6
1 20
```

```
output
11 10
10 11
-1
-1
```

---

## I: Lottery

Kira was tired of laundering money and decided to buy lottery tickets instead. The lottery tickets had a scratch card and beneath that if the word was a \*Palindrome, Kira would win the lottery.

Help Kira find out whether or not he won the lottery.

\*A Palindrome is a string which can be read the same forward and backward.

**Note:** You can use a linked list of your choice to solve this problem, but we'd encourage you to implement a doubly linked list for this one.

### Input

A single integer  $n$  ( $1 \leq n \leq 10^6$ ) - size of the word.

A string  $s$  of size  $n$  - a **case sensitive** word beneath the scratch card.

### Output

"YES" if Kira wins the lottery, otherwise "NO" (without the quotes).

---

input

9

Malayalam

output

NO

---

input

3

uWu

output

YES

---

input

6

uWuntu

output

NO

---

## J: Someone Stop TheHackerCat

Vidyateja was bored of not having trapped any kids using his websites. So he decided to make a music website instead, as all kids were addicted to music. He named his website as `stopify.donut.com`. The website could do the following operations:

1. Print the Now Playing Song.
2. Add a Song to Play Next to the Now Playing Song.
3. Add a Song to the End of the Queue.
4. Play Next Song (Skip Current Song).
5. Play Previous Song.
6. Delete the Now Playing Song and go to the Next Song (if Now Playing Song is the last, go to the first song).

Help Vidyateja lure more and more kids into his trap. You can do this by implementing the playlist of songs as a doubly linked list and testing  $q$  operations on it. Assume that the first element is the initial Now Playing Song.

**Note:** If there is no next song or no previous song, stay at the current.

### Input

The first line contains two integers  $n$  and  $q$  ( $1 \leq n, q \leq 10^3$ ) - the number of songs initially in the playlist and the number of operations to be tested.

The second line contains  $n$  integers  $a_1, a_2, \dots, a_n$  ( $1 \leq a_i \leq 10^9$ ) - each integer is a song in the initial playlist.

Consequent  $q$  lines contain a single integer for operations 1 and 4-6 - the operation number, and two integers for operations 2 and 3 - the operation number and song (same constraints as  $a_i$ ).

### Output

Print the song for each call of operation 1 in a new line. If there is no song playing, print 0.

---

```
input
4 7
1 2 3 4
1
6
1
5
1
4
1
```

output

1  
2  
2  
3

---

input

~~2 10~~  
5 6  
4  
4  
1  
3 7  
3 8  
2 9  
4  
1  
2 10  
4  
1

2 11

.

output

6  
9  
10

---