

Assignment 1: ‘Revising’ C Concepts

CS2.201a Computer Systems Organization (CSO)

January 30, 2023

1. Write a C program that implements a doubly linked list for heap allocated strings. This task will be graded automatically, so please follow the input/output format carefully.

The first line of input will contain a single integer q , $1 \leq q \leq 10^5$ the number of queries you will have to process. Each query will be in one of the following 4 types.

- 1 $pos\ str$ - This means, insert the string str at position pos in the current list. It is guaranteed that the first query will have $pos = 0$. To clarify, pos is the number of elements in the list from the left after which you insert str . For example, if the current list was

$"abc" \iff "def" \iff "ghi"$

an insert to $pos = 2$ would result in the following list:

$"abc" \iff "def" \iff "new\ string" \iff "ghi"$

- 2 id - Delete the string at position pos in the current list. It is guaranteed that this query will always correspond to a valid position in the current list. id here is the **0-indexed** position of the element in the list.
- 3 $l\ r$ ($l \leq r$) - Print all the strings (space separated) that satisfy $l \leq id \leq r$ in increasing order of pos (from left to right)
- 4 $l\ r$ ($l \leq r$) - Print all the strings (space separated) that satisfy $l \leq id \leq r$ in decreasing order of pos (from right to left)

Sample input

7

1 0 hello

1 0 world

1 2 pointers

4 0 2

3 2 2

2 0

3 0 1

Sample output

pointers hello world

pointers

hello pointers

Note: It is guaranteed that the sum of the characters you'll have to read and print will be $\leq 10^5$.

2. Shoreki and Ramsri get access to a treasure vault that has n boxes in it. Each box contains a_i amount of coins in it. They both decide to play a game to decide who gets how many coins. The rules of the game are as follows:

The game occurs in turns and Kishore has the first turn. During their turn, the participant can choose any remaining box and give it to either of the contestants.

Each of them want to maximize the amount of coins gained and hence they make decisions optimally. How much coins will they each have at the end?

Input format

The first line of the input will contain an integer n ($1 \leq n \leq 10^4$). The next line of input will contains n space separated integers a_i ($1 \leq i \leq n, 1 \leq a_i \leq 10^5$).

Output format

Print two space separated integers, k and s . The number of coins Kishore and Sriram gain respectively if they play optimally.

Sample input

15

3026 3027 4599 4854 7086 29504 38709 40467 40663 58674 61008 70794 77517 85547 87320

Sample output

306375 306420

3. **Note:** The following code contains undefined behavior and *may not* show the **exact** behavior described when run on your system.

The code we're referring to can be found [here](#).

This code contains some undefined behavior due to which the following effects were observed on our target machine.

- The code was compiled as given using the command `gcc printf.c -o printf` and run with the input:

input.txt

```
fname:WhyC
lname:Again
age:21
```

It executes without any issue and provides the expected output:

```
#> ./printf < input.txt
Age: 21
First name: WhyC
Last name: Again
```

- Now, the `printf` on line **23** is commented / removed and the program is run again with the exact same compilation options and input as before. However, this time the program segfaults!

We are extremely puzzled by this bizarre behavior and want to know the reason behind this voodoo. There are two parts to this problem, first try to identify the bug in the program that is causing the undefined behavior. Second, try to reason why the bug does not cause a segfault when the *printf* statement is present in the code.

Hints:

- (a) *The bug is related to the memory allocation and subsequent accesses that are taking place in the program.*
- (b) *To figure out why printf "fixes" the bug, think about how memory is usually allocated to a program and about the internal workings and requirements of printf. You do not need to read printf's library code, just reason about what printf requires to work.*