

## Programming Assignment 4 – Router's Packet Scheduling

In computer networks, routers are responsible for forwarding the network packets to outgoing links. The incoming packets arrive at a router in sequence and are queued in the buffer of the router. The router needs to decide the order of packets to send to the outgoing link. This is called the packet scheduling problem.

To simplify the problem, we assume the incoming packets are accumulated in the buffer and will be sent out in a batch when the buffer is full. We also assume the scheduling mechanism is **priority scheduling**. In priority scheduling, packets are divided into two categories, high priority packets and low priority packets (*we use H to represent high priority and L to represent low priority*). In a batch, high priority packets will be sent first. For packets with the same priority, they will be sent in the order of arrival. For example, given three incoming packets with priority of HLH respectively, the outgoing order of the packets should be 0, 2, 1. Here the packet number is assigned implicitly based on the packets' arrival order, *starting from 0*. The three incoming packets with priority of H, L, H will become packet 0, 1, 2 respectively.

In this problem, we assume the buffer size is 3. Given the priority of a number of incoming packets, you need to print out the outgoing order of packets. For example, the three packets with priority of H, L, H will be output in the order of 0, 2, 1.

If the number of packets  $n$  is not divisible by 3, the buffer is supposed to output the remaining  $n\%3$  packets instead of holding them. For example, five incoming packets have the priority of H, L, H, L, H respectively. The first three packets will arrive and make the buffer full, so they will be sent out in a batch in the order of 0, 2, 1. The remaining two packets will be sent in the order of 4, 3. Therefore, the outgoing order of all packets should be 0, 2, 1, 4, 3.

### Input of The Program

The input of your program consists of an integer and a string. The integer is the number of incoming packets. The string is the priority for the incoming packets. The packet number is assigned implicitly based on the packets' arrival order, starting from 0. For example, input ``4 HLHH" represents that there are four incoming packets and the priority for packet 0, 1, 2, 3 are respectively H, L, H, H.

### Output of The Program

Given the input, you should print out the order of outgoing packets. For example, for input ``4 HLHH", the order of outgoing packets should be ``0 2 1 3".

**Keep in mind that you need to check the correctness of input:**

If the priority of packets is not "H" or "L", then the output should be "Wrong input: the priority must be H or L".

If the number of packets is 0 or smaller than 0, then the output should be "Wrong input: the number of packets must be greater than 0".

If the length for priority string does not equal to the number of packets specified, then the output should be "Wrong input: the number of packets is wrong."

#### **Example Input and Output of the Program:**

Sample 1:

Input: 5 HLHLH

Output: 0      2      1      4      3

Sample 2:

Input: 3 LHL

Output: 1      0      2

#### **Deliverables:**

1. You should submit a program in a language you prefer: C, Java or Python. The template code for C is provided.
  - a. The program should take 2 inputs: number of incoming packets, and the priority string for the incoming packets.
  - b. The program's output should match what is required in this assignment. For example, For example, for input "4" and "HLHH", the order of outgoing packets should be "0 2 1 3".
  - c. The grader will run your program and test your program with random input. Your program should pass all the test cases.
2. You also need to submit a report with a screenshot of your code and screenshots of execution of the code. Be prepared to demonstrate your code to the grader or instructor.