Last time homework

- Geometric analysis Example 2020Q3.

Today’s new question

- Construct a new class in solving a tree/node style question. 2018Q5: Choose your own path.
- Smart way to solve a hard problem 2017Q5: Nailed It.

Problem J5: Choose your own path

Problem Description

There is a genre of fiction called *choose your own adventure* books. These books allow the reader to make choices for the characters which alters the outcome of the story.

For example, after reading the first page of a book, the reader may be asked a choice, such as "Do you pick up the rock?" If the reader answers "yes", they are directed to continue reading on page 47, and if they choose "no", they are directed to continue reading on page 18. On each of those pages, they have further choices, and so on, throughout the book. Some pages do not have any choices, and thus these are the "ending" pages of that version of the story. There may be many such ending pages in the book, some of which are good (e.g., the hero finds treasure) and others which are not (e.g., the hero finds a leftover sandwich from 2001).

You are the editor of one of these books, and you must examine two features of the choose your own adventure book:

1. ensure that every page can be reached – otherwise, there is no reason to pay to print a page which no one can ever read;
2. find the shortest path, so that readers will know what the shortest amount of time they need to finish one version of the story.

Given a description of the book, examine these two features.

Input Specification

The first line of input contains N ($1 \leq N \leq 10000$), the number of pages in the book. Each of the next N lines contain an integer M_i ($1 \leq i \leq N; 0 \leq M_i \leq N$), which is the number of different options from page i, followed by M_i space-separated integers in the range from 1 to N, corresponding to each of the pages to go to next from page i. It will also be the case $M_1 + M_2 + \cdots + M_N$ is at most 10000.

If $M_i = 0$, then page i is an ending page (i.e., there are no choices from that page). There will be at least one ending page in the book.

Note that you always begin the book on page 1.

For 4 of the available 15 marks, $N \leq 100$, $M_i \leq 10$ for $1 \leq i \leq N$.

For an additional 3 of the available 15 marks, the book is guaranteed to have no cycles.

For an additional 4 of the available 15 marks, $N \leq 1000$, $M_i \leq 25$ for $1 \leq i \leq N$.

Output Specification

The output will be two lines. The first line will contain `Y` if all pages are reachable, and `N` otherwise.

The last line will contain a non-negative integer K, which is the shortest path a reader can take while reading this book. There will always be a finite shortest path.

Sample Input 1

```
3
2 2 3
0
0
```

Output for Sample Input 1

```
Y
2
```

Explanation of Output for Sample Input 1

Since we start on page 1, and can reach both page 2 and page 3, all pages are reachable. The only paths in the book are $1 \rightarrow 2$ and $1 \rightarrow 3$, each of which is 2 pages in length.

Sample Input 2

```
3
2 2 3
0
1 1
```

Output for Sample Input 2

```
Y
2
```

Explanation of Output for Sample Input 2

Every page is reachable, since from page 1, we can reach pages 2 and 3. The shortest path is the path $1 \rightarrow 2$, which contains two pages.

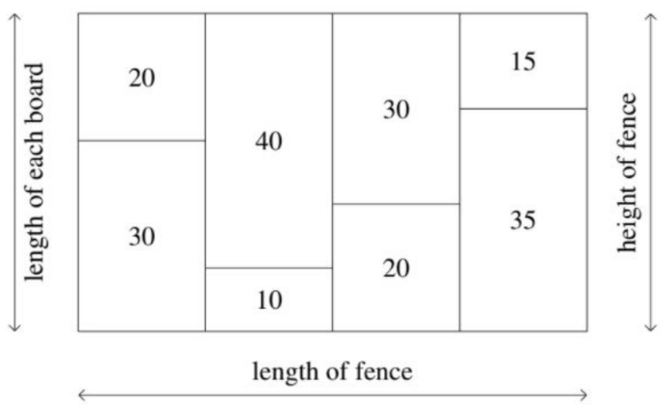
Problem J5: Nailed It!

Time limit: 2 seconds

Problem Description

Tudor is a contestant in the Canadian Carpentry Challenge (CCC). To win the CCC, Tudor must demonstrate his skill at nailing wood together to make the longest fence possible using boards. To accomplish this goal, he has N pieces of wood. The i^{th} piece of wood has integer length L_i.

A *board* is made up of **exactly two** pieces of wood. The length of a board made of wood with lengths L_i and L_j is $L_i + L_j$. A *fence* consists of boards that are the same length. The *length of the fence* is the number of boards used to make it, and the *height of the fence* is the length of each board in the fence. In the example fence below, the length of the fence is 4; the height of the fence is 50; and, the length of each piece of wood is shown:



Tudor would like to make the longest fence possible. Please help him determine the maximum length of any fence he could make, and the number of different heights a fence of that maximum length could have.

Input Specification

The first line will contain the integer N ($2 \leq N \leq 1\,000\,000$).
The second line will contain N space-separated integers $L_1, L_2, \ldots, L_N$ ($1 \leq L_i \leq 2\,000$).

For 7 of the 15 available marks, $N \leq 100$.
For an additional 6 of the 15 available marks, $N \leq 1000$.
For an additional 1 of the 15 available marks, $N \leq 100\,000$.

Output Specification

Output two integers on a single line separated by a single space: the length of the longest fence and the number of different heights a longest fence could have.

Sample Input 1

```
4
```

```
1 2 3 4
```

Output for Sample Input 1

```
2 1
```

Explanation for Output for Sample Input 1

Tudor first combines the pieces of wood with lengths 1 and 4 to form a board of length 5. Then he combines the pieces of wood with lengths 2 and 3 to form another board of length 5. Finally, he combines the boards to make a fence with length 2 and height 5.

Sample Input 2

```
5
1 10 100 1000 2000
```

Output for Sample Input 2

```
1 10
```

Explanation for Output for Sample Input 2

Tudor can't make a fence longer than length 1, and there are 10 ways to make a fence with length 1 by choosing any two pieces of wood to nail together. Specifically, he may have a fence of height 11, 101, 1001, 2001, 110, 1010, 2010, 1100, 2100 and 3000.