IOI Training Camp 2011 – Final 1, 21 June, 2011

Problem 2 Fair selection

Suppose you start with a tree with N vertices $1, 2, \ldots, N$ in which every vertex i has a weight w_i. Let A be a fixed subset of the vertices.

A subset S of vertices is said to be a *fair selection* with respect to A if the following conditions are satisfied:

- Every vertex in S has an ancestor in A.
- Every vertex in A has exactly one descendant in S.

Every vertex is considered to be an ancestor as well as a descendant of itself.

In this problem, you have to answer the following queries about a given weighted tree with an associated subset A.

- Does there exist a fair selection S with respect to A?
- Find the minimum total weight of a fair selection and list out the lexicographically smallest witness S with this minimum total weight.

  By lexicographically smallest, we mean the smallest with respect to the usual dictionary order assuming the elements in each subset are listed in ascending order.
- Find the minimum average weight of a fair selection and list out the lexicographically smallest witness S with this minimum average weight.

Input format

The input consists of six lines.

- The first line is a single integer N, the number of vertices in the tree. The vertices in the tree are labelled $1, 2, \ldots, N$ and 1 is the root.
- The second line of input consists of N integers, the weights w_1, w_2, $\ldots$, w_N of the vertices $1, 2, \ldots, N$.
- The third line of input consists of $N-1$ integers, listing out the parent vertex in the tree of vertices $2, 3, \ldots, N$, in that order.
- The fourth line of input is a single integer M, the size of the set A.
- The fifth line of input consists of M integers, the M vertices that belong to A.
- The last line of input is an integer $F \in \{1, 2, 3, 4, 5\}$, indicating the query to be answered in this test case.

Output format

The output format depends on the query type F.

- In all cases, $F \in \{1, 2, 3, 4, 5\}$, the first line contains `YES` if there exists a fair selection with respect to A, and `NO`, otherwise.
- If the first line is `NO`, there is no further output for any of the query types.

  If the first line is `YES`, output additional lines depending on the query type, as described below.

$F = 1$ No further lines of output.

$F = 2$ Output a second line containing a single integer, the minimum total weight of a fair selection with respect to A.

$F = 3$ Output a second line containing two integers n and d such that $\frac{n}{d}$ is the reduced fraction equal to the minimum average weight of a fair selection with respect to A.

$F = 4$ Output two additional lines.

- The second line of output should be a single integer, the minimum total weight of a fair selection with respect to A.
- Let $S = \{i_1, i_2, \ldots, i_k\}$ be the lexicographically smallest set S with this minimum total weight. The third line of your output should have k+1 integers, starting with the number k, followed by a list of the k elements of S in ascending order.

$F = 5$ Output two additional lines.

- The second line of output should contain two integers n and d such that $\frac{n}{d}$ is the reduced fraction equal to the minimum average weight of a fair selection with respect to A.
- Let $S = \{i_1, i_2, \ldots, i_k\}$ be the lexicographically smallest set S with this minimum average weight. The third line of your output should have k+1 integers, starting with number k, followed by a list of the k elements of S in ascending order.

Test Data

In all subtasks, $1 \leq N \leq 10^6$, $1 \leq M \leq N$ and for $i \in \{1, 2, \ldots, N\}$, $1 \leq w_i \leq 1000$.

- *Subtask 1 (20 marks):* $F = 1$.
- *Subtask 2 (20 marks):* $F = 2$.
- *Subtask 3 (20 marks):* $F = 3$.
- *Subtask 4 (20 marks):* $F = 4$.
- *Subtask 5 (20 marks):* $F = 5$.

Sample input 1

```
5
10 12 15 10 13
1 1 1 1
3
2 3 5
1
```

Sample output 1

```
YES
```

Sample input 2

```
5
10 12 15 10 13
1 1 1 1
3
2 3 5
2
```

Sample output 2

```
YES
40
```

Sample input 3

```
5
10 12 15 10 13
1 1 1 1
3
2 3 5
3
```

Sample output 3

```
YES
40 3
```

Sample input 4

```
5
10 12 15 10 13
1 1 1 1
3
2 3 5
4
```

Sample output 4

```
YES
40
3 2 3 5
```

Sample input 5

```
5
10 12 15 10 13
1 1 1 1
3
2 3 5
5
```

Sample output 5

```
YES
40 3
3 2 3 5
```

Sample input 6

```
5
10 12 15 10 13
1 1 1 1
5
1 2 3 4 5
3
```

Sample output 6

```
NO
```

Time and memory limits

The time limit for this task is 5 seconds. The memory limit is 128 MB.