CS3230 programming assignment 1

Due: 6 Nov 23:59

1 Problem statement

You live in a country with n cities and $n-1$ bidirectional roads. The transport network of this country can be modelled as a rooted, weighted tree:

- The vertices are labelled $1, 2, \ldots, n$ and each vertex represents a city.
- The edges are labelled $1, 2, \ldots, n-1$. Road i connects city $i+1$ to its parent $p[i+1]$
- Associated with each road i is a weight $w[i]$. $w[i]$ represents the amount of fuel in liters, required to travel from city $i+1$ to its parent $p[i]$, or vice versa (the roads are bidirectional, and the fuel required to traverse the road in either direction is $w[i]$ liters).

City $i (1 \leq i \leq n)$ contains a petrol station which charges $d[i]$ dollars per liter (different cities can have different prices).

You are currently in your car in city 1 and wish to travel to city n. Your car is currently out of petrol and you wish to find the cheapest way to travel from city 1 to city n (i.e. minimize the total amount of money you pay to all petrol stations). For the purposes of this problem, we will make the following assumptions:

- There is no limit to the amount of petrol that your car can hold.
- The amount of petrol in your car is not allowed to be negative.
- You are not allowed to sell excess petrol to petrol stations.
- You are allowed to end the journey with an empty petrol tank.

Time complexity requirement: $\mathcal{O}(n^2)$ for full credit (5 points). Solutions which run in $\mathcal{O}(n^3)$ will get partial credit (3 points).

2 Input format

The first line of the input consists of a single integer n. The second line of the input consists of n space-separates integers $d[1]$ $d[2]$ $\ldots$ $d[n]$, representing the cost of petrol in city i.

$n-1$ lines then follow. The i-th of these line contains two space-separated integers $p[i+1]$ and $w[i]$.

3 Output format

Output a single integer, the minimum cost required to travel from city 1 to n, followed by a endline character.

4 Constraints

All test cases will satisfy the following constraints:

- $3 \leq n \leq 10000$
- $1 \leq d[i] \leq 10^6$ (for each $1 \leq i \leq n$)
- $1 \leq p[i] \leq i$
- $1 \leq w[i] \leq 10^6$

The test cases under the **partial** task will also satisfy $n \leq 500$.

5 Sample input and output

5.1 Sample input 1

```
3
10 1 1
1 1
1 100
```

5.2 Sample output 1

```
111
```

5.3 Sample input 2

```
5
14 2 2 11 7
1 10
1 1
1 3
1 1
```

5.4 Sample output 2

```
14
```

6 Submission instructions and grading

Submit your solution to CodeCrunch in either C++ or Java. You need to pass all test cases to get 5 points (or all test cases satisfying $n \leq 500$ to get 3 points).

The tasks will be labelled **full** and **partial**.

- If your final submission to full is correct, you will receive 5 points and your submission to partial will be ignored. If you are confident of your submission to full, you do not need to submit to partial.
- If your submission to full is incorrect, or you did not submit to full, then your solution to partial will be graded, in which you may receive 3 points if your solution to partial is correct.
- If multiple submissions are made, only the last one will be graded.

No proofs are required.

7 Collaboration policy

You may discuss the problems with your classmates, though you should write up your solutions on your own. Please note the names of your collaborators in your submission. You may want to refer to the plagiarism policy from Lecture 2.

You are not allowed to share code.