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<http://courses.softlab.ntua.gr/p12/>

Programming Languages II

Solutions to the exercises are to be handed in to the instructors in electronic form. Deadlines are firm. You may hand in at most one late exercise.

Exercise 1 Haskell for electrical engineers

Due date: 3/11/2010

Write a Haskell program to solve the following problem.

Problem description. Christmas is approaching and the young Gustav Kirchhoff (contrary to the normal flow of history) is ready to decorate his garden with colourful electric lightbulbs. His garden contains N bushes (numbered from 1 to N) and in each one of them, depending on the size of the foliage, Gustav has installed b_i identical lightbulbs ($1 \leq i \leq N$). As his finances have deteriorated after the IMF's involvement, Gustav decided to connect the bushes with as few power cables as possible. His best friend Leonhard (again contrary to the normal flow of history) explained to him that it suffices to use $N - 1$ cables, which essentially form a tree — the tree of bushes! Gustav, who is good at currents but poor in graph theory and gardening, was not sure that he understood but he hurried to install the cables.

However, when he had just connected the nearest bush to the power source and was about to flick the switch, Gustav conceived the famous first rule: “at any node in an electrical circuit, the sum of currents flowing into that node is equal to the sum of currents flowing out of that node.” He stopped and thought for a little while, and was thankful that he did not flick the switch. If he had done so, some of his cables would have melted because of the high current that would pass through them. Help him find to which bush he must connect the power source, so that the most “loaded” cable has the least possible current.

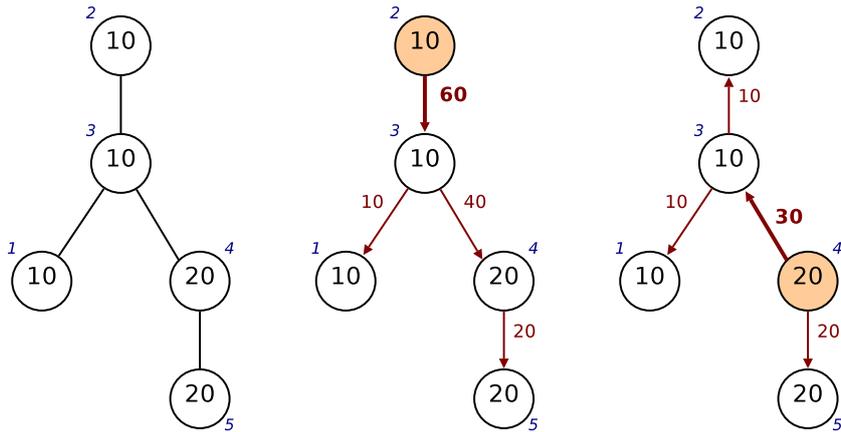
Input and output. Your program must read data from the standard input and write the result to the standard output.

The first line of the input will contain the natural number N . The next N lines correspond to the bushes in the garden, in increasing order — the second line corresponds to bush number 1, the third to bush number 2, and so on. Each of these lines contains two natural numbers b_i and p_i (where $1 \leq i \leq N$); b_i is the number of lightbulbs in bush i ; and p_i is the number of the bush that is the “parent” of i in the tree of bushes. If bush i is the root of the tree of bushes, it will be $p_i = 0$.

Your program must output the number of the bush where the power source must be connected. If more than one optimal solutions exist, your program must output the bush with the smallest number.

Input example.

5
10 3
10 0
10 2
20 3
20 4



Output example.

4

Explanation. The tree of bushes is shown in the left figure. If the power source is connected to bush 2, then the currents that pass through the cables are shown in the middle figure. The maximum load is 60, in the cable between bushes 2 and 3. However, if the power source is connected to bush 4, then the currents are shown in the right figure. The maximum load is 30, in the cable between bushes 4 and 3. This is the optimal solution.

Constraints. To obtain a full grade, your solution must be efficient. There will be constraints in the size of the input, the execution time and memory. Correct solutions with a complexity of $O(N^2)$ will achieve approximately half score. Notice that, in a purely functional language like Haskell, reading the input efficiently and constructing the desired representation for the tree of bushes can prove to be a hard task.