

12057 Prefix Codes

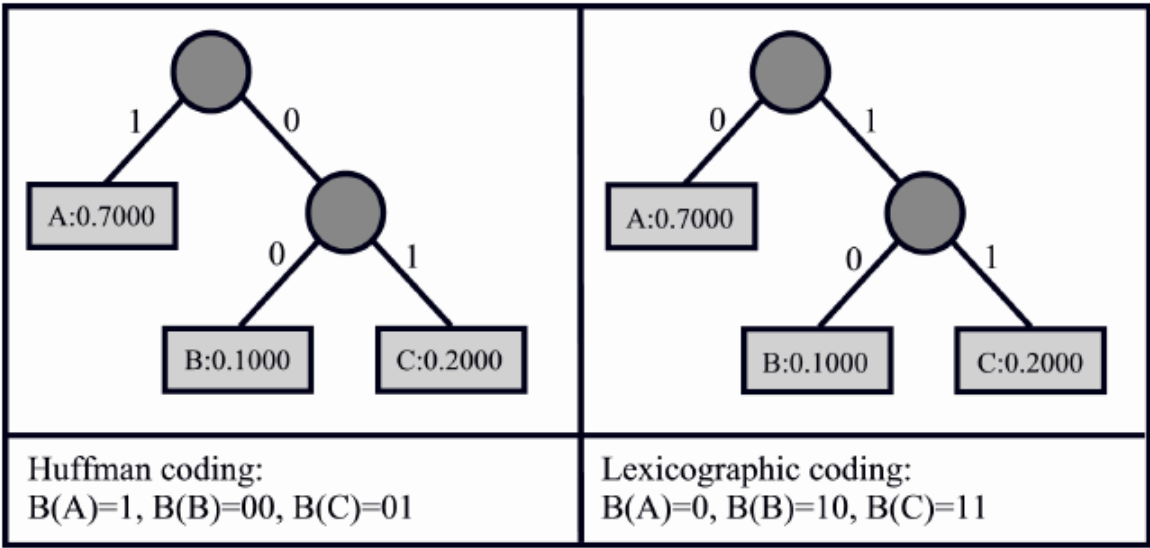
Given an alphabet S , and a probability $Prob(a)$ for each $a \in S$, a binary prefix code represents each a in S as a bit string $B(a)$, such that $B(a_1)$ is not a prefix of $B(a_2)$ for any $a_1 \neq a_2$ in S .

Huffman's algorithm constructs a binary prefix code by pairing the two least probable elements of S , a_0 and a_1 . a_0 and a_1 are given codes with a common (as yet to be determined) prefix p and differ only in their last bit: $B(a_0) = p_0$ while $B(a_1) = p_1$. a_0 and a_1 are removed from S and replaced by a new element b with $Prob(b) = Prob(a_0) + Prob(a_1)$. b is an imaginary element standing for both a_0 and a_1 . The Huffman code is computed for this reduced S , and p is set equal to $B(b)$. This reduction of the problem continues until S contains one element a represented by the empty string; that is, when $S = \{a\}$, $B(a) = \epsilon$.

Huffman's code is optimal in that there is no other prefix code with a shorter average length defined as:

$$\sum_{a \in S} Prob(a) \times |B(a)|$$

One problem with Huffman codes is that they dont necessarily preserve any ordering that the elements may have. For example, suppose $S = \{A,B,C\}$ and $Prob(A) = 0.7$, $Prob(B) = 0.1$, $Prob(C) = 0.2$. A Huffman code for S is $B(A) = 1$, $B(B) = 00$, $B(C) = 01$. The lexicographic ordering of these strings is $B(B)$, $B(C)$, $B(A)$ [i.e. 00,01,1], so the coding does not preserve the original order A, B, C . Therefore, algorithms like binary search might not work as expected on Huffman-coded data.



Given an ordered set S and $Prob$, you are to compute an ordered prefix code — one whose lexicographic order preserves the order of S .

Input

Input consists of several data sets. Each set begins with $0 < n \leq 100$, the number of elements in S . n lines follow; the i -th line gives the probability of a_i , the i -th element of S . Each probability is given as '0.dddd' (that is, with exactly four decimal digits). The probabilities sum to 1.0000 exactly. A line containing '0' follows the last data set.

Output

For each data set, compute an optimal ordered binary prefix code for S . The output should consist of one line giving the average code length, followed by n lines, with the i -th line giving the code for the i -th element of S . If you have solved the problem, these n lines will be in lexicographic order. *If there are many optimal solutions, choose any one.*

Output an empty line between cases.

Sample Input

```
3
0.7000
0.1000
0.2000
3
0.7000
0.2000
0.1000
0
```

Sample Output

```
1.3000
0
10
11

1.3000
0
10
11
```