Problem A: Practice

How much does winning ACM depend on practice?

We assume that *p*, the probability that a given team will win a given contest, is related to *n*, the number of practice problems solved by the team prior to the contest. This relationship is modelled by the *logistic* formula

$$log(p/(1-p)) = a + b\,n\ ,$$

for some *a* and *b*. Your job is to find *a* and *b* such that the formula most accurately reflects a set of observed results.

Each observation consists of *n* and *w*. *n* is the number of practice problems solved by some team prior to a contest, and *w* is 1 if the team wins the contest, 0 if it does not.

Given *a*, *b*, and *n* the formula above may be used to compute *p*, the estimated probability that *w* = 1. The *likelihood* of a particular observation is *p* if *w* = 1 and *1-p* if *w* = 0; The likelihood of a set of observations is the product of the likelihoods of the individual observations.

You are to compute the *maximum likelihood estimate* for *a* and *b*. That is, the values of *a* and *b* for which the likelihood of a given set of observations is maximized.

The input contains several test cases followed by a line contatining 0. Each test case begins with $1 < k \leq 100$, the number of observations that follow. Each observation consists of integers $0 \leq n \leq 100$ and $0 \leq w \leq 1$. The input will contain at least two distinct values of *n* and of *w*. For each test case, output a single line containing *a* and *b*, rounded to four digits to the right of the decimal.

Sample Input

```
20
0 0
0 0
0 0
0 0
1 0
1 0
1 0
1 1
2 0
2 0
2 1
2 1
3 0
3 1
3 1
3 1
4 1
4 1
4 1
4 1
0
```

Output for Sample Input

```
-3.1748 1.5874
```

Gordon V. Cormack