HKUST Local Contest 2015

Lab 3, 12 Sept 2015

Organized by: Prof. Ke Yi & Mr. Minhao Jiang

Problem Setter & Judge: Mr. Minhao Jiang

Contest Time: 13:30 - 17:30, 12 Sept 2015

Contest Rules and Regulations:

1. This contest is an individual contest. **Discussions between contestants are strictly prohibited.** Sanctions will be imposed on contestants if they are found to have violated the regulations governing integrity and honesty.

2. In this contest, the contestants are given six programming problems. The goal is to solve as many problems as possible. For those who solve the same number of problems, the one with lower score wins. (The scoring system will be explained below.)

3. The programming languages to be used in this contest is C/C++. The contestants use PC^2 to submit their source codes to the judge and the source codes are compiled by Visual Studio C++.

4. The contestant should read the input and write the output via **standard I/O**, i.e. no exception handling or file I/O.

5. The correctness of each submission is judged by inputting test cases into the submitted program. The submission is regarded as correct if its outputs match completely with the model outputs. The submission is judged as correct or wrong. **No partial credit is given.**

6. The contestants can re-submit another source code after previous wrong submissions.

7. All programs should not run for more than the time limit specified in the problem. (In most cases a "correct" implementation will run far less than the time limit we provide.)

8. **The contestants are ranked firstly by the number of problems solved, and secondly the total time spent on solving the problems.** Time spent on solving one problem is the time between the start of contest and the submission of the correct implementation of that problem. For each problem you solved, a penalty of 20 minutes will be added to your score for each wrong submission of that problem.

Problem A. Score

Time limit: 1 second
Memory limit: 256 MB

Farmer Ken often plays an online game with his friends in weekend. However, he kept losing games recently and he is a little upset right now. In the coming weekend, his friends are going to play with Ken again. Ken would like to predict the result.

More specifically, Ken will play one game with each of his friends in the weekend. He has N friends in total. In each game, the winner will get 3 points, and the loser will get 0 point. If it is a tie, each of them can get 1 point. Ken also has some records about the games played in the last few months, which are W(the number of his wins), D(the number of his draws) and L(the number of his losses). In each of the coming N games, Ken simply assumes that he is going to win by probability W/(W+D+L). Similar for the probability of draw and loss. Each game is independent. Do you know the probability of scoring at least S points after the N games?

<u>Input</u>:
There are multiple test cases. Each test case is a line containing 5 integers, N, S, W, D, L. The input ends with a line with 5 zeros. ($0 \leq N, W, D, L \leq 10$, $0 \leq S \leq 30$)

<u>Output:</u>
For each test case, output the probability with 2 digits after the decimal point.

Input	**Output**
3 5 5 5 4 1 1 1 1 1 0 0 0 0 0	0.43 0.67

Problem B. Power

Time limit: 1 second
Memory limit: 256 MB

Farmer Ken is good at mental arithmetic. One day, he wanted to show off his talent to impress his girlfriend Fiona.

Ken wrote N integers A_1, A_2, ... A_N in a paper. He asked Fiona to add some operators between the numbers, and claimed that he can calculate the result in his head very fast and accurately. In order to make a joke at Ken, Fiona put a power operator between each of the numbers, and said, "The answer of raising their powers might be too big to write it down, so you can simply tell me its remainder when divided by this number P".

Ken failed to calculate the result and felt very embarrassed. Do you know how to do that?

Input:
There are multiple test cases. Each test case is a line begins with two numbers, N and P, followed by N integers A_1, A_2, …, A_N. The input ends when N = 0 and P = 0. ($1 \le N \le 100000$, $1 \le P \le A_1 \le A_2 \le \ldots \le A_N \le 100000$)

Output:
For each test case, output A_1^A_2^…^A_N modulo P.

Input	Output
2 3 4 5 3 123 456 789 1011 0 0	1 90

Hit: The second test case means 456^(789^1011) modulo 123 = 90

Problem C. Weapon

Time limit: 1 second
Memory limit: 256 MB

Farmer Ken is trying the newly launched weapon system in his favorite online game. The feature of this system is that players can forge their own weapons now instead of simply buying from the stores.

The most important value of a weapon is its damage D. Before forging anything, a character has two weapons with damage D_1 and D_2 respectively. A character with IQ and EQ can forge them into the 3-rd weapon with damage $D_3 = IQ*D_1 + EQ*D_2$. In short, the i-th weapon is forged by the (i-2)-th weapon and the (i-1)-th weapon, by $D_i = IQ*D_{i-2} + EQ*D_{i-1}$.

Now, Ken only knows the damage D_k of his k-th weapon. Ken cannot remember the IQ and EQ of his character, but he remembers that the damage of the first 2 weapons were both 1. IQ and EQ are non-negative integers. Ken wants to know the damage D_n of his n-th weapon if he keep forging new weapons.

Input:
There are multiple test cases. Each test case is a line containing 3 integers k, n and D_k. The input ends with 3 zeros. ($3 \le k, n, D_k \le 1000000$)

Output:
For each test case, output the damage D_n of the n-th weapon modulo 1000000.
Note that sometimes Ken may remember something wrong, so it may be impossible to have such the k-th weapon with damage D_k. Output -1 if it is this case.
When there are multiple pairs (IQ, EQ) can result in the k-th weapon with damage D_k, output the answer based on (IQ, EQ) with the smallest IQ*1000000+EQ.

Input	Output
4 10 13 0 0 0	16897

Problem D. Stone

Time limit: 6 second
Memory limit: 256 MB

Farmer Ken is playing a stone picking game with his girlfriend Fiona.

There are M stones on the desk and N cards in the box. A number is written on a card. The numbers on different cards may be different. In a game, Ken and Fiona takes turns to pick cards from the box randomly, and Ken always picks first. When the number A on the card picked by Ken is not larger than the number of stones on the desk, Ken removes A stones from the desk and Fiona's turn comes. Otherwise, Ken picks another card from the box again. The same for Fiona. Once a card is picked from the box, it will be discarded until a new game begins. The winner is the one that removes the last stone. If the box is empty, which means it is a tie game and there is no winner in this game, they will start a new game by putting the N cards into the box and the M stones back to the desk, until there is a winner.

Given the N cards $\{A_1, A_2, \dots, A_N\}$ they have, Fiona feels that Ken can always win the game for some special M. It means sometimes, i.e. when M is one of those special values, Ken can always win finally, maybe after several tie games, and Fiona is impossible to win.

Do you know in the range of [1, S], how many such Ken-sure-win M exists?

<u>Input</u>:
There are multiple test cases. Each test case begins with a line containing 2 integers N and S. The second line is N numbers which are the numbers A_i on the cards. The input ends with 2 zeros. ($1 \le N \le 10000$, $1 \le A_i \le S \le 100000$)

<u>Output:</u>
For each test case, output how many M with $1 \le M \le S$ where Ken can always win.

Input	Output
3 8 1 5 7 0 0	3

Hit: When M = 1, 5 or 7, Ken can always win the game.

Problem E. Express

Time limit: 1 second
Memory limit: 256 MB

Farmer Ken just changed his career to express delivery. He lives in a city with N houses and M roads. Each road is bidirectional and connects two houses. He usually takes the shortest path from his home to each destination. There is only exactly one shortest path from his home to each house.

Today Ken is planning new alternate paths for his delivery. He wants to know if the last road of the original shortest path from his home to the x-th house is blocked, how long the new shortest path will be. Ken's home is house 1. Do you know how long the new shortest path will be for each x of the other N-1 houses?

Input:
There are multiple test cases. Each test case begins with 2 integers N and M, followed by M lines where each line contains 3 integers u, v and d for each road meaning that the length of road between u and v is d. The input ends when N = 0 and M = 0. ($1 \le u, v \le N \le 100000$, $1 \le M \le 200000$, $1 \le d \le 1000$)

Output:
For each test case, output the lengths of N-1 new shortest paths in N-1 lines. Note that for some x, there may not be such new shortest path. Output -1 in that line in this case.

Input	Output
4 5 1 2 2 1 3 2 2 3 1 2 4 3 3 4 4 4 4 1 2 1 1 3 1 2 3 1 3 4 1 0 0	3 3 6 2 2 -1

Hit: The answers for the first test case are explained as follows. When x = 2, the only road blocked is (1->2), and the new shortest path is (1->3->2) with length 3. When x = 3, the only road blocked is (1->3), and the new shortest path is (1->2->3) with length 3. When x = 4, the only road blocked is (2->4), and the new shortest path is (1->3->4) with length 6.

Problem F. Follow

Time limit: 2 second
Memory limit: 256 MB

Farmer Ken has a new account in Twitter. He has crawled a small network of N accounts from Twitter. He wants to know which of the N accounts he should follow.

Ken should follow an account if (1) it is an interesting account and (2) all of the accounts (directly and indirectly) followed by it are also interesting accounts. To check whether the i-th account is interesting, he can spend ti seconds to read the tweets posed by it. The probability of the i-th account that Ken may consider it as interesting is pi. Different reading orders may lead to different expected time for Ken to know which of the N accounts should be followed. Do you know the shortest possible expected time?

Input:
There is only one test case in the input. The first line is an integer N. The next N lines are about the N accounts. The i-th of them begins with an integer ti, a real number pi, an integer mi, and followed by mi integers which are the mi accounts that the i-th account directly follows. An account cannot follow itself. The accounts are labeled from 1 to N. (0 ≤ mi ≤ N ≤ 500, 1 ≤ ti ≤ 1000, 0.0001 ≤ pi ≤ 0.9999)

Output:
Output the shortest expected time with 3 digits after decimal point.

Input	Output
4 5 0.3 1 2 6 0.99 0 2 0.2 1 4 2 0.2 0	13.350

Input	Output
2 12 0.2 1 2 10 0.9 0	20.800

Hit: The second test case is a social network with 2 accounts v1 and v2. The reading order is either v1v2 or v2v1.
If the reading order is v1v2, Ken reads v1 first in 12 seconds, and no matter v1 is interesting or not, Ken should continue to read v2, and then Ken spends 10 more seconds, so in total, the expected time is 12 + 10=22 seconds.
If the reading order is v2v1, Ken first reads v2 in 10 seconds. If v2 is not interesting (with probability 1 - 0.9 = 0.1), Ken doesn't need to read v1 since in this case, Ken will follow neither v2 nor v1. If v2 is interesting (with probability 0.9), Ken should continue to read v1 by 12 more seconds. Therefore, the expected time is (1 - 0.9) * (10 + 0) + 0.9 * (10 + 12) = 20.800