Vipul Kumar ⏻

Coding Area

A	**B**	**C**	**D**	**E**	**F**	**G**	**H**

ONLINE EDITOR (C)

Club Council

+ Problem Description

Tony is president of his local club.

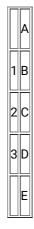The club has 5 seats for the administrative body which are elected from the club members.

Rather than individually electing 5 different members, he wants to elect the 5 members together in a proportional voting system.

On this end, he was recently reading about a voting system called STV - Single Transferable Vote.

Let's understand STV:

Say, that there are 3 seats to be filled among 5 Candidates, A, B, C, D, E.

Each voter is given a ballot paper like this:

As shown, the vote can list their preferred candidates in their preferred order. (B followed by C followed by D in this case).

Please note: A user can give more than 1 preferential vote, if more than 1 vote is given, they MUST be RANKED.

Now the winners are declared in the following algorithm:

Step 1: Count all votes (1st preference votes are counted first, if they are exhausted (explained below) then 2nd Preference and so on..), N.

Step 2: Determine Quota (number of votes needed to win) as: **floor(N/(S+1))+1**. (S is the number of seats). As an example, 20 voters deciding on 3 seats, means each candidate needs at least: floor(20/4)+1 = 6 votes to win.

Step 3: Find out the candidate who crossed the quota by the highest margin/candidate with lowest votes (if no one crossed the Quota).

Step 4: Eliminate the Candidate in Step 3.

If the candidate had crossed quota, declare them a winner, and reassign their votes using the following scale down ratio.

Ratio = (V-Q)/V (V is the number of votes by which the candidate won, Q is quota).

Note: Once a Candidate is eliminated, their votes are removed from the ballot and the vote will automatically transfer to the next candidate listed on the ballot. (If there are no more candidates listed on the ballot, that ballot will be ignored)

Step 5: Repeat Steps 1-4 till all the seats are filled, or there is only 1 candidate left. In case there is 1 only candidate left, declare them the winner.

Let's look at an example to understand this:

These are the ballot papers:

Candidate	Choice	Candidate	Choice	Candidate	Choice	Candidate	Choice	Candidate	Choice
A	1	B		C	2	D	3	E	4
A		B	1	C	3	D	2	E	
A		B		C		D	1	E	2
A	3	B	1	C	2	D		E	4
A	1	B		C	2	D	3	E	4
A		B	1	C		D		E	
A		B	2	C	1	D		E	3
A		B	1	C		D		E	
A	5	B	4	C	3	D	2	E	1
A	3	B	1	C		D	2	E	

Based on this, we get the below table:

1st	2nd	3rd	4th	5th
A	C	D	E	
B	D	C		
D	E			
B	C	A	E	
A	C	D	E	
B				
C	B	E		
B	D			
E	D	C	B	A
B	D	A		

Consider the votes as shown above for 5 Candidates A, B, C, D, E and 2 Seats to be decided.

Round 1: Votes are counted and we get the following:

A	B	C	D	E	Quota
2	5	1	1	1	4

Quota = floor(N/(S+1))+1 = floor (10/3) + 1 = 4. (10 is total no of votes).

B is above Q, so, B is declared winner.

As there is a winner, votes need to be redistributed.

Ratio = (V-Q)/V = (5-4)/5 = 0.2

So, we get the following table:

1st	2nd	3rd	4th	5th	Weight
A	C	D	E		1
	D	C			0.2
D	E				1
	C	A	E		0.2
A	C	D	E		1
					0
C		E			1
	D				0.2
E	D	C		A	1
	D	A			0.2

Note that all B's have been removed as a part of elimination.

Also, note that due to vote redistribution, the weight of B's vote has been scaled by the ratio above (0.2). Since, the row highlighted in RED has no other preferences, that row (ballot) is excluded from all subsequent countings has now a weight of 0.

Finally, the row before the last row (highlighted in ORANGE) had a B in the 4th position, which has been eliminated but weight is still 1, as the vote belongs to E (as E is in 1st position) till E is eliminated, then to D and so on..

Round 2: After 2nd Round of Counting, we get:(B won, so not counting further)

A	B	C	D	E	Quota
2	5	1	1	1	4
2		1.2	1.6	1	3

Note: In absence of B, next preference is counted.

Quota = floor (5.8/2) + 1 = 3.

None reached 3, so eliminating E as E has lowest votes.

1st	2nd	3rd	4th	5th	Weight
A	C	D			1
	D	C			0.2
D					1
	C	A			0.2
A	C	D			1
					0
C					1
	D				0.2
	D	C		A	1
	D	A			0.2

Round 3: After counting, we get:

A	B	C	D	E	Quota
2	5	1	1	1	4
2		1.2	1.6	1	3
2		1.2	2.6		3

Next, C is eliminated.

1st	2nd	3rd	4th	5th	Weight
A		D			1
	D				0.2
D					1
		A			0.2
A		D			1
					0
					0
	D				0.2
	D			A	1
	D	A			0.2

Round 4: After counting, we get:

A	B	C	D	E	Quota
2	5	1	1	1	4
2		1.2	1.6	1	3
2		1.2	2.6		3
2.2			2.6		3

Now, A is eliminated. Since only D remains, D is declared winner along with B.

Getting a somewhat grasp of rules, Tony wants to test out this idea via a program. Please help him out in this regard.

You are given a set of ballot papers, as shown above. Determine the winners by the process described above.

Additional Rules:

1. Ballot Papers will be given in the following format:

A*B*C*D*E* : The * in between the candidates can represent ANY character (input-able by keyboard, i.e., **excluding** special invisible characters and whitespace). * can even be blank to indicate voter has left that choice blank.

E.g.: A1B2CDE.

However, anything other than 1-5 is considered as invalid (like A+B1CDE).

Also, A1B2C2DE and AB2CDE etc are again invalid (as there only be 1 of each number, and 2nd choice without 1st is meaningless, i.e, the choices if present must be in ascending order => 4th choice means 1,2,3 are already there).

Finally, ABCDE is again invalid as it means no votes cast.

So the program needs to check for and identify such invalid votes.

If more than 10% (> 10%) initial votes are invalid, the output would be INVALID.

2. In case of any Ties, alphabetical order is checked.

Like, if A and C both have enough votes (one needs to be winner), A would be winner of that round.

If, A and C both have same votes (one needs to be eliminated due to lower no of votes) , C would be eliminated in that round, preference given to A.

3. During vote counting and calculating ratios, each individual calculation is to be rounded off to 3 digits after decimal.

So, if ratio is 10/3, It is taken as 3.333 and then if existing weight of a ballot is 0.25, then, new weight would be $W_{new}=W_{old}$ * **Ratio**, again rounded to 3 digits, thus rounding twice.

+ Constraints

$10<=N<=500$ (All integers)

$1<=S<=4$ (All integers)

Length (Ballot)<=10.

+ Input Format

First line contains the number of votes N.

Second line contains the number of Seats, S.

Next N lines, represent the ballots.

+ Output

One line that consist of the winners, separated by comma, in order they won or the text INVALID, if >10% of the initial number of votes, N are invalid.

+ Test Case

+ Explanation

Example 1

Input 10

2

A1BC2D3E4

AB1C3D2E

ABCD1E2

A3B1C2DE4

A1BC2D3E4

AB1CDE

AB2C1DE3

AB1CD2E

A5B4C3D2E1

A3B1CD2E

Output B,D

Example 2

Input 20

1

A1BC2D3E4

AB1C3D2E

ABCD1E2

A3B1C2DE4

A1BC2D3E4

ABCD1E

AB2C1DE3

ABCD2E1

A5B4C3D2E1

A3B1CD2E

A3BC2D1E

AB3C1DE2

AB1C2D3E4

A2B3C1DE4

A4BC1D3E2

A2B1CDE

A1B2C3D4E5

A1BCDE

ABC1D2E

A3BCD2E1

Output C

Upload Solution [Question : C]

☐ I, **vipul kumar** confirm that the answer submitted is my own.   ☐ Took help from online sources (attributions)

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