

Junior Knights Program: Match Making

The Problem

Arup has noticed that there are many match-making websites and event planners out there, but none of them seem to have very much success, on average. He is confident that he has an idea that is sure to beat all the others out there. Most of the websites out there ask clients all sorts of information and then produce a match score between pairs of people based on the answers to these questions. From there, anyone is free to email anyone else and can view the corresponding match score.

Of course, without meeting someone, you can never really predict if you might like them. Thus, Arup has decided that if he is to make a match-making business, he must get people to meet in person. An example of such an event is speed-dating, where each of the participants has several mini-dates. At the end of the night, participants go to a website and for each person they met, they simply state whether or not they are interested in that person. If there is a “match”, each person receives the other’s contact information. We may assume that any speed-dating session has an identical number of men and women.

What’s particularly troubling to Arup about the speed-dating scenarios is that some people may get many matches while others get none. This does not appeal to his egalitarian principles. He would prefer that after a round of speed-dating, each person gets matched with exactly one person of the opposite sex. Since Arup is a numbers guy, he would prefer that each person rate each person they have a mini-date with using a number from 1-10, represent how much they like that person. Using this data, Arup is sure he can match everyone up in a way that maximizes the total group’s “likeability” quotient.

A matching is simply a listing of each female in the group paired with an individual male.

The “likeability” quotient of a matching is as follows:

For each couple in the matching, look at how much the man likes the woman and the woman likes the man. (Both of these will be numbers from 1 to 10.) Record the minimum of the two numbers.

Add each of these numbers for each couple in the matching to determine the likeability quotient of the matching.

Since Arup is too busy heading the marketing division of the company, he has asked you to write the software that will calculate the matching that leads to a group’s maximum “likeability” quotient. Each group will be relatively small (no more than 10 men and 10 women). Thus, you can try all possible matchings (no more than 10!) and determine the one that leads to the greatest “likeability” quotient.

If more than one matching leads to the same maximal “likeability” quotient, your goal will be to minimize the difference in likeability between all of the pairs. Just go through each couple in the matching and add up the differences in how much they like each other. (If his score for her is 5

and her score for him is 2, then the difference is 3.) In case of ties, the matching you want to pick is the one that minimizes this sum.

The reasoning behind these metrics is fairly clear:

If one person likes the other person more, then as a pair, their liking for each other is only as strong as the person who likes the other person less.

Secondly, it's generally bad to have a relationship where one person likes the other much, much more, since it creates an inequality. Thus, minimizing this inequality ought to be a way to break ties between competitive matchings.

Let's go through a simple example with 3 men and 3 women:

Let the men's names be Adam, Bob and Carl, and the women's names be Diana, Ellen and Fran.

The following chart shows how much the men like the women:

	Diana	Ellen	Fran
Adam	4	8	7
Bob	6	7	5
Carl	5	9	6

This chart shows how much the women like the men:

	Adam	Bob	Carl
Diana	7	6	8
Ellen	6	5	9
Fran	4	7	3

Now, let's look at the six possible matchings and their scores

M1	S	M2	S	M3	S
Adam+Diana	4	Adam+Diana	4	Adam+Ellen	6
Bob+Ellen	5	Bob+Fran	5	Bob+Diana	6
Carl+Fran	3	Carl+Ellen	9	Carl+Fran	3
Total	12		18		15

M4	S	M5	S	M6	S
Adam+Ellen	6	Adam+Fran	4	Adam+Fran	4
Bob+Fran	5	Bob+Diana	6	Bob+Ellen	5
Carl+Diana	5	Carl+Ellen	9	Carl+Diana	5
Total	16		19		14

In this situation, the best matching is the fifth one placing Adam with Fran, Bob with Diana, and Carl with Ellen, for a "likeability" quotient of 19.

Had there been a tie, we would have broken it by looking at the differences in the matching. For matching #5, the difference between Adam and Fran is 3, Bob and Diana is 0, and Carl and Ellen is 0, for a total difference of $3+0+0 = 3$.

The input will be such that there will always be a unique matching that is optimal based on these two criteria.

Input Specification (read from stdin)

The first line of the file will contain a single positive integer, n , representing the number of speed-dating events. Each of the n test cases will follow. The first line of each test case will contain a single positive integer, c ($1 < c < 11$), representing the number of couples in the test case. The second line of each test case will contain c alphabetic strings (19 or fewer characters) separated by spaces representing the names of the men, from man #0 to man #(c-1). The third line of each test case will contain c alphabetic strings (19 or fewer characters) separated by spaces representing the names of the women, from woman #0 to woman #(c-1). The next c lines will contain the men's ratings of the women. The first line will contain the ratings of man #0, the second line, the ratings of man #1, etc. Each of these ratings will be positive integers from 1 to 10, inclusive, separated by spaces. The first rating on each of these lines is for woman #0, the second rating is for woman #1, etc. the last c lines of each test case will contain the women's ratings of the men, with the first line being woman #0's ratings, the second line being woman #1's ratings, etc. Similarly, on each of these lines, the first integer will be the rating of man #0, the second integer will be the rating of man #1, etc, and all of these ratings will be separated by spaces as well.

Output Format

For each test case, output the following header:

```
Matching #k: Maximum Score = X.
```

where k ($1 \leq k \leq n$) represents the speed dating session, and X represents the maximum "likeability" quotient for the group.

Skip a blank line, and follow with each pair in the matching, the man's name followed by the woman's name, separated by a space. The ordering of the matching should be in the same ordering the men were given in the input file.

After each test case, skip two blank lines.

Implementation Restrictions

Use the permutation algorithm shown in class permuting an array of integers and use this to index into either the array of men or the array of women.

Sample Input

```
2
3
Adam Bob Carl
Diana Ellen Fran
4 8 7
6 7 5
5 9 6
7 6 8
6 5 9
4 7 3
2
Brad Tom
Katie Angelina
5 8
9 7
4 8
7 6
```

Sample Output

Matching #1: Maximum Score = 19.

```
Adam Fran
Bob Diana
Carl Ellen
```

Matching #2: Maximum Score = 15.

```
Brad Angelina
Tom Katie
```