Indian Statistical Institute

Semester-I 2018-2019

M.Tech.(CS) - First Year

Lab Test I (21 August, 2018)

Subject: Data and File Structures Laboratory

Total: 60 marks Duration: 4 hrs.

**SUBMISSION INSTRUCTIONS**

1. Naming convention for your programs: `cs18xx-test1-progy.c`
2. When you have finished, copy all your files to `~dfslab/2018/labtest1/cs18xx/`.

1. **(30 marks)** Stable marriage problem: let $M = \{p_1, p_2, p_3, \ldots, p_m\}$ be a set of men, and let $W = \{q_1, q_2, q_3, \ldots, q_n\}$ be a set of women. Each person (a man/woman) has ranked all members of the opposite gender (women/men) in order of preference. A *matching* is a 1-1 mapping from the elements of one set to the elements of the other set. Your objective is to find a *stable* matching between $M$ and $W$.[1] When $m = n$, this problem can be solved using the *Gale-Shapley algorithm* that uses "provisional" engagements that preserve the stability of choosing partners. It involves an iterative approach as stated below.

   **Step 1.** Assume everyone is initially UNENGAGED and do the following.

   (a) Each UNENGAGED man proposes to the woman he prefers most.

   (b) Each woman replies MAYBE to the suitor she most prefers, and NO to all other suitors. She is then provisionally ENGAGED to the suitor she most prefers so far, and that suitor is likewise provisionally ENGAGED to her.

   **Step 2.** Do the following.

   (a) Each UNENGAGED man proposes to the most-preferred woman to whom he has not yet proposed (regardless of whether the woman is already ENGAGED).

   (b) Each woman considers the proposals received. If she receives a proposal from someone whom she prefers to her existing provisional partner, she replies MAYBE to the proposal she most prefers, and rejects the rest (including her current provisional partner).

   **Step 3.** Repeat Step 2 until everyone gets ENGAGED.

   Given any $M$ and $W$ such that $|M| = |W|$, and given the preferences of each man and woman, write a program to solve this problem.

   **Input Format**

   The input is a number $n$, followed by a space-separated two-dimensional matrix of size $2n \times n$ where $n$ is the number of men or women. Rows from 0 to $n-1$ represent the preference lists of men (following their numbering), and rows from $n$ to $2n-1$ represent the preference lists of women (following their numbering).

[1] Recall that a matching is said to be *stable* if there are no two people of opposite sex who would both rather have each other than their current partners.

### Output Format

The output will print a list of engaged partners. Each line will print a pair of partners (a woman followed by a man) separated by a single space.

### Sample Input 0

```
3
4 5 3
3 5 4
3 4 5
---
0 1 2
1 2 0
2 1 0
```

**Explanation:** Men correspond to indices 0–2, women correspond to indices 3–5. The first man prefers the women in the order 4, 5, 3. Similary, the first woman prefers the men in the order 0, 1, 2.

### Sample Output 0

```
3 1
4 2
5 0
```

### Sample Input 1

```
4
7 5 6 4
5 4 6 7
4 5 6 7
4 5 6 7
---
0 1 2 3
0 1 2 3
0 1 2 3
0 1 2 3
```

### Sample Output 1

```
4 2
5 1
6 3
7 0
```

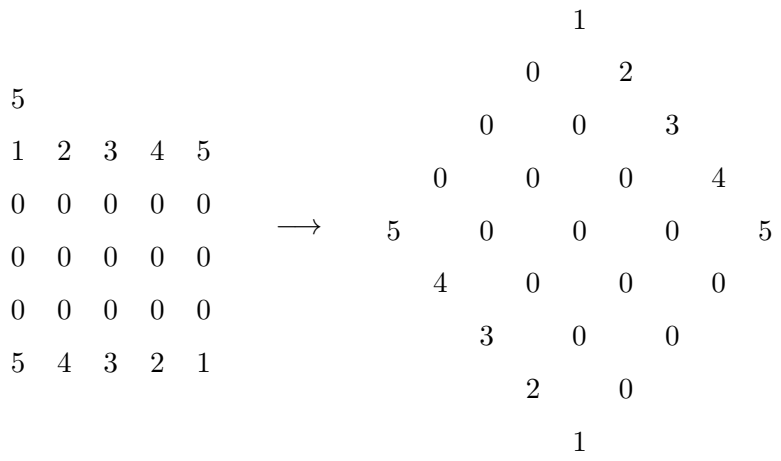
HINTS: You may find it useful to maintain the following arrays:

- 1-dimensional arrays:
  - `men_status`: stores the status of each man (either UNENGAGED, or the index of the woman to whom provisionally engaged)

- `women_status`: as above, for women
- `women_suitor_rank`: for a woman, stores the position (rank) of her current suitor in her preference list

- 2-dimensional arrays:
  - `men_preferences`, `women_preferences`: stores the preference lists provided in the input
  - `men_proposed`: keeps track of whether the $i$th man has proposed to the $j$th woman
  - `women_proposed`: keeps track of whether the $i$th woman received a proposal from the $j$th man **during the current round**.

2. **(20 marks)** Your input is a positive integer $n$, followed by an $n \times n$ square matrix $A$ with each cell filled with a digit between 0 and 9. Write a program to display $A$ in the terminal rotated clockwise at an angle of 45° as shown in the example below.



3. **(10 marks)** Suppose a file contains a sequence of $k$ integers read in a row major fashion from an $n \times m$ matrix $A$. The dimensions $n$ and $m$ of the matrix are unknown. Write a program to print the possible values of the matrix $A$ that can lead to the contents given in the file.

**Input Format**

The name of a file in which the number $k$ itself, followed by the $k$ matrix elements are written.

**Output Format**

All the distinct matrices for which the given input sequence may be obtained. Successive matrices should be separated by a blank line. Matrices should be printed in increasing order of the number of rows.

**Sample Input 0**

A file `sequence.txt` containing the following: 4 1 3 5 6

**Sample Output 0**

1 3 5 6

1 3
5 6

1
3
5
6

**Sample Input 1**

A file `sequence.txt` containing the following: 6 2 5 3 7 2 5

**Sample Output 1**

2 5 3 7 2 5

2 5 3
7 2 5

2 5
3 7
2 5

2
5
3
7
2
5