Birla Institute of Technology and Science, Pilani

Second Semester 2017-2018, DSA (CS F211)

Lab Assignment #5

1. Given a string S, find the maximum value f(s) can take, where s is any substring of S and f(s) = |s| X no. of times s occurs in S
   Input: One line consisting of a String
   Output: One line containing the maximum value f(s) can take for that string S.
   Sample Input: aaaaa
   Sample Output: 9
   Explanation:
   f('a') = 5
   f('aa') = 8
   f('aaa') = 9
   f('aaaa') = 8
   f('aaaaa') = 5
   Highest value is 9
   Sample Input 2: ababa
   Sample Output 2: 6
   Constrains: $|S|<10^5$
   Time Limit: 2 seconds.
   Note: You have to generate a random long string to show that your code satisfies the time limit.

2. Given an integer N calculate the value of F(1) + F(2) + F(3) + …….. F(N), where F(i) is defined as Least Common Multiple of the integers i and N.
   Input:
   The first line contains T the number of test cases. Each of the next T lines contain an integer N.

   Output:

   Print T lines, one for each test case, containing the required sum.

   Constraints:

   1 <= T <= 300000
   1 <= n <= 1000000

   Note:

   You have to generate random test cases such that T = 300000 to show that your code passes the time limit of 2 secs.

   Sample Input:

   3

   1

2

5

Sample Output:

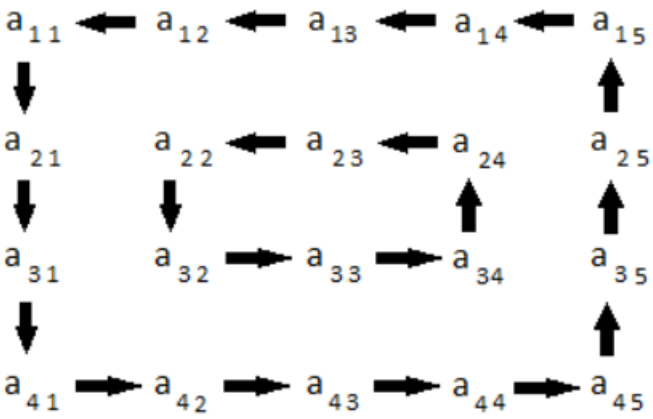
1

4

55

3. **Find Peak:** Given a 2D array find a peak element in it. A peak would be defined an element of the array whose neighbours have values less than or equal to its value. A neighbour is defined as the adjacent element in the either the same column or the row.
There may be many peaks in an array.
Input:
n m – n rows and m columns of the array
n x m array.
Output: Any one peak
Sample Input:
3 3
10 20 15
5 30 19
20 25 35
Sample Output:
30 or 35 – both are correct in this case. Find any one.
Time Complexity: O(log(m)log(n))

4. Given a matrix of size m X n and an integer r, rotate the matrix r times in anti-clockwise direction. It is guaranteed that the minimum of m and n will be even
Example: Given 4 X 5 matrix, one rotation is depicted in the figure.



Input:
Line 1 - m n where m is the number of rows and n is number of columns.
Line 2 - m X n matrix.
Output: m X n rotated matrix

Constraints: 2<= m,n <= 100 ; r<=10^8
Note: You have to generate random matrices to show that your code satisfies the time limit of 2 seconds.
Sample Input 1:
4 4 2
1 2 3 4
5 6 7 8
9 10 11 12
13 14 15 16

Sample Output 1:
3 4 8 12
2 11 10 16
1 7 6 15
5 9 13 14

Sample Input 2:

5 4 7
1 2 3 4
7 8 9 10
13 14 15 16
19 20 21 22
25 26 27 28

Sample Output 2:

28 27 26 25
22 9 15 19
16 8 21 13
10 14 20 7
4 3 2 1

5. Using median of medians algorithm, find the median of an unsorted array in linear time. Generate a long array of size n using random integers and find its median.
Input: n – size of array
Output: k – median of the array generated
Time Complexity: O(n)

6. Find a positive integer n such that there are exactly m numbers in n+1 to 2n (both inclusive) whose binary representation has exactly k 1s.
Input: m k
Output: n
Constraints: m<=10^{18} and k<=64. Also answer is less than 10^{18}.

Sample Input 1:

3 2
Sample Output 1:
5

Sample Input 2:
820882585293 13
Sample Output 2:
167167411424854017

7. Aditya Caterers is distributing laddoos on Republic Day in the hockey field. People are standing in line to get their laddoos. The i^{th} person joins the queue at l_i^{th} second and can wait till r_i^{th} second. If he doesn't get the laddoo by r^{th} second, he leaves the line. It takes 1 second for a person to get the laddoo and leave. For each person, determine the time when he gets his laddoo.
   Input:
   n : – number of students
   followed by n lines of l_i and r_i which represent the joining and leaving times.
   Output:
   An array of size n in which i^{th} element represents the time he receives the laddoo. Let it be 0 if he leaves without taking any.
   Sample Input 1:
   2
   1 2
   1 4
   Sample Output 1:
   1 2
   Sample Input 2:
   3
   1 5
   1 1
   2 3
   Sample Output 2:
   1 0 2
   Constraints:
   $l_{i-1} <= l_i$; n<1000 ; l,r<5000

8. Yash has come up with a new way of sorting strings. He would sum up asci values of all the characters in the string and sort them according to the number of 1s in the binary representation of the sum. But if two strings have the same corresponding values, the one which appears first in the input list should appear first in the sorted list too, i.e., the sorting must be stable. Since Yash is not a CS student, he needs your help to write a program to sort the strings.
   Time Complexity: O(n) where n is the number of strings.

9. Tanmay and Vishal are playing a game of cards. In this game, all the cards are numbered and there can be multiple instances of each number. A number of cards are placed on the desk

such that they can see number on each card. They choose a card turn by turn starting with Vishal. When a card is chosen, that card and the cards which are numbered lesser than that card are discarded. A player loses when he has no cards left to choose from. Because both Tanmay and Vishal are intelligent, they choose cards optimally. Given a set of cards, determine who will win the match.
Input: n – number of cards
Set of numbers on the cards.
Output: 'Tanmay' or 'Vishal' depending on who wins.
Sample Input 1:
3
4 5 7
Sample Output 1:
Vishal
Sample Input 2:
2
1 1
Sample Output 2:
Tanmay
Sample Input 3:
5
2 2 2 3 3
Sample Output 3:
Vishal

10. Raju hates Maths a lot and he is given a problem for which he has to find out the number of n-beautiful numbers between a and b. A n-beautiful number is the number which has n-divisors. For example, 1 is 1-beautiful, 4 is 3 beautiful, 6 is 4 beautiful. Can you help Raju by finding the number of n-beautiful numbers between a and b.

    Input:
    Three integers a, b, n.

    Output:
    Output the number of n-beautiful numbers between a and b inclusive.

    Constraints:
    1 <= a, b <=10^9
    0 <= b - a <= 10^4
    1 <= n <= 100

    Sample-Input 1:
    1 7 2

    Sample-Output 1:
    4