December 1 — Binary Search

- Problem

Player A chooses a secret number n. Player B can guess a number x and A replies how does x compare to n (equal, larger, smaller). What's an efficient strategy for B to guess n?

Ex:
Say my chosen number is 38. What are you going to do? Do a binary search:

Guess 50 (half of 0 to 100) → you're too high.
Guess 25 (half of 0 to 50) → you're too low.
Guess 37 (half of 25 to 50) → you're too low.
Guess 43 (half of 37 to 50) → you're too high.
Guess 40 (half of 37 to 43) → you're too high.
Guess 38 (half of 37 to 40) → spot on!

- Uses

- Binary search is used for faster checking of data within a file. It helps to locate data from a larger file in an easier and faster way.
- It is used in debugging of codes.If the code has many steps and there's a bug, you can isolate the bug by finding the earliest step where the code produces results which are different from the expected ones.
- Figuring out resource requirements for a larger system.

- Resources

https://www.geeksforgeeks.org/binary-search/

December 2 -Bubble Sort

- Problem

    You have given an array of size N and an integer M.
    Your task is to calculate the difference between maximum sum and minimum sum of N-M elements of the given array.

    Constraints:
    1<=t<=10

1<=n<=1000
1<=a[i]<=1000

Input:
First line contains an integer T denoting the number of testcases.
First line of every testcase contains two integer N and M.
Next line contains N space separated integers denoting the elements of array
Output:
For every test case print your answer in new line

- Uses
  One daily use of this algorithm?Let me take you back to nostalgic memories of your physical education classes or sports classes back in school. Lined up in a random order in front of the teacher, who's put to the task of lining you all up in an ascending order of height. The bubble sort algorithm comes in handy here. In this case every person's height is an element of the list. With every pass that the teacher goes over the students, they slowly start standing in a more orderly fashion till all of them stand according to height.

- Resources

  Video link tutorial: https://www.youtube.com/watch?v=6Gv8vg0kcHc

December 3- Digit manipulation

- **Problem**

Ticket numbers usually consist of an even number of digits. A ticket number is considered lucky if the sum of the first half of the digits is equal to the sum of the second half. Given a ticket number n, determine if it's lucky or not.
Example For n = 1230, the output should be
isLucky(n) = true;
For n = 239017, the output should be
isLucky(n) = false.

- **Resources**

The basic functionality needed to solve this problem is extracting all the digits from a number and manipulate it according to your needs for which this link can be used.
https://www.youtube.com/watch?v=rporZ07Tc4M

December 4-Big factorial

- **Problem**

Factorial of a non-negative integer, is multiplication of all integers smaller than or equal to n. For example factorial of 6 is 6*5*4*3*2*1 which is 720.Factorial of 100 has 158 digits. It is not possible to store these many digits even if we use long long int. The challenge in this is to implement an algorithm to find the factorial of large numbers

- **Uses**

Factorials are used everywhere. We use it when we have to find the numbers of ways in which objects have to be used and also the number of ways they can be arranged. It is used in probability and statistics greatly which is in turn used in a lot of data analysis. But using the normal coding languages we can only find out the factorials of whole numbers upto 13 which is not of much value in these applications hence the need for big factorial.

- **Resources**

factorial(n):

1. Create an array ‘res[ ]’ of MAX size where MAX is number of maximum digits in output.
2. Initialize value stored in ‘res[ ]’ as 1 and initialize ‘res_size’ (size of ‘res[ ]’) as 1.
3. Do following for all numbers from x = 2 to n......
4. a) Multiply x with res[ ] and update res[ ] and res_size to store the multiplication result.

multiply(res[ ], x)

1. Initialize carry as 0.
2. Do following for i = 0 to res_size – 1 .....
3. a) Find value of res[i] * x + carry. Let this value be prod.
4. b) Update res[i] by storing last digit of prod in it.
5. c) Update carry by storing remaining digits in carry.
6. Put all digits of carry in res[ ] and increase res_size by number of digits in carry

December 5- File Handling

- Problem

Handling files is an integral part of any programming language as it helps us store the result of our operations and it also helps us perform some operation on data. There are two parts in this problem’s implementation which have to be coded as two functions. They are:

1)A function that counts how often each word appears in the text and prints:

word1 count1

word2 count2

2)A function which is similar to the above function but which prints just the top 20 most common words sorted so the most common word is first, then the next most common, and so on.

- Uses

Using file operations we can read data from a word document or an excel sheet and it can be manipulated in any way we would like .

E.g: We use csv files for machine learning in python

- Resources

Files in C here : https://www.programiz.com/c-programming/c-file-input-output

Files in C++ here : http://www.cplusplus.com/doc/tutorial/files/

Files in Java here : https://www.tutorialspoint.com/java/java_files_io.htm

Files in python here : https://www.w3schools.com/python/python_file_handling.asp

An interesting video to visualise sorting : https://www.youtube.com/watch?v=kPRA0W1kECg

December 11-Printing matrix in spiral form

- **Problem:**
  - Given a Matrix of size M * N, output its elements in spiral form.
  To better understand the problem statement, consider the following matrix
  ```
  01	02	03
  04	05	06
  07	08	09
  ```
  The Spiral form of a matrix is as below.

  01-->02-->03-->06-->09-->08-->07-->04-->05

  Move Right, Move Down, Move Left, Move Up till you cover all elements of matrix.
- **Uses:**
  Matrices are used much more in daily life than people would have thought. In fact it is in front of us every day when going to work, at the university and even at home.
  [Real Applications of Matrices](https://www.ukessays.com/essays/mathematics/application-of-matrices-in-real-life-problems.php)

- **Resources**
  Matrices are represented using two dimensional arrays in any . So to access a single element in the matrix two “for loops”
  [Operations on Matrices](https://www.geeksforgeeks.org/different-operation-matrices/)

December 12- Reversing a singly linked list

- **Problem**
  Taking a singly linked as the input the output has to be another singly linked list having the reverse of the initial linked list

  Example:

  Input:

  10->20->34->23->889

  Output:

  889->23->34->20->10
- **Uses**
  There are pretty good real examples to show the usage and importance of linkedlist.
  - Consider the history section of web browsers, where it creates a linked list of web-pages visited, so that when you check history (traversal of a list) or press back button, the previous node's data is fetched.
  - One common sighted example is low level memory management (i.e. the heap as managed by malloc in C or new in Java, etc) is often implemented as a linked list, with each node representing a used or available (free) block of memory. These blocks may be of any size, change size (combine and split), be freed or assigned in any order, and reordered. A linked list means you can keep track of all of these "nodes" and manipulate them fairly easily.
  - Also, Hashtables that use chaining to resolve hash collisions typically have one linked list per bucket for the elements in that bucket.
- **Resources**:

  This is how linked lists work : https://www.youtube.com/watch?v=NobHlGUjV3g

  Clue: This problem requires the use of another data structure

December 13 - Lexicographical arrangement

- **Problem:**
  In this question the input is a string with a given number of characters. The problem here is to arrange all the possible permutations of this string in the alphabetical order. The next step is to find out the position at which this string occurs in this order.

  For example:
  Input: dac
  Possible combinations:
  acd
  adc
  cad
  cda
  dac
  dca
  The output for this will be **5** as dac is present in the 5th position in this order
- **Uses and Resources:**

  This question is a brain teaser and does not have any practical application as it is and for the resources it is an application of everything you have solved until now and maybe requires the use of some *mathematics*.

December 14 -CEASER CIPHER

- **Problem:**

There is a specific code in which after the encoding process is done each of the characters are moved by a certain position. The number of positions by which they are moved is given by the number of characters that are present in the given word. This problem requires you to take the input string and encrypt it according to this system and add an decrypting algorithm

Example:
Input: and
Encoded output: dqg

Example:

Input feel:

Encoded output:jiip

December 15 - The Strongest String

Problem:

A string is called unique if all characters of string are distinct.

String s1 is called subsequence of string s2 if s1 can be produced from s2 by removing some characters of s2.

String s1 is stronger than s2 if s1 is lexicographically greater than s2.

You are given a string. Your task is to find the strongest unique string which is subsequence of given string.

Input:
first line contains length of string.
second line contains the string.

Output:
Output the strongest unique string which is subsequence of given string.

Constraints:
$1 \le |S| \le 100000$
All letters are lowercase English letters.

Reference and uses:
https://www.hackerearth.com/practice/algorithms/string-algorithm/basics-of-string-manipulation/tutorial/

December 16 - Lost in the Islands

Problem:

There are many islands that are connected by one-way bridges, that is, if a bridge connects islands a and b, then you can only use the bridge to go from a to b but you cannot travel back by using the same.

If you are on island a, then you select (uniformly and randomly) one of the islands that are directly reachable from a through the one-way bridge and move to that island. You are stuck on an island if you cannot move any further. It is guaranteed that after leaving any island it is not possible to come back to that island.

Find the island that you are most likely to get stuck on. Two islands are considered equally likely if the absolute difference of the probabilities of ending up on them is <=10−9.

Input format:

- **First line:** Three integers n (the number of islands), m (the number of one-way bridges), and r (the index of the island you are initially on)
- **Next m lines:** Two integers ui and vi representing a one-way bridge from island ui to vi.

Output format:

Print the index of the island that you are most likely to get stuck on. If there are multiple islands,then print them in the increasing order of indices (space separated values in a single line).

Input Constraints:

1≤n≤200000
1≤m≤500000
1≤ui,vi,r≤n

Reference and uses:

https://www.geeksforgeeks.org/topological-sorting/

December 17 - Bytelandian Gold Coins

Problem:

In Byteland they have a very strange monetary system. Each Bytelandian gold coin has an integer number written on it. A coin n can be exchanged in a bank into three coins: n/2, n/3 and n/4. But these numbers are all rounded down (the banks have to make a profit).

You can also sell Bytelandian coins for American dollars. The exchange rate is 1:1. But you can not buy Bytelandian coins. Yo u have one bytelandian gold coin. What is the maximum amount of American dollars you can get for it?

Input:
The input will contain several test cases (not more than 10). Each testcase is a single line with a number n, 0 <= n <= 1 000 000 000. It is the number written on your coin.

Output:
For each test case output a single line, containing the maximum amount of American dollars you can make.

Explanation:
You can change 12 into 6, 4 and 3, and then change these into \$6+\$4+\$3 = \$13. If you try changing 2 into 3 smaller coins, you will get 1, 0 and 0, and later you can get no more than \$1 out of them. It is better just to change the 2 coin directly into \$2.

Reference: https://www.geeksforgeeks.org/dynamic-programming/#concepts

December 18 - Beautiful Strings

Problem:

A string is beautiful if it has equal number of a,b,and c in it.

Example "abc" , "aabbcc" , "dabc" , "" are beautiful.

Given a string of alphabets containing only lowercas aplhabets (a-z), output the number of non-empty beautiful substring of the given string.

Input :

The first line of the input contains an integer T denoting the number of test cases. The description of T test cases follows. Each test case consists of a line containing a string a length L.

Output:

For each test case, output a single line containing the number of beautiful substring.

Constraints:

1<=T<=10
1<=L<=100000

Reference:
https://www.geeksforgeeks.org/quick-sort/

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