Brain Storming (Day-1)

Note: 1. Discussion with in the group is very much essential.

2. Any Suggestion or solution given by any individual should be discarded or accepted after properly discussing its merits and demerits.

3. It may be good exercise to make notes of different suggestions that came up and how all finally agreed to a solution.

4. We should also see whether we have tried different tools (algorithm design tricks or strategies) to make our algorithm better.

For the following three problems try to see the similarities and differences. How these should make you choose different strategies to solve these problems. See how you can leverage the work done in one problem in other part.		
1	i	Write an efficient algorithm to find out the factorial of a number.
	ii	Write an efficient algorithm to print the series of first n factorial numbers starting from 1, 2, 3…. n
	iii	Write an efficient algorithm if a given positive integer is factorial of some number or not.
2	i	Write an efficient algorithm to print the series of first n Fibonacci numbers starting from 1,2,3…. n
	ii	Write an efficient algorithm to print Fibonacci number corresponding to the first n numbers in the Fibonacci series.
	iii	Write an efficient algorithm to find factorial of first n Fibonacci primes.
3	i	Write an efficient algorithm to print first n prime numbers.
	ii	Write an efficient algorithm to find whether the given number is prime or not.
	iii	Write an efficient algorithm for writing first n prime numbers which are Fibonacci numbers also

Brain Storming (Day-2)

1	Given a number and an exponent write all the values of powers of that number from one to given number.
2	Write an efficient program to find the decimal equivalent of a given series of hexadecimal numbers from m to n.
3	Write a program to find whether a given number is a triangle number or not.
4	Suppose that each row of an m X n array A consists of 1's and 0's such that in any row i of A, all the 1's come before any 0's in that row. Suppose further that the number of 1's in the row i is less than or equal to the number in row i+1. Assuming A is already in memory, describe a method running in O(n) time for counting the number of 1's in the array.
5	An evil king has a cellar containing n bottles of expensive wine, and his guards have just caught a spy trying to poison the king's wine. Fortunately, the guards caught the spy after he succeeded in poisoning only one bottle. Unfortunately they don't know which one. To make the matter worse the poison the spy used was very deadly. Just one drop diluted even to a billion will still kill someone. Even so, the poison works slowly. It takes a full month for the person to die. Design a scheme that allows the evil king to determine exactly which one of his wine bottles was poisoned in just one month's time while expending at most O(logn) of his taste testers. First integer gives number of bottles and the sequence gives the number of taste testers who died.

Brain Storming (Day-3)

1	Consider the problem of searching in a sorted matrix. That is, you are given an m×n matrix A, where each entry is an integer. Each row of the matrix is sorted in ascending order, and each column is also sorted in ascending order. Given a value x, the problem is to decide whether x is stored somewhere in the array (i.e., whether there is some i and j such that A[i][j] = x). First number gives m and second gives n.
2	There is a list of distinct sorted numbers stored in array A. Design an efficient algorithm for finding an index i such that A[i]=i or concluding that no such index exists. First number gives the total number of elements in the list.
3	There are n closed doors along a corridor numbered from 1 to n. A person walks through the corridor and opens each door. Another person walks through the corridor and closes every alternate door. Continuing like this, ith person comes and toggles every ith door starting from position i. Determine how many doors are open and which one after nth person has walked through the corridor.
4	With the help of stacks solve Stock span problem, which has applications in Financial markets. Suppose, for a stock, we have a series of *n* daily price quotes, the *span* of the stock's price on a particular day is defined as the maximum number of consecutive days for which the price of the stock on the current day is less than or equal to its price on that day.
5	Your friend is working as a camp counsellor who is in charge of organizing activities for a set of junior high-school-age campers. One of the plans is the following mini-triathlon exercise: each contestant must swim 20 laps of a pool, then bike 10 kilometres, then run 3 kilometres. The plan is to send the contestants out in a staggered fashion, via the following rule: the contestants must use the pool one at a time. In other words, first one contestant swims the 20 laps, gets out, and starts biking. As soon as this first person is out of the pool, a second contestant begins swimming the 20 laps; as soon as he or she is out and starts biking, a third contestant begins swimming . . . and so on. Each contestant has a projected swimming time (the expected time it will take him or her to complete the 20 laps), a projected biking time (the expected time it will take him or her to complete the 10 kms of bicycling), and a projected running time (the expected time it will take him or her to complete the 3 kms of running). Your friend wants to decide on a schedule for the triathlon: an order in which to sequence the starts of the contestants. Let's say that the completion time of a schedule is the earliest time at which all contestants will be finished with all three legs of the triathlon, assuming they each spend exactly their projected swimming, biking, and running times on the three parts. (Again, note that participants can bike and run simultaneously, but at most one person can be in the pool at any time; also, contestants must complete the events in the same order—swimming, biking, running—to avoid giving anyone an unfair advantage.) What's the best order for sending people out, if one wants the whole competition to be over as early as possible? More precisely, give an idea that produces a schedule whose completion time is as small as possible, together with a short proof that your algorithm is correct.

Brain Storming Day 4

1	Find the index of the first occurrence of an element k in the sorted array A whose length is unknown in advance, however accessing the array beyond its limits will throw an exception. Output should be -1 if element is not present in the array.
2	You are given two sorted arrays of length m and n. Give a O(log m+ log n) time algorithm for computing the kth smallest element in the union of the two arrays. Keep in mind that the elements may be repeated. First two numbers gives the size of the arrays followed by value of k.
3	Consider an mXn array A containing integer elements (positive integer and zero). Assume that element in each row of A are in strictly increasing order and the elements in each column of A are in strictly decreasing order. Write an efficient program that counts the number of zeros in A. First number gives m and second gives n
4	There are K nuclear reactor chambers labelled from 0 to K-1. Particles are bombarded onto chamber 0. The particles keep collecting in the chamber 0. However if at any time, there are more than N particles in a chamber, a reaction will cause 1 particle to move to the immediate next chamber(if current chamber is 0, then to chamber number 1), and all the particles in the current chamber will be be destroyed and same continues till no chamber has number of particles greater than N. Given K,N and the total number of particles bombarded (A), find the final distribution of particles in the K chambers. Particles are bombarded one at a time. After one particle is bombarded, the set of reactions, as described, take place. After all reactions are over, the next particle is bombarded. If a particle is going out from the last chamber, it has nowhere to go and is lost.
5	Three students are asked to make a list of numbers from a given range. Write an efficient program which makes a final list from these three lists that will contain only those numbers that appear in at least two of the three lists. Those numbers that appear in only one list will not appear in the final list.

Brain Storming Day 5

1	You are given a number of identical balls and a building with N floors. You know that there is an integer X lessthan N such that the ball will break if it is dropped from any floor X or higher but will remain intact if dropped from a floor below X.Given K balls and N floors what is the minimum number of ball drops that are required to determine X in the worst case.Input is in the order (K,X,N).
2	Three lists of unsorted arrays. find if taking one from each of them sums up to 0 in n^2 time.
3	Arbitrage is the use of discrepancies in the currency exchange rates to make profit. Suppose 1 US $ buys 0.74 pounds, 1 pound buys 2 Australian dollars & 1 Australlian dollar buys 0.70 US $. Then 1 US $ buy 0.75 *2 * 0.7 = 1.05 US $ having a profit of 5 %. We are given n currencies c1,c2,…,cn & nXn table R of exchange rates, such that one unit of currency Ci buys R[i,j] units of currency Cj . Give an efficient algorithm to determine the maximum profit for a sequence [i1,i2].R[i2,i3]……R[ik-1,ik].R[ik,i1] Input File should consist of a table consisting of currency exchange rates.
4	Gauri wants to throw a party and she is trying to decide who to invite. She has n people to choose from, and she knows which pairs of these people know each other. She wants to pick as many people as possible, subject to two constraints: i) For each guest, there should be at least five other guests that they already know. ii) For each guest, there should be at least five other guests that they don't already know. Write an algorithm that computes the largest possible number of guests she can invite, given a list of n people and the list of pairs who know each other.
5	A King‟s garden has thousands of flowerpots which are very expensive and require careful handling. One day king‟s princess says that she wants to watch the flowerpots arranged in the order of „number of flowers in each pot‟. Garden supervisor orders his subordinates to move the flowerpots in such a way so that there is minimum movement in terms of the total distance moved from the current position and final position of all the flowerpots. This is required to minimize the damage that may be done to the delicate flowerpots due to heavy movements. If the supervisor takes advice from you, what kind of sorting mechanism and data structure you will suggest so as to minimize the total movement of the flowerpots. Suppose supervisor provides you with the pot number and the number of flowers in each pot. Justify your answer.

Brain Storming Day 6

1	You are given a sequence of n numbers (positive or negative): x1,x2,...,xn Your job is to select a subset of these numbers of maximum total sum, subject to the constraint that you can't select two elements that are adjacent (that is, if you pick xi then you cannot pick either xi-1 or xi+1). Explain how you can find, in time polynomial in n, the subset of maximum total sum.
2	You are given an n-by-n grid, where each square (i, j) contains c(i, j) gold coins. Assume that c(i, j) > 0 for all squares. You must start in the upper-left corner and end in the lower-right corner, and at each step you can only travel one square down or right. When you visit any square, including your starting or ending square, you may collect all of the coins on that square. Give an algorithm to find the maximum number of coins you can collect if you follow the optimal path.
3	You are planning a cross-country trip along a straight highway with n+1 gas stations. You start at gas station 0, and the distance to gas station i is di miles (0 = d0 < d1 < . . . < dn). Your car's gas tank holds G > 0 gallons and your car travels m > 0 miles on each gallon of gas. You start with an empty tank of gas (at gas station 0), and your destination is gas station n. You may not run out of gas, although you may arrive at a gas station with an empty tank. As you are very rich, rather than trying to plan the cheapest trip, you want to minimize the total number of stops you need to make (you stop at a gas station only if you need to buy gas there). Assume that G, m, and all di are positive integers (except d0 = 0) and are polynomially bounded as a function of n. Assume all di are distinct. If possible, give a polynomial time algorithm to determine the value of the optimal solution (i.e. the minimum number of stops).
4	You have a sequence S of n characters from an alphabet of size k <= n; each character may occur many times in the sequence. You want to find the longest subsequence of S where all occurrences of the same character are together in one place; for example, if S = aaaccaaaccbccbbbab, then the longest such subsequence is aaaaaaccccbbbb = aaa__aaacc_ccbbb_b. In other words, any alphabet character that appears in S may only appear in one contiguous block in the subsequence. If possible, give a polynomial time algorithm to determine the value of the optimal solution (i.e. the length of longest such subsequence).
5	A Project Manager in a company is in a typical situation due to a computational problem for which he is looking for an algorithm. He asks five of his programmers to come up with a solution. P1 is always concerned about the length and structure of his code, so he comes up with the shortest code. P2 is always concerned about the memory usage his code will be using, so he comes up with a code which is taking least memory. P3 is always concerned with the time consumed by the code, so he comes up with a code that takes least time. P4 is always concerned about optimizing his program for a particular input, so he comes up with a code that works optimally in time and space for a particular input. P5 is always concerned about the correct output for all inputs, so he comes up with a code which gives the correct output for all inputs. If you are project manager what you will do. If you will choose one of the codes given by programmers. If yes, which one and why. If no, then what strategy you will use to come up with best code for your problem.

Brainstorming Day 7

1	Let N! for any positive integer N has a value called zeroattheend(N!). We also know that if x<y then zeroattheend(x!) ≤ zeroattheend(y!). Given a number N write an efficient algorithm to find the value of the function zeroattheend(N!) . Your algorithm need not calculate the exact factorial of the given value and then calculate the trailing zeros. There are other efficient ideas that must be used.
2	Suppose you are consulting for a bank that is concerned about fraud detection, and they come to you with the following problem. They have a collection of n bank cards that they have confiscated, suspecting them of being used in fraud. Each bank card is a small plastic object, containing a magnetic strip with some encrypted data, and it corresponds to a unique account in the bank. Each account can have many bank cards corresponding to it, and we will say that two bank cards are equivalent if they correspond to the same account. It is very difficult to read the account number off a bank card directly, but the bank has a high-tech "equivalence tester" that takes two bank cards, and after performing some computations, determines whether they are equivalent. Their question is the following: among the collection of n cards, is there a set of more than n/2 of them that are all equivalent to one another? E.g. if there are 10 cards, is there a set of more than 5 of them that are all belonging to the same account. Only feasible operations you can do with the cards are to pick two of them and plug them into the equivalence tester. Show how to decide the answer to their question with only O(n log n) invocations of the equivalence tester.
3	A common super sequence of two strings A and B is another string that includes both the characters of A in order (may not be continuous) and the characters of B in order (may not be continuous). Write an algorithm to compute the length of the shortest common super sequence of two strings A[1..m] and B[1.. n]. You do not need to compute an actual super sequence, just its length. For example, if the input strings are ANTHROHOPOBIOLOGICAL and PRETERDIPLOMATICALLY, your algorithm should output 31, because a shortest common super sequence of those two strings is PREANTHEROHODPOBIOPLOMATGICALLY.
4	A palindrome is any string that is exactly the same as its reversal, like HANNAH. Describe and analyse an algorithm to find the length of the longest subsequence of a given string that is also a palindrome. For example, the longest palindrome subsequence of HDYNAMICPROGRAMZLETMESHOWYOUTH is HYMRORMYH, so given that string as input, your algorithm should return the integer 9.
5	Suppose we need to distribute a message to all the nodes in a rooted tree. Initially, only the root node knows the message. In a single round, any node that knows the message can forward it to at most one of its children. Describe and analyse an efficient algorithm to compute the minimum number of rounds required for the message to be delivered to every node.

Brainstorming Day 8

1	Every year, Prof Gupta assigns the instructors at Thapar to various faculty committees. There are n faculty members and c committees. Each committee member has submitted a list of their prices for serving on each committee; each price could be positive, negative, zero, or even infinite. For example, Professor Jindal might declare that he would serve on the Student Recruiting Committee for 1000 Rs, that he would pay 10000 Rs to serve on the Drug abuse Committee and that he would not serve on the Discipline committee for any price. Conversely, Gupta knows how many instructors are needed for each committee, as well as a list of instructors who would be suitable members for each committee. If Gupta assigns an instructor to a committee, he must pay that instructor's price from the University treasury. Gupta needs to assign instructors to committees so that (1) each committee is full, (3) no instructor is assigned to more than three committees, (2) only suitable and willing instructors are assigned to each committee, and (4) the total cost of the assignment is as small as possible. Write an efficient algorithm that either solves Gupta's problem, or correctly reports that there is no valid assignment whose total cost is finite.
2	In an army recruitment drive all eligible persons are standing in a queue and there looks no logical way to select one out of them. So the Army general uses the following trick to select one person out of the eligible persons. He gives every person a number in the order of their position in the queue like 1,2,3,4…Then he starts removing every odd person starting from the queue and the persons left are with the numbers 2,4,6,…Again he does the same thing and removes every alternate person starting from the front. Now he is left with persons numbered 4,8…Write an algorithm, given the number of persons in the queue, at which position you should stand so that you are chosen by the General, if he uses the above approach.
3	Write an efficient algorithm that returns the parenthesization of an unparenthesized expression after maximizing the value of the expression. Expression may contain addition, subtraction and multiplication operators. For example 5-3*4+6 will yield -25= 5-(3*(4+6)) -13=5-((3*4)+6) 20= (5-3) * (4+6) -1 = (5-(3*4)) + 6 14 = ((5-3*4) + 6 So the maximum value is returned by the parenthesization at line 3.
4	How a non stable sorting algorithm can be made stable. Give the idea taking into context any exiting non stable algorithm.
5	You are working in the finance office for ABC corporation. There are n employees and each employee received ci compensation last year and total compensation disbursement was C. This year the company needs to cut payroll expenses to C*. Company wants to put a cap # on salaries such that any employee who was paid more than # last year will be paid # this year. Employees who were paid less than # last year will be paid the same amount as of last year. e.g. if(c1,c2,c3,c4,c8) = (90,30,100,40,20) and C*=210 then 60 is suitable value for #. Write an efficient algorithm for finding #.Input file first number gives number of employees followed by C* and then followed by the salary of last year of each employee