Algorithm Problems - Zeta

Easy

Question: Gully Cricket
In a gully cricket match, a batsman can score 1 run, 2 run or 3 run on a single ball with restrictive rules. In how many ways a user can score n runs given batsman will score at least 1 run on each ball he plays.

Solution:
Simple recursion and use DP for implementation.

Author: Ashwin
Solution: n ways(by Abhinav)

Solution:
f(n) = f(n-1) + f(n-2) + f(n-3)
with base case
f(1) = 1
f(2) = 2
f(3) = 4

Question: Snakes and Ladder
Given a snakes and ladders board, find out the minimum number of moves (user can score anything from 1 - 6 on dice) required to win the match.

Solution:
Simple DP

Author: Ashwin

Question: Chess
Minimum number of moves required by knight to reach from location A to location B in chess.

Solution:

Simple DP

Author: Ashwin

Author - Swapnil Gupta

Easy Medium

Matrix Median
Given a matrix of integers **A** of size **N x M** in which each row is sorted.

Find and return the overall median of the matrix **A**.

Note: No extra memory is allowed.

Note: Rows are numbered from top to bottom and columns are numbered from left to right.

Input Format

The first and only argument given is the integer matrix A.

Output Format

Return the overall median of the matrix A.

Constraints

1 <= N, M <= 10^5
1 <= N*M <= 10^6
1 <= A[i] <= 10^9
N*M is odd

Solution

Bruteforce:

Try pivoting elements around the center of the matrix. Assume that the pivot is median and then start comparing with the left hand side elements. Swap elements when required. Do the same for the right hand side. Stop when all the elements towards the left are smaller or equal to the pivot and all the elements on the right are greater or equal to the pivot element.

Optimised:

- If we consider N*M matrix as 1-D array then the median is the 1 + M*N/2 th element
- Then consider x will be the median if x is an element of the matrix and number of matrix elements ≤ x equals `1 + N*M/2`.
- As the matrix elements in each row are sorted then you can easily find the number of elements in each row `less than or equals x`. For finding in the whole matrix, the complexity is `N*log M` with binary search.
- Then first find the minimum and maximum element from the N*M matrix. Apply Binary Search on that range and run the above function for each x.
- If the number of elements in matrix `≤ x` is `1 + N*M/2` and x contains in that matrix then `x` is the median.

Medium

Author - Rahul Nishad
Questions
Let's consider there is only one way to go from marathahalli bridge towards zeta and it goes till infinite. There are n number of cars at different places between zeta office and marathahalli and each car are at some distance from bridge, which we can think as there are location on this road. All cars have different speed and all travelling from marathahalli to zeta office. We need to find how many crosses will happen before infinite, given that cars have infinite time to travels.

Test case -
Car 1 2 3
Location- 0 1 3
Speed - 2 1 2

Answer- 1

For simplicity consider location will be always ascending order.

Answer- 1

Data Structure - Simple solution in O(N2) Solution - simple traversal.
optimized solution -Average O(Nlog(N)), worst can go O(N2) Solution- BST with count*(edited)*

Question: Parking length
You have given a contract to develop a parking lot (1 dimension) for the new office building. Being a contractor, you wanted to save money and thus wanted to minimize the size of parking lot. You have given the incoming as well as
time of each vehicle that enters the parking lot along with the size of vehicle.

Example:
Enter timing: 1 2 3 4 5
Exit timing: 3 2.5 6 5 5.25
Length: 2 3 1 3 2

Solution: Linear programming
Author: Ashwin

Difficult

Question: Marathon
We have a lot of people who loves running in Zeta. In the upcoming Marathon of 42 Kms, Avinash from Zeta team is planning for this marathon and he wanted to make sure that he should be fully hydrated for the entire marathon. He went to Decathlon and got confused in the capacity of the bottle he should buy. He knows the entire map of the Marathon, and also aware of the places where he can get a refill. He can spent only Rs.x (each refill cost him Rs. 1) and he needs to consume 1 liter for every Km. Help Avinash to decide the bottle capacity.

Example:
Refill station locations: 2 5 10
Money: 1 Rs
Total marathon length: 42

Solution: Binary search
Author: Ashwin

Easy Medium

A supermarket has lots of counters with each counter having a big queue. Today, only one of the counters is working due to some issue with the system. The counter is picking up the person who is at the front of one of the queues and has the minimum number of items. Tell the order in which the customers are processed.

Test case:

2(Number of queues)

3(first queue size)
20 25 40
3(second queue size)
10 15 30

Solution:
10 15 20 25 30 40

Solution: Priority Queue
Author: Shubham

Hard

Question: Tetris puzzle
A 4x5 tetris board has been given with blocks of different shapes. Each block can be rotated and placed anywhere on the board. Overlapping is not allowed. The block should not go outside the boundary. Place the blocks in such a way that the board is completely filled.

Example:

Input:

1 1 1
0 1 0

2

3 3 3
0 0 3

Output:

1 1 1
3 1 2
3 3 3

Solution: DP+Bitmask
Author: Shubham

Medium

Question: File distributor

There are 1000 files containing 1000x records upto a total of million records. There are two servers of equal capacity and one service is running on each server which can process these files. The services can process only 1 file at a time. The files cannot be broken. Distribute the files between the two servers in such a way that the idle time difference for the two servers is minimum.

Solution: DP
Author: Shubham

Difficult

Question:

Given an array that contains all elements 3 times except one element. Find the element that appears one time
[1, 1, 1, 3] => 3
[100, 100, 100, 3] => 3

Solution:
Convert into bits, find the sum of set bits at ith position in all array elements,the bit with sum not multiple of 3 are the bits of element with single occurrence.
Author: Anuj

Medium

Question:
Find an element in the matrix **m X m** where every row & column are sorted. Also, the last element of each row will be less than the start element of next row.

{10, 20, 21, **25**},
{**30**, 31, 32, 33},
{35, 40, 60, 62},
{63, 64, 65, 66}

31 => true
36 => false;

Solution: binary search
Author: Anuj

Difficult/Medium

Question:

Find the longest chain in given list of Strings, after removing any char from a given string if there is matching string present in set, it will contribute in chain and so on
{"cba","ba","a","dcba"}
Ans(3) in this case

Solution: DP + String manipulation
Author:Anuj

Medium

Question: Tic Tac Toe
Given a state of a tic tac toe board, and assuming optimal play, determine who wins, or if it is a draw. The board in question will always be in a “valid state”.

For tougher complexity, given that you have to process some 10k test cases.

Alternate/Additional Problem: How many unique board states are “valid states”. Two states S1, S2 are same, if upon rotating the board for S1, S1 = S2, at one of the 4 rotations. A state is valid, if it can be reached in normal play, with the game stopping once a player wins, given that X starts first, and players alternate.

Variation: What if we have a 4x4 board? What is the number of unique “valid states” reachable?

Example:
Input:
X O _
_ X O
_ X O

Output:
Draw

Complexity:
Multiple queries:
Simple: 3^9 (DP, suboptimal)
For x*x board: 3^(x*x) states

Solution: DP/Game Theory
Author: Priyanshu Das

Difficult

Question: Counting Cards

Consider a standard deck of 52 cards. Suppose you shuffle the deck, and reveal cards, one by one. There are K queries/reports of 2 types:

1. Reveal a card (eg. 2 of hearts)
2. Find the probability of next card satisfying a set of parameters.

The set of parameters for query could be:

1. Color (Red or Black)
2. Number (x to y)
3. Face Card
4. Specific Suit

Notes:

To solve this, one would need to keep track of the properties of cards revealed, and an efficient way of counting what is the count of items revealed which are satisfying a set of parameters, and how many are still in the deck. The simplest variation can be solved by just iterating over the list of cards revealed and counting, but we can progressively increase the complexity.

Variations we can add to make it more complex/easier, eg:

- What if we shuffle x decks instead of one? x itself could be an input.
- What if we have to find the probability of at least/at max/etc one of the next 3 cards to satisfy the parameters?
- What if we have only one suit of cards (easier)
- What if we want to shuffle some k cards from bottom of reveal pile, back into the deck and then continue?

Solution: Multiple possible ways to implement DS to solve, based on the restrictions placed.
Complexity:
Simple Form: 52*52 (Simple iteration)
Simple solution for K decks: (52*k)^2
Suppose n cards total.
When k is high (say 10^4 decks), optimization is needed

- Suppose only have to keep track of black or white
    - 52*O(k) [keep count of black/white]
- Suppose we have to keep track of suit and number
    - 13*4 counters, 13*4*52*O(k) = 2.7*10^3*n
    - Can be further optimized for range queries on a suit
        - 8.32*10^2*n
- Suppose 4 suits, and x numbers in each suit (can be large like 10^4, 10^8)
    - Query on what is prob of next card being in range (l-r) of hearts
        - Requires range query in (l-r) for that suit
        - O(logx*n)
    - Query on what is prob of next card being either hearts/spades of range (x-y)
        - Range query in both suits O(logx*n)
- Suppose c suits, and x numbers in each suit
    - Query on what is prob of a subset s of these suits having a card in range (l-r)
    - O(logx*s*n) ~ O(logx*c*n)
    - Sample: c=20, x = 10^6, n = 10^5
    - This means we have 10^6 counts in a suit, 20 suits, and 10^5 cards drawn

Author: Priyanshu Das

Difficult

Easy Tree (Author: Amit Raj)

You are given a tree of N nodes. The nodes are numbered from 1 to N. The tree is rooted at node numbered 1.

There is a cost associated with each node. Initially the cost is equal to the number of the node.
eg. The node numbered 1 has initial cost 1, node numbered 5 has initial cost 5.

There are 2 types of operations that can be performed on the tree.

Type 1 :
Format - 1 U X
Operation - You are given two integers U and X. Add X to the cost of each node in the subtree of U.

Type 2 :
Format - 2 U
Operation - You are given one integer U. Print the sum of cost of nodes that come in the path from 1 to U (including 1 and U).

Input

- The first line contains two integers N and Q, the number of nodes and the number of operations.
- The next N - 1 lines contains two integers U and V. There is an edge between U and V.
- The next Q lines contain one operation per line.

Output
For each operation of type 2, print the answer to the operation.

Constraints

- $1 \leq N, U, V, X \leq 100000$

Sample Input

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

Sample Output

11
16
6

Explanation

Initially, cost[1] = 1, cost[2] = 2, cost[3] = 3, cost[4] = 4, cost[5] = 5.

After first operation the cost[1] = 2, cost[2] = 3, cost[3] = 4, cost[4] = 5, cost[5] = 6.

For second operation sum of cost of nodes in the path from 1 to 5 = cost[1] + cost[2] + cost[5] = 11

After third operation the cost[1] = 2, cost[2] = 6, cost[3] = 4, cost[5] = 8, cost[5] = 9.

For fourth operation the sum of cost of nodes in the path from 1 to 4 = cost[1] + cost[2] + cost[4] = 16

For fourth operation the sum of cost of nodes in the path from 1 to 3 = cost[1] + cost[3] = 6

Solution :
The expected complexity is O(N*squareRoot(N)). Square root decomposition on queries achieves that. The bucket size should be square root of N.
Two other solutions are also possible with worst case complexity of O(N*log(N)). One using segment tree and other using heavy light decomposition. Expecting this in interviews will be a little too much.
Author: Amit Raj

Easy

No palindromes

Given N, find the number of strings such that none of it's substring of length greater than 1 is a /drome.

Note : The candidate should inquire about the alphabet and language and should not consider the number of letters to be 26 in the language.

Solution :
Basic combinatorics
If the number of letters in the language is x
If (N == 1) -> x
Else If (N == 2) -> x*(x-1)
Else x*(x-1)*(x-2)^(N-2)
Author: Amit Raj

Easy
Sum of a sub matrix

Given a N*M matrix ‘A’. Find sum of each submatrix formed by considering pairs of (i_1, j_1) (i_2, j_2) and as diagonal elements.

Test case:
M=4
N=4

A = {10, 20, 21, **25**},
{**30**, 31, 32, 33},
{35, 40, 60, 62},
 {63, 64, 65, 66}
x=1
1,2,3,4 (representing submatrix between (1,2) and (3,4))

Solution :
Basic geometry
Create another matrix to store sum from (0,0) to any position i,j

sum = {10, 30, 51, **76**},
{**40**, 91, 140, 198},
{75, 166, 275, 395},
{138, 293, 467, 653}

Way to create this sum[i] [j] = A[i] [j] + sum[i -1] [j] + sum[i] [j -1] - sum[i -1] [j -1]

We can extend the same logic to calculate the sum of submatrix from the sum matrix

Given x (number of) can be very large

Expected time complexity M*N

Author: Manish

Easy

Largest Number

Given a list of non negative integers, arrange them such that they form the largest number.

For example:

Given [3, 30, 34, 5, 9], the largest formed number is 9534330.

Note: The result may be very large, so you need to return a string instead of an integer.

Solution: modify the comparator to sort in lexical order
(Sorting)

Expected time complexity N Log N

Author: Manish

Medium

Distribute Books

N number of books are given.
The ith book has Pi number of pages.
You have to allocate books to M number of students so that maximum number of pages allocated to a student is minimum. A book will be allocated to exactly one student. Each student has to be allocated at least one book. Allotment should be in contiguous order, for example: A student cannot be allocated book 1 and book 3, skipping book 2.

P : [12, 34, 67, 90]
M : 2

Output : 113

There are 2 number of students. Books can be distributed in the following fashion :
1) [12] and [34, 67, 90]
   Max number of pages is allocated to student 2 with 34 + 67 + 90 = 191 pages
2) [12, 34] and [67, 90]
   Max number of pages is allocated to student 2 with 67 + 90 = 157 pages
3) [12, 34, 67] and [90]
   Max number of pages is allocated to student 1 with 12 + 34 + 67 = 113 pages

Of the 3 cases, Option 3 has the minimum pages = 113.

Solution: Binary search on number of pages
Expected time complexity N Log N
Author: Manish

Easy

Nearest Smaller Element

```
G[i] for an element A[i] = an element A[j] such that
    j is maximum possible AND
    j < i AND
    A[j] < A[i]
```

Input : `A : [4, 5, 2, 10, 8]`

Return : `[-1, 4, -1, 2, 2]`

Solution: Stack
Expected complexity : O(N)
Author: Manish

HARD

You are given a bag of size W kg and you are provided costs of packets different weights of oranges in array cost[] where cost[i] is basically cost of ‘i’ kg packet of oranges. Where cost[i] = -1 means that ‘i’ kg packet of orange is unavailable

Find the minimum total cost to buy exactly W kg oranges and if it is not possible to buy exactly W kg oranges then print -1. It may be assumed that there is an infinite supply of all available packet types.

Input : W = 5, cost[] = {20, 10, 4, 50, 100}
Output : 14
We can choose two oranges to minimize cost. First
orange of 2Kg and cost 10. Second orange of 3Kg
and cost 4.

Input : W = 5, cost[] = {1, 10, 4, 50, 100}
Output : 5
We can choose five oranges of weight 1 kg.

Solution: Knapsack
Expected complexity : O(W*Cardinality(cost))
Author: Manish

HARD

There is carrot field in which carrots are planted in a single line. Each carrot has a nutrient value associated with it. On picking out a carrot i, the number of calories gained is equal to A[i-1]*A[i]*A[i+1]. Also, carrots i-1 and i+1 now become adjacent. Find the maximum possible calories that can be extracted after picking all the carrots. Assume an extra 1 at each boundary.

Input : 6, 12
Output : 84
Explanation - First pick 6, Calories = 1*6*12
Then pick 12, Calories += 1*12*1
Total = 84

Solution : DP
Complexity: N^3
Author: Manish

Easy Medium

Find the minimum number of elements that should be removed such that max of the array A - min of the array A should be less than equal to K. After removal of elements, Amax and Amin is considered from the remaining elements.

Examples:
Input :
a[] = {1, 3, 4, 9, 12, 17, 20, 10, 11}
k = 4

Output :
5
Explanation: Sort the array and then using a window function find the max length array

Solution: Window function (multiple approaches)
Complexity: N(lgN)
Author: Swapnil

Quantitative Aptitude

Q.1) A father leaves from his home(at constant speed) to pick up his son from school which closes at 3:30 PM(time at which father reaches school) daily. On a particular day, school closed at 2:30 PM,so his son started walking towards his home at 7 km/hr. On the way, he meets his father who started at his usual time. They return from there only(with speed of father) towards their home. Upon reaching home, they find that they have reached 24 minutes earlier than their normal time of reaching home. Find speed of Father(in km/hr).

(hint:Distance = speed * time)
Author:Abhinav

Chess Related

Q1) What is the maximum number of Knights that can be placed on a chess board so that none of them cancels any other in a single move?
(For those who know the rules of Chess.)
(To be asked, if a candidate says that his hobbies include playing Chess)
Author:Abhinav

Obsolete : (never ask these, these are mentioned on various forums as frequently being asked in zeta interview)

There are N nuts and N bolts, all unique pairs of Nut and Bolt
You can’t compare Nut with Nut.
You can’t compare Bolt with Bolt
You CAN compare Nut with Bolt
Now how would you figure out matching pairs of nut and bolt from the given N nut and Bolt.