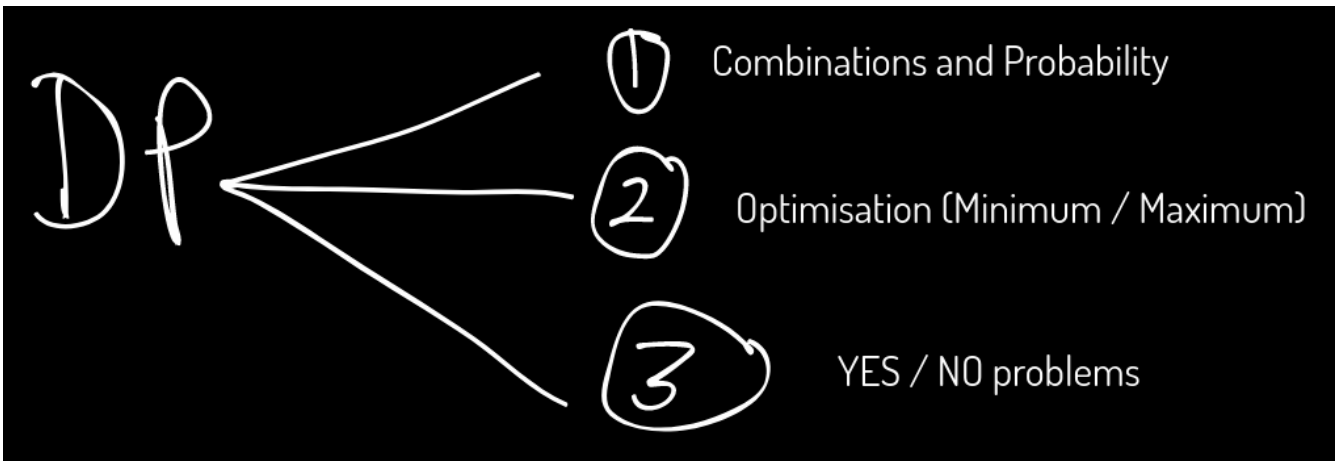
Solving easy DP Problems

Recap

For DP, we need:-
1. Recursive relation (with base case)
2. Overlapping subproblems

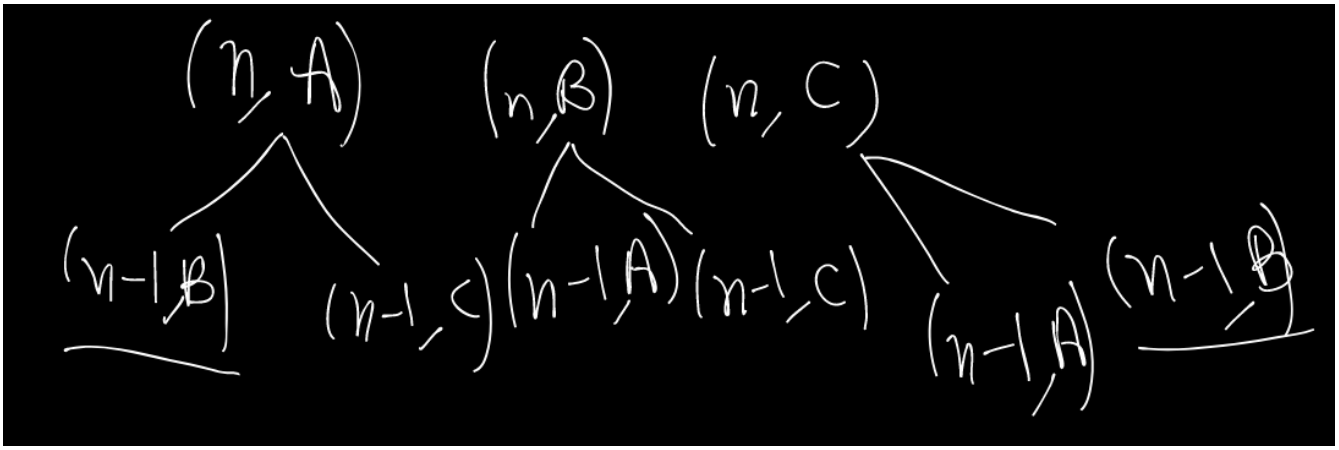


1.
https://atcoder.jp/contests/dp/tasks/dp_c

dp[i][j] = The maximum total happiness points till i^{th} day if he performed j^th activity on the current day.

dp[i][j] = max (dp[i-1][k] + pj, k ≠ j)

dp[0][0] = p0
dp[0][1] = p1
dp[0][2] = p2



In the above recursion tree, you can observe the overlapping subproblems.

```cpp
// Problem : C - Vacation
// Contest : AtCoder - Educational DP Contest
// URL : https://atcoder.jp/contests/dp/tasks/dp_c

#include <bits/stdc++.h>
using namespace std;

int points[100005][3];
int dp[100005][3];

int solve(int i, int j) {
 // i: current day
 // j: activity performed on i-th day
 if (i == 1) {
   return points[i][j];
 }

 if (dp[i][j] != -1) return dp[i][j];
```

```
 int ans = 0;
 for (int k = 0; k < 3; k++) {
   // k: activity on (i-1)th day
   if (k != j) {
     ans = max(ans, solve(i - 1, k) + points[i][j]);
   }
 }
 return dp[i][j] = ans;
}

int32_t main() {
 int n;
 cin >> n;

 for (int i = 1; i <= n; i++) {
   for (int j = 0; j < 3; j++) {
     dp[i][j] = -1;
   }
 }

 for (int i = 1; i <= n; i++) {
   for (int j = 0; j < 3; j++) {
     cin >> points[i][j];
   }
 }

 cout << max(max(solve(n, 0), solve(n, 1)), solve(n,
2));
```

```
 return 0;
}
```

2.
https://codeforces.com/problemset/problem/455/A
9
1 2 1 3 2 2 2 2 3
Score =2 , 2 2 2 2
1 1 2 2 2 2 2 3 3
dp[1]=2;
dp[2]=2*5=10
dp[3]=3*2=6;

1 2 3
dp[1]=1,dp[2]=2,dp[3]=3;
I , freq[i];
i*freq[i]

dp[i] : max score you can get by considering numbers till i
dp[1] = 2
dp[2] = dp[1], dp[0]+2*freq[2]
dp[3] = dp[2],dp[1]+3*freq[3];
dp[i] = max(dp[i-1],dp[i-2]+i*freq[i])
ans = dp[100000]
Sol:

```
    int n;
    cin>>n;
    int a[n];
    int freq[100001]={0};
    for(int i=0;i<n;i++){
        cin>>a[i];
        freq[a[i]]++;
    }
    int dp[100001]={0};
    dp[1] = freq[1];
    for(int i=2;i<=1e5;i++){
        dp[i] = max(dp[i-1],dp[i-2]+i*freq[i]);
    }
    cout<<dp[100000];
```

3) https://codeforces.com/contest/1475/problem/G

Approach:- I've discussed using a whiteboard in video.

Solution:

```cpp
#include<bits/stdc++.h>
using namespace std;
int main(){
    int t;
    cin>>t;
    while(t--){
        int n;
        cin>>n;
        vector<int> a(n);
        for(int i=0;i<n;i++) cin>>a[i];
        const int MAX=2e5+1;
        vector<int> dp(MAX);
        //dp[i]-> The max reside if we consider i element at
the end of the beautiful array
        sort(a.begin(),a.end());
        dp[a[0]]=1;
        for(int i=1;i<n;i++){
            dp[a[i]]=dp[a[i]]+1;
            // Now I'm going through all the factors of a[i]
below
            if(a[i]!=1) dp[a[i]]=max(dp[a[i]],dp[1]+1);
                                    // Here factor is 1
            for(int j=2;j*j<=a[i];j++){
                if(a[i]%j==0){
                    dp[a[i]]=max(dp[a[i]],dp[j]+1);
                                    // Here factor is j
                    dp[a[i]]=max(dp[a[i]],dp[a[i]/j]+1);
                                    // Here factor is a[i]/j
```

```
                }
            }
        }

        int ans=0;
        for(int i=0;i<=MAX;i++) ans=max(ans,dp[i]);
        cout<<n-ans<<endl;
    }
}
```

H.W:- Solve the problem using a recursive approach.