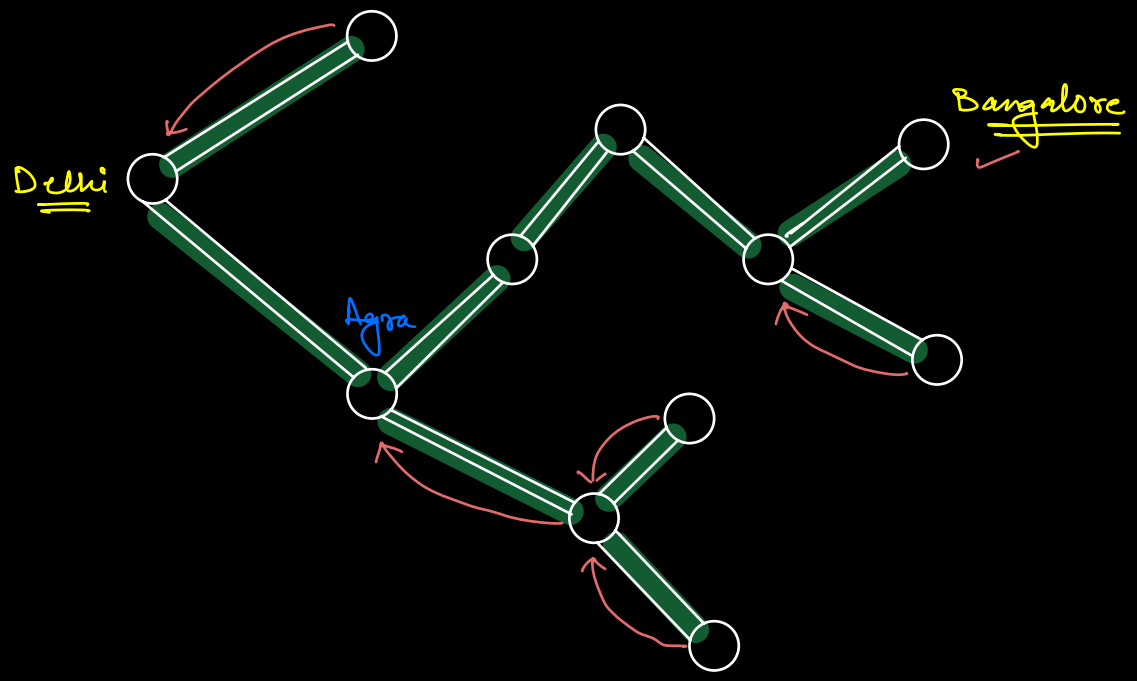


Backtracking ⇒ Try out all possibilities (Brute force)

↓

Recursion + Backtrace

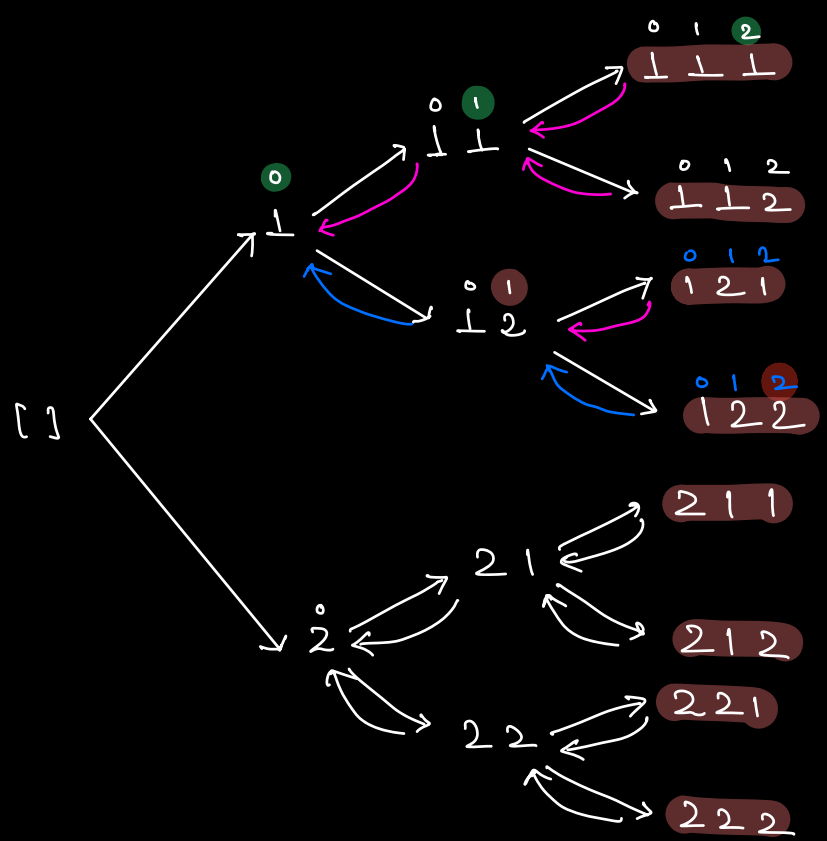
Q.1 Print all N digit numbers using {1 & 2}

N=1 ⇒ 1
2

N=2 ⇒ 1 1
1 2
2 1
2 2

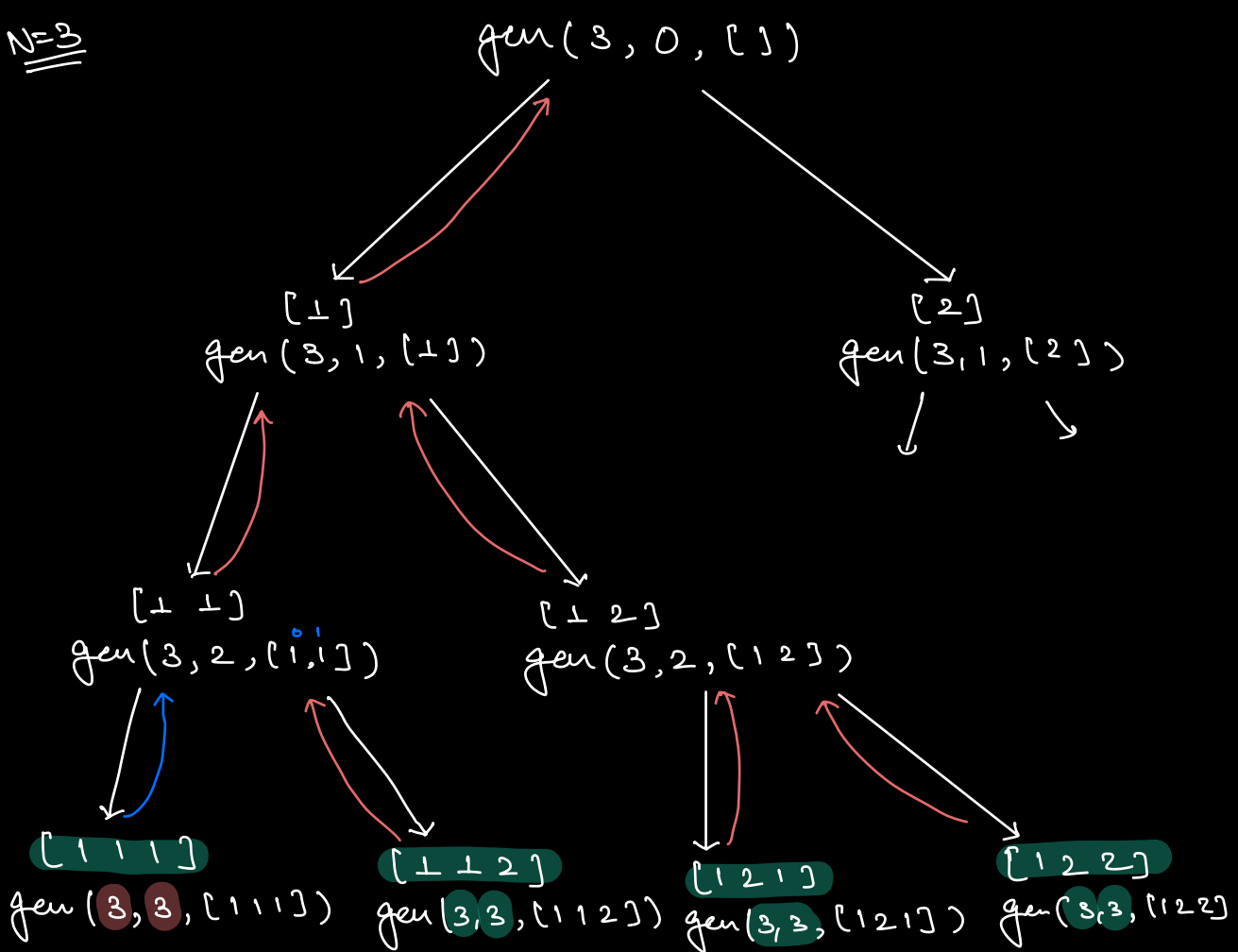
N=3 [1 1 1]
[1 1 2]
1 2 1
1 2 2
2 1 1
2 1 2
2 2 1
2 2 2

N=3 [(1) _ _]
0 1 2



```
void generateNumbers(N, idx, currList) {
    if (idx == N) {
        print(currList); ⇒ O(N)
        return;
    }
    currList[idx] = 1
    generateNumbers(N, idx+1, currList);
Backtrack { currList[idx] = 2
    generateNumbers(N, idx+1, currList);
}
```

N=3



Quiz TC:

TC of a recursive fun^ :

(# of recursive fun^ calls) * TC of each fun^ call

$2^N * N$

Recurrence relation :-
T(N) = 2 * T(N-1) + N

* **TC: $O(N \cdot 2^N)$**

SC: $O(N)$

SC = Height of tree. O(N) + Current List is also O(N) so overall O(N)

* Return a list of list

[[1 1 1], [1 1 2], [1 2 1], [1 2 2], [2 1 1], [2 1 2], [2 2 1], [2 2 2]]

List<List<int>> ans;

```
void generateNumbers(N, idx, currList) {
    if (idx == N) {
        ans.add(currList);   // O(N)
        return;
    }
    currList[idx] = 1
    generateNumbers(N, idx+1, currList);
    backtrack
    currList[idx] = 2
    generateNumbers(N, idx+1, currList);
}
```

Need to create new temp list and add that list to ansList. Its O(N) for time

ans : [currList , currList , currList]

[1 1 2]

ans : [[2 2 2] [2 2 2] ....]

* HW

* Hard Copy vs Soft Copy. ⇒ Java
  * Deep copy vs Shallow Copy

currList : [1 1 1]

temp : [1 1 1]

ans :

$TC : O(N \cdot 2^N)$

Q: Print all N digit numbers using {1, 2, 3, 4 4 5}.

```
void generateNumbers(N, idx, currList) {
    if (idx == N) {
        print(currList); ⇒ O(N)
        return;
    }
    currList[idx] = 1
    generateNumbers(N, idx+1, currList);
    currList[idx] = 2
    generateNumbers(N, idx+1, currList);
    currList[idx] = 3
    generateNumbers(N, idx+1, currList);
    currList[idx] = 4
    generateNumbers(N, idx+1, currList);
    currList[idx] = 5
    generateNumbers(N, idx+1, currList);
}
```

5

```
for(i = 1; i <= 5; i++) {
    currList[idx] = i;
    generateNumbers(N, idx+1, currList);
}
```

3

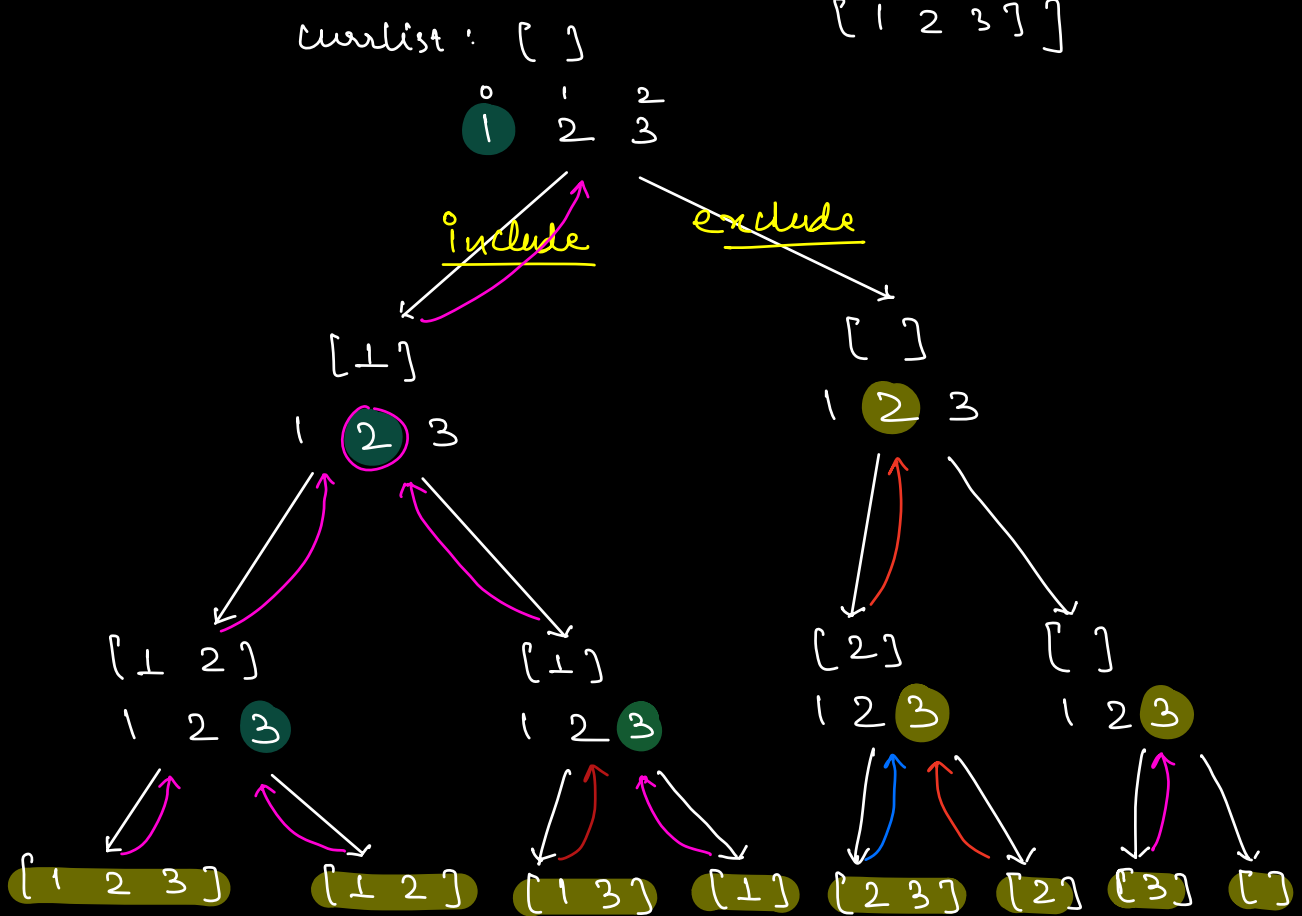
TC: $O(N \cdot 5^N)$

Q: Given an Array, generate all subsets of the Array.

Amazon
MS:

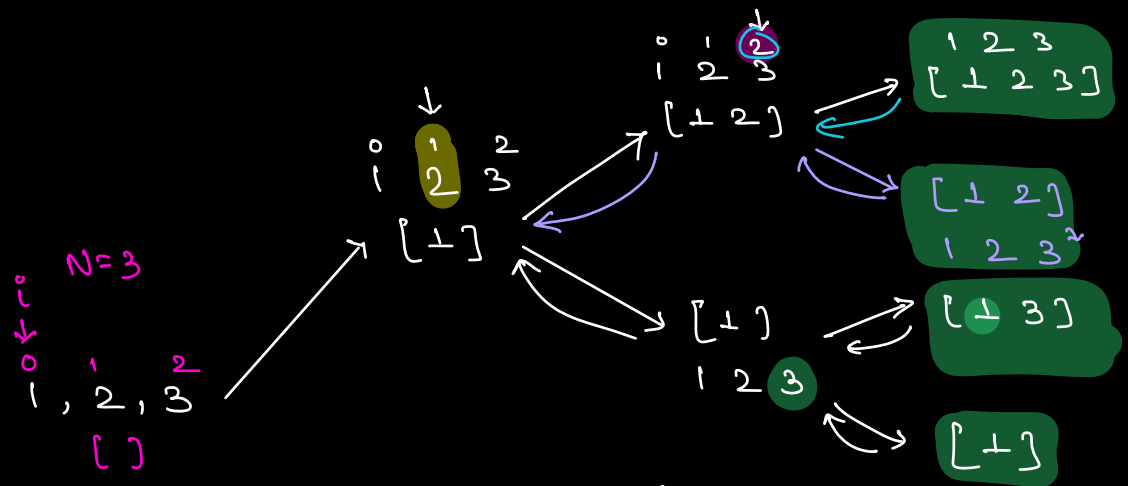
A: [1 2 3]

[[ ]
[1]
[2]
[3]
[1 2]
[1 3]
[2 3]
[1 2 3]]



No. of subsets $\Rightarrow 2^N$

```
Void generateSubsets(A[], N, idx, currList[]) {
    if(idx == N) {
        print(currList);
        return;
    }
    // Include A[idx] in the subset
    currList.add(A[idx]);
    generateSubsets(A, N, idx+1, currList);
    // Exclude A[idx] in the subset
    currList.pop(A[idx]);
    generateSubsets(A, N, idx+1, currList);
}
```



TC: $O(N \cdot 2^N)$

$2^{10} = 1024 \approx 10^3$

$2^{20} \approx 10^6$

$N \cdot 2^N \Rightarrow N = 30$

$\downarrow$

$\sim 10^9$ X

$N = 10^6 \Rightarrow O(N)$

$N = 10^3 \Rightarrow N^2$

$N = 20 \Rightarrow$ Recursive or Backtracking