Back tracking. →

Algorithmic technique used to find solution by exploring all the possible candidates for your ans.

① Print all N-digit numbers which can be formed by {1,2}

N = 3.

1/2, 1/2 1/2

1 [2 digit (1/2)]

2 [2 digit no. {1,2}]

} Recursion

1 1 1

1 1 2

1 2 1

1 2 2

2 1 1

2 1 2

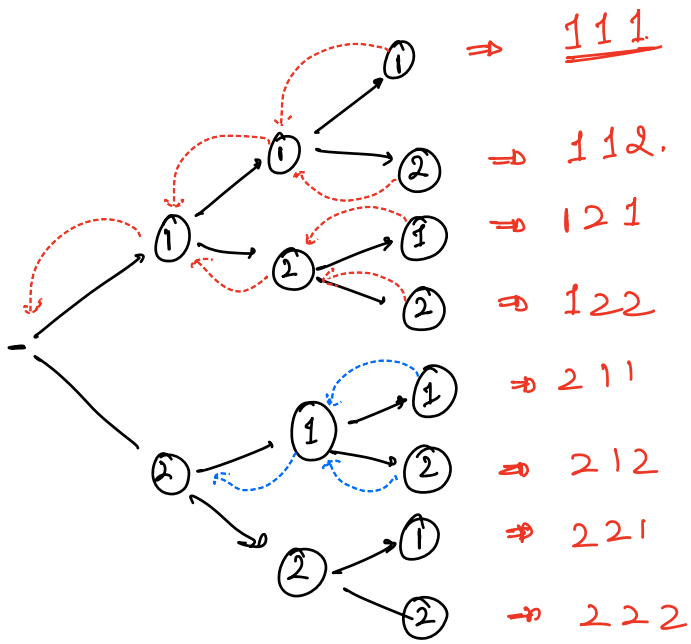
2 2 1

2 2 2

idea. 1. Using Bit Manipulation

⇒ 0 to $2^n - 1$.

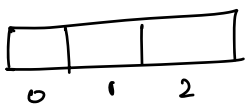
$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$



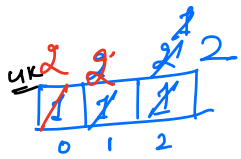
parameters → i , n , temp[n]

current position to be fixed

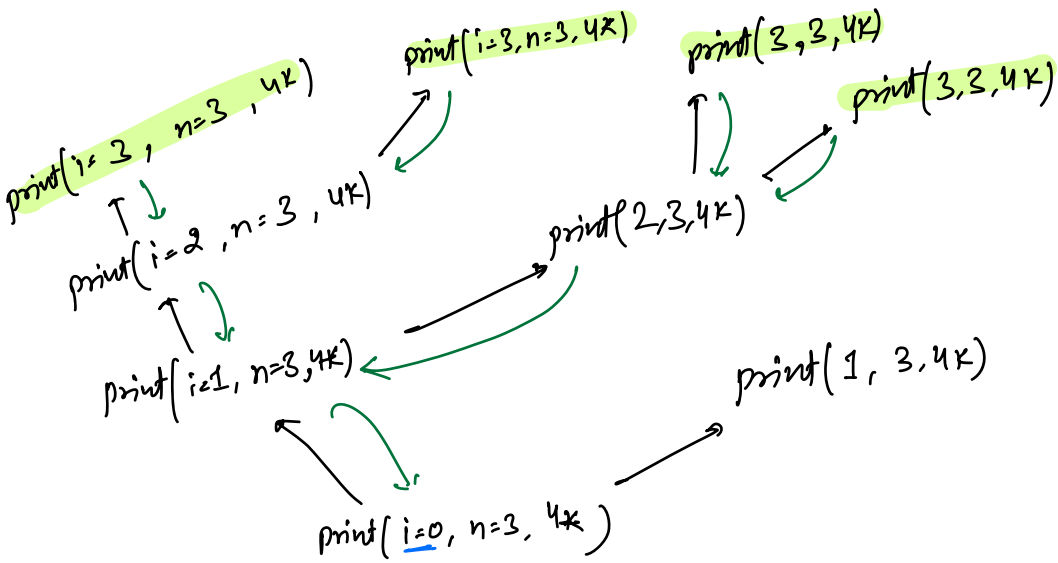
```
void print ( int i, int n, int temp[n] ){
    if( i == n) { for( j=0; j<n; j++) { print (temp[j]) } }
                                  return

    temp[i] = 1 ;
    print( i+1 , n, temp );

    temp[i] = 2 ;
    print( i+1, n, temp) ;
}
```



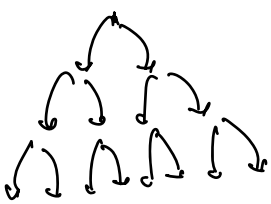
```
void print ( int i, int n, int temp[n] ){
    if( i == n){ for( j=0; j<n; j++) { print (temp[j]) } }
                              return

    temp[i] = 1 ;
    print( i+1 , n, temp);

    temp(i) = 2 ;
    print( i+1, n, temp) ;
}
```



1 1 1
1 1 2
1 2 1
1 2 2



N=3.



no. of recursive calls * time taken

$T.C \rightarrow O(2^N * N)$

function calls

time to print the temp[]

$S.C \rightarrow O(N)$

1
2
4
8
16
32

digits → {1, 2, 3, 4, 5}

```
void print( int i, int n, int temp[n]){
    void print( int i, int n, int temp[n]){
        if( i == n){ for( j=0; j<n; j++) { print (temp [j]) } }
        if( i == n)  for( j=0; j<n; ~~j++~~ return print (temp [j]) } }
                                    return
        for( j = 1 ; j ≤ 5 ; j++) {
                                  i++){
            temp (i) = j
            print ( i+1, n, temp);;
                                n , temp)
        }
    }
}
```

use loop when options are very large in no.

options → {2, 3, 7, 9}

```
void print( int i, int n, temp[n], options[7]){
        // base condition
        for( j = 0 ; j < options.size() ; j++){
            temp (i) = options [j]
            print( i+1, n, temp, options)
        }
}
```

Q.) Find the count of subsets with sum = K.

Given N distinct elements.

arr[] → [5 -2 9 2], K = 7

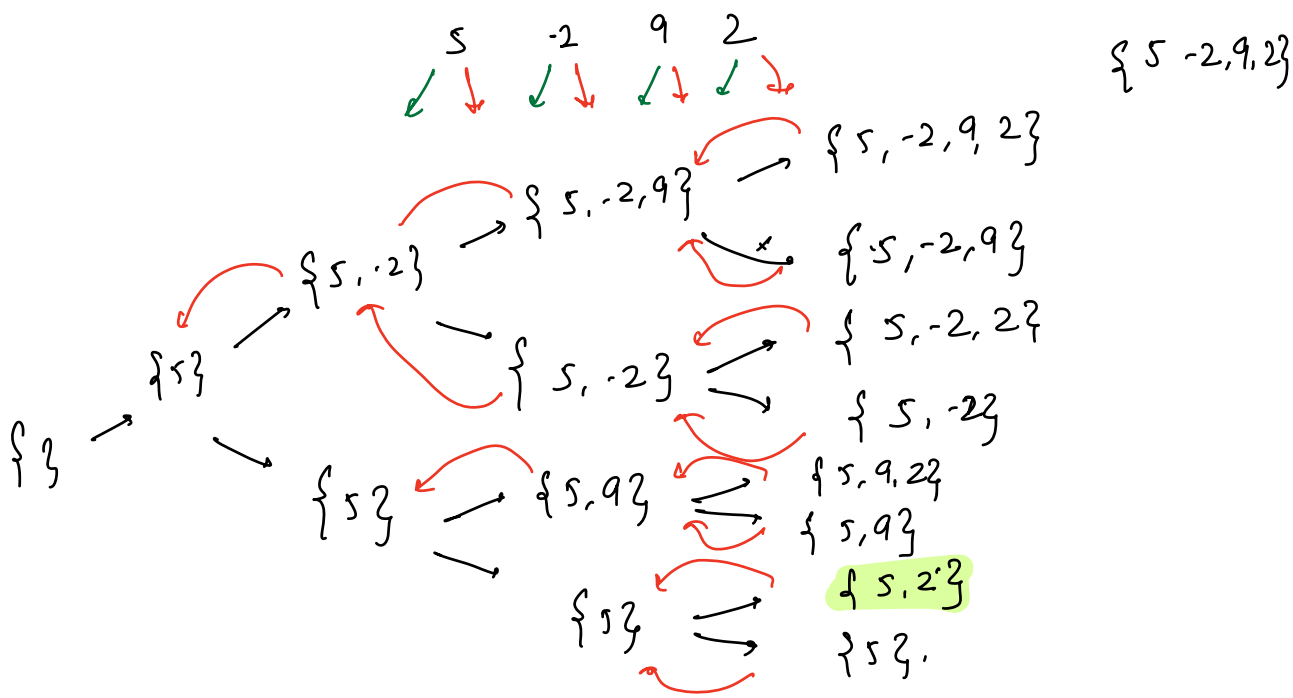
0 1 2 3

[5, 2]

[-2, 9]

ans = 2.

B.f. Consider all the subsets.



parameters

i, n, currsum, arr[], K

```
int countSubsetsWithSumK ( i, n, currsum, arr[N], k ){
    if ( i == n ) { if ( currSum == k ) return 1 }
                  else return 0

    ans = 0
    // option no. 1 → if current element is included
        currSum += arr[i]
        ans += countSubsetsWithSumK ( i+1, n, currsum, arr, k)

    //option no. 2 → if current element is not included
        currSum -= arr[i]
        ans += countSubsetsWithSumK ( i+1, n, currsum, arr, k)

    return ans;
}
```

T.C → $O(2^N)$
S.C → $O(N)$

→ [Generate all the subsets.]
H.W.

Break → 10:38 → 10:45

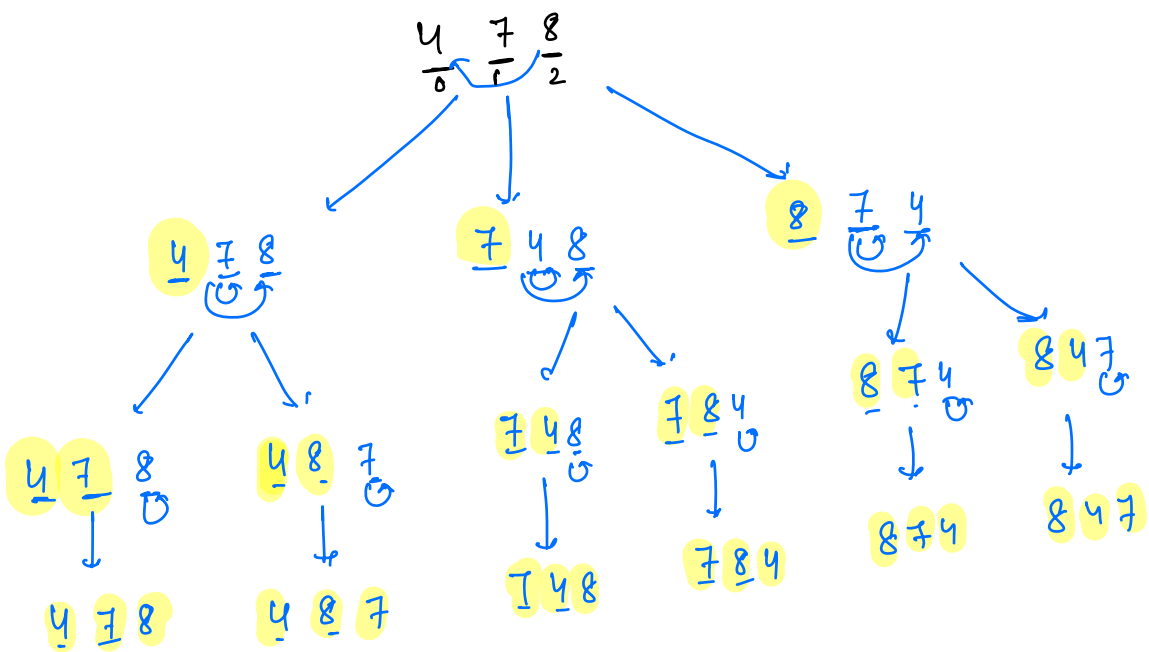
Q: Generate All Permutations (unique elements)

4 7 9

4 7 9
4 9 7
7 4 9
7 9 4
9 4 7
9 7 4

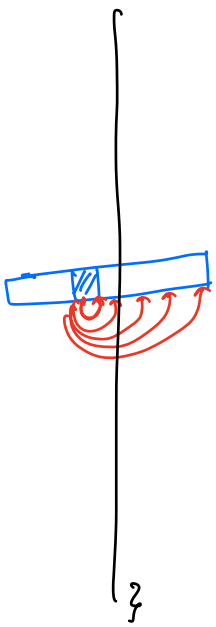
n elements.
↓
$n!$

$n * (n-1) * (n-2) \ldots 1$
⇓
$n!$



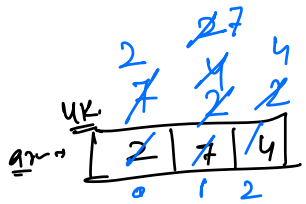
parameters → i, n, arr[]

```
void permutations (int i, int n, int arr[n]) {
    if(i == n) { print arr[] & return }

    for( j = i ; j < n ; j++) {
        swap ( arr[i], arr[j])
        permutations ( i+1 , n , arr)
        swap ( arr[i], arr[j])
    }
}
```

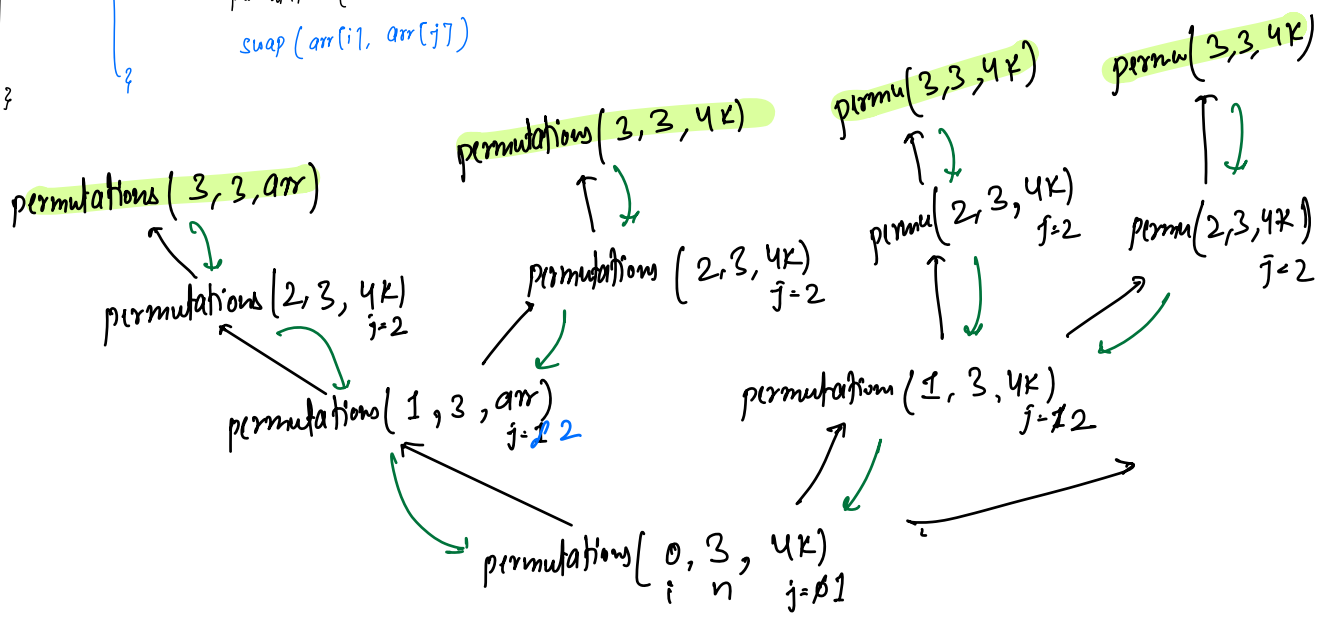


T.C → $O(n! * n)$
S.C → $O(n)$


```
void permutations (int i, int n, int arr[n]) {
    if(i == n) { print arr[] & return }

    for( j = i ; j < n ; j++) {
        swap ( arr[i], arr[j])
        permutations ( i+1 , n , arr)
        swap ( arr[i], arr[j])
    }
}
```

2, 7, 4
2, 4, 7
7, 2, 4
7, 4, 2

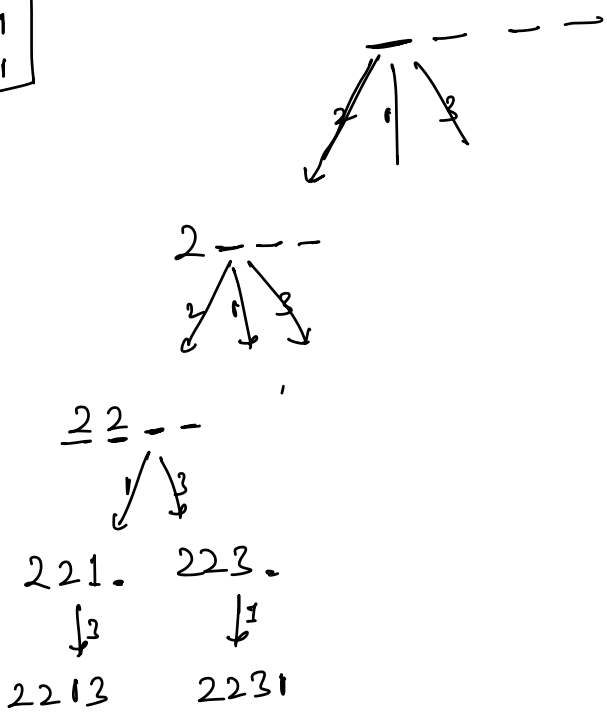


Duplicates?

swap ✗

2 1 2 3 → 2123, 1223, 2123, 3122

$2 \to \cancel{2}\ 0$
$1 \to 1$
$3 \to 1$



$[2,1,2,3] \Rightarrow \frac{4!}{2!} = \frac{4\times3\times\cancel{2}}{\cancel{2}} = 12$

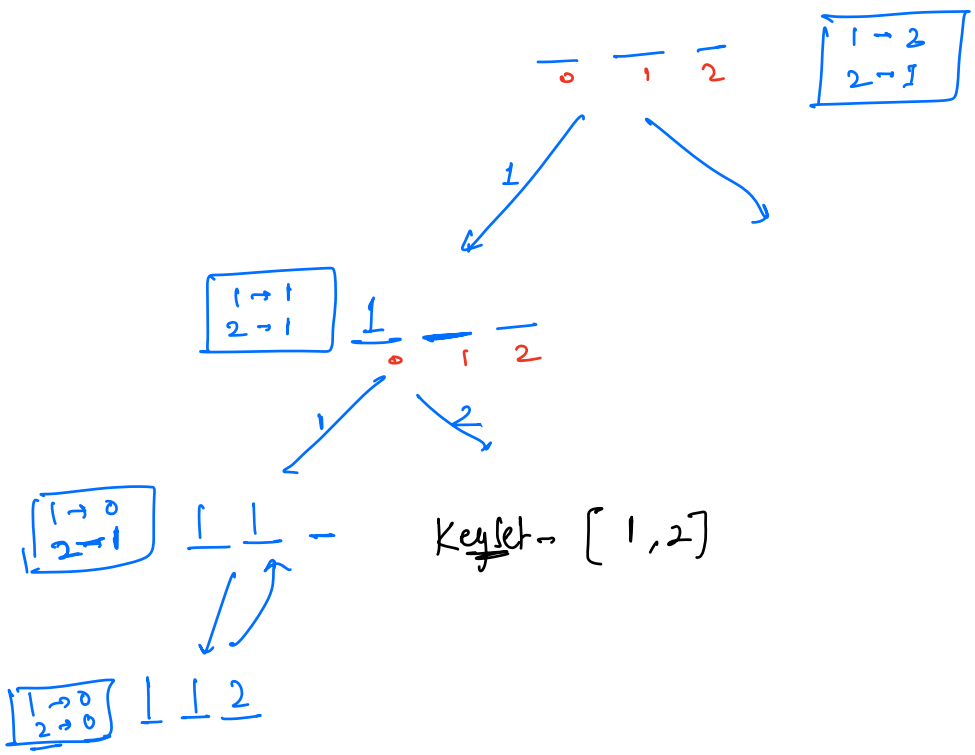
1, 2, 2, 3
1, 2, 3, 2
1, 3, 2, 2
2, 1, 2, 3
2, 1, 3, 2
2, 2, 3, 1
2, 2, 1, 3
2, 3, 1, 2
2, 3, 2, 1
3 1 2 2
3 2 1 2
3 2 2 1

Hm → freq.

```
void permutations( i , n, arr, freq){
    if(i==n) { ———— }

    for( traverse in the hashmap){
        if( hm[x] > 0){
            arr[i] = x
            hm[x] --
            permutations( i+1, n, arr, freq)
            hm[x] ++
        }
    }
}
```

elem	freq
1	2
2	1

T.C → $O(n! * n)$
S.C → $O(n)$



KeySet → [1, 2]

Structure

```
func( ———————————→ ) {
    // base-case.

    try all the options {
        ////// do.
        recursive call
        ////// undo
    }
}
```

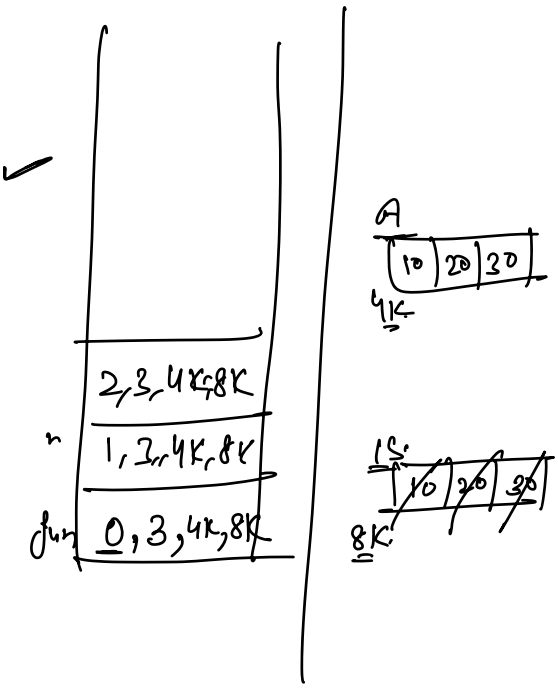
→ Backtracking.

- N Queens.
- Rat in maze.
- Sudoku.

- Work Break

A = 10, 20, 30

```
fun(                    ) {
    // don't
    → fun( i+1, n, A, cs)
    // add cur
    → cs.addLast(A[i])
      fun(i+1, n, A, cs)
      cs.remove(last());
}
```



cs → current subset

ans.addLast(cs)

ans = [8K, 8K, 8K, 8K, 8K, 8K, 8K, 8K]