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Grokking the Coding Interview: Patterns for Coding Questions

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Subsets (easy)

We'll cover the following

Problem Statement

Given a set with distinct elements, find all of its distinct subsets.

Example 1:

```
Input: [1, 3]
Output: [], [1], [3], [1,3]
```

Example 2:

```
Input: [1, 5, 3]
Output: [], [1], [5], [3], [1,5], [1,3], [5,3], [1,5,3]
```

Try it yourself

Try solving this question here:

Java | Python3 | JS | C++

```java
import java.util.*;

class Subsets {

  public static List<List<Integer>> findSubsets(int[] nums) {
    List<List<Integer>> subsets = new ArrayList<>();
    // TODO: Write your code here
    return subsets;
  }

  public static void main(String[] args) {
    List<List<Integer>> result = Subsets.findSubsets(new int[] { 1, 3 });
    System.out.println("Here is the list of subsets: " + result);

    result = Subsets.findSubsets(new int[] { 1, 5, 3 });
    System.out.println("Here is the list of subsets: " + result);
  }
}
```

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Solution

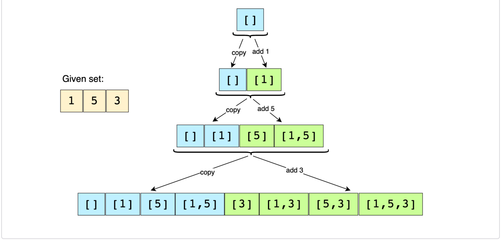
To generate all subsets of the given set, we can use the **Breadth First Search (BFS)** approach. We can start with an empty set, iterate through all numbers one-by-one, and add them to existing sets to create new subsets.

Let's take the example-2 mentioned above to go through each step of our algorithm:

Given set: [1, 5, 3]

1. Start with an empty set: [[]]
2. Add the first number (1) to all the existing subsets to create new subsets: [[], **[1]**];
3. Add the second number (5) to all the existing subsets: [[], [1], **[5], [1,5]**];
4. Add the third number (3) to all the existing subsets: [[], [1], [5], [1,5], **[3], [1,3], [5,3], [1,5,3]**].

Here is the visual representation of the above steps:



Since the input set has distinct elements, the above steps will ensure that we will not have any duplicate subsets.

Code

Here is what our algorithm will look like:

Java | Python3 | C++ | JS

```java
import java.util.*;

class Subsets {

  public static List<List<Integer>> findSubsets(int[] nums) {
    List<List<Integer>> subsets = new ArrayList<>();
    // start by adding the empty subset
    subsets.add(new ArrayList<>());
    for (int currentNumber : nums) {
      // we will take all existing subsets and insert the current number in them to create new
      int n = subsets.size();
      for (int i = 0; i < n; i++) {
        // create a new subset from the existing subset and insert the current element to it
        List<Integer> set = new ArrayList<>(subsets.get(i));
        set.add(currentNumber);
        subsets.add(set);
      }
    }
    return subsets;
  }

  public static void main(String[] args) {
    List<List<Integer>> result = Subsets.findSubsets(new int[] { 1, 3 });
    System.out.println("Here is the list of subsets: " + result);

    result = Subsets.findSubsets(new int[] { 1, 5, 3 });
    System.out.println("Here is the list of subsets: " + result);
  }
}
```

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Time complexity

Since, in each step, the number of subsets doubles as we add each element to all the existing subsets, therefore, we will have a total of $O(2^N)$ subsets, where 'N' is the total number of elements in the input set. And since we construct a new subset from an existing set, therefore, the time complexity of the above algorithm will be $O(N * 2^N)$.

Space complexity

All the additional space used by our algorithm is for the output list. Since we will have a total of $O(2^N)$ subsets, and each subset can take up to $O(N)$ space, therefore, the space complexity of our algorithm will be $O(N * 2^N)$.