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Daily Coding Problem #96

Problem

This problem was asked by Microsoft.

Given a number in the form of a list of digits, return all possible permutations.

For example, given `[1,2,3]`, return `[[1,2,3],[1,3,2],[2,1,3],[2,3,1],[3,1,2],[3,2,1]]`.

Solution

There are a few ways to do this, and most solutions will have the same run-time. We will need to generate all $N!$ permutations, so our algorithm will have $O(N!)$ run time.

The most straightforward method is to use recursion. We can think of the problem in terms of subproblems, where we can generate permutations of a sublist. A permutation of a single digit (e.g. `[1]`) would return simply the single digit. To get

permutations of size n , we get all permutations of size $n-1$ and add the next character within each position (index 0 to n). For example, one permutation of the sublist $[2, 3]$ is $[2, 3]$. We add 1 to three positions to obtain $[1, 2, 3]$, $[2, 1, 3]$, and $[2, 3, 1]$.

```
def permute(nums):
    if len(nums) == 1:
        return [nums]

    output = []
    for l in permute(nums[1:]):
        for idx in range(len(nums)):
            output.append(l[:idx] + [nums[0]] + l[idx:])
    return output
```

An alternative way we can formulate the recursion is by generating all permutations of length $n-1$, but with all digits allowed. The permutations of size 1 would return the input array (e.g. $[[1], [2], [3]]$). Then, we append the n th digit to the front of the permutations.

```
def permute(nums):
    def helper(nums, index, output):
        if index == len(nums) - 1:
            output.append(nums.copy())
        for i in range(index, len(nums)):
            nums[index], nums[i] = nums[i], nums[index]
            helper(nums, index + 1, output)
            nums[index], nums[i] = nums[i], nums[index]

    output = []
    helper(nums, 0, output)
    return output
```

Both solutions run in $O(N!)$ time and space, where N is the size of the input list.

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