1. Remove Element

Given an integer array nums and an integer val, remove all occurrences of val in nums in-place. The relative order of the elements may be changed.

Since it is impossible to change the length of the array in some languages, you must instead have the result be placed in the first part of the array nums. More formally, if there are k elements after removing the duplicates, then the first k elements of nums should hold the final result. It does not matter what you leave beyond the first k elements.

Return k *after placing the final result in the first* k *slots of* nums.

Do not allocate extra space for another array. You must do this by modifying the input array in-place with O(1) extra memory.

Custom Judge:

The judge will test your solution with the following code:

```
int[] nums = [...]; // Input array
int val = ...; // Value to remove
int[] expectedNums = [...]; // The expected answer with correct length.
                            // It is sorted with no values equaling val.

int k = removeElement(nums, val); // Calls your implementation

assert k == expectedNums.length;
sort(nums, 0, k); // Sort the first k elements of nums
for (int i = 0; i < actualLength; i++) {
    assert nums[i] == expectedNums[i];
}
```

If all assertions pass, then your solution will be accepted.

Example 1:

Input: nums = [3,2,2,3], val = 3

Output: 2, nums = [2,2,_,_]

Explanation: Your function should return k = 2, with the first two elements of nums being 2.

It does not matter what you leave beyond the returned k (hence they are underscores).

Example 2:

Input: nums = [0,1,2,2,3,0,4,2], val = 2

Output: 5, nums = [0,1,4,0,3,_,_,_]

Explanation: Your function should return k = 5, with the first five elements of nums containing 0, 0, 1, 3, and 4.

Note that the five elements can be returned in any order.

It does not matter what you leave beyond the returned k (hence they are underscores).

Constraints:

- **0 <= nums.length <= 100**
- **0 <= nums[i] <= 50**
- **0 <= val <= 100**

PROGRAM:

```
def remove_element(nums, val):
    """
    In-place removal of elements with value val from array nums.

    Args:
    nums: An array of integers.
    val: The value to remove.

    Returns:
    The new length of the array after removing elements.
    """
    i = 0
    for num in nums:
        if num != val:
            nums[i] = num
            i += 1
    return i

nums = [3, 2, 2, 3]
val = 3
new_length = remove_element(nums, val)
print("New length:", new_length)
print("Updated nums:", nums[:new_length])
```

OUTPUT:

```
= RESTART: C:/Users/mahu
New length: 2
Updated nums: [2, 2]
```

37. Sudoku Solver

Write a program to solve a Sudoku puzzle by filling the empty cells.

A sudoku solution must satisfy all of the following rules:

1. **Each of the digits 1-9 must occur exactly once in each row.**
2. **Each of the digits 1-9 must occur exactly once in each column.**
3. **Each of the digits 1-9 must occur exactly once in each of the 9 3x3 sub-boxes of the grid.**

The '.' character indicates empty cells.

Example 1:

5	3			7				
6			1	9	5			
	9	8					6	
8				6				3
4			8		3			1
7				2				6
	6					2	8	
			4	1	9			5
				8			7	9

Input: board =
[["5","3",".",".","7",".",".",".",".","."],["6",".",".","1","9","5",".",".",".","."],[".","9","8",".",".",".",".",".","6","."],["8",".",".",".",".","6",".",".",".",".","3"],["4",".",".",".","8",".","3",".",".","1"],["7",".",".",".",".","2",".",".",".",".","6"],[".","6",".",".",".",".",".","2","8","."],[".",".",".","4","1","9",".",".",".","5"],[".",".",".",".",".","8",".",".",".","7","9"]]

Output:
[["5","3","4","6","7","8","9","1","2"],["6","7","2","1","9","5","3","4","8"],["1","9","8","3","4","2","5","6","7"],["8","5","9","7","6","1","4","2","3"],["4","2","6","8","5","3","7","9","1"],["7","1","3","9","2","4","8","5","6"],["9","6","1","5","3","7","2","8","4"],["2","8","7","4","1","9","6","3","5"],["3","4","5","2","8","6","1","7","9"]]

Explanation: The input board is shown above and the only valid solution is shown below:

Constraints:

- **board.length == 9**
- **board[i].length == 9**
- **board[i][j] is a digit or '.'.**
- **It is guaranteed that the input board has only one solution.**

PROGRAM:

```
def is_valid_sudoku(board):
    """
    Checks if a Sudoku board is valid.

    Args:
    board: A list of lists representing the Sudoku board.

    Returns:
    True if the board is valid, False otherwise.
    """
    rows = [[False] * 9 for _ in range(9)]
    cols = [[False] * 9 for _ in range(9)]
    boxes = [[False] * 9 for _ in range(9)]

    for row in range(9):
        for col in range(9):
            if board[row][col] != ".":
                num = ord(board[row][col]) - ord('1')
                box_index = (row // 3) * 3 + col // 3

                if rows[row][num] or cols[col][num] or boxes[box_index][num]:
                    return False

                rows[row][num] = cols[col][num] = boxes[box_index][num] = True

    return True
sudoku_board = [
    ["5","3",".",".","7",".",".",".",".","."],
    ["6",".",".","1","9","5",".",".",".","."],
    [".","9","8",".",".",".",".",".","6","."],
    ["8",".",".",".",".","6",".",".",".",".","3"],
    ["4",".",".","8",".","3",".",".",".","1"],
    ["7",".",".",".",".","2",".",".",".",".","6"],
    [".","6",".",".",".",".",".","2","8","."],
    [".",".",".",".","4","1","9",".",".",".","5"],
    [".",".",".",".",".","8",".",".","7","9"]
]

print(is_valid_sudoku(sudoku_board))
```

OUTPUT:

```
== RESTART: C:/Use
True
```

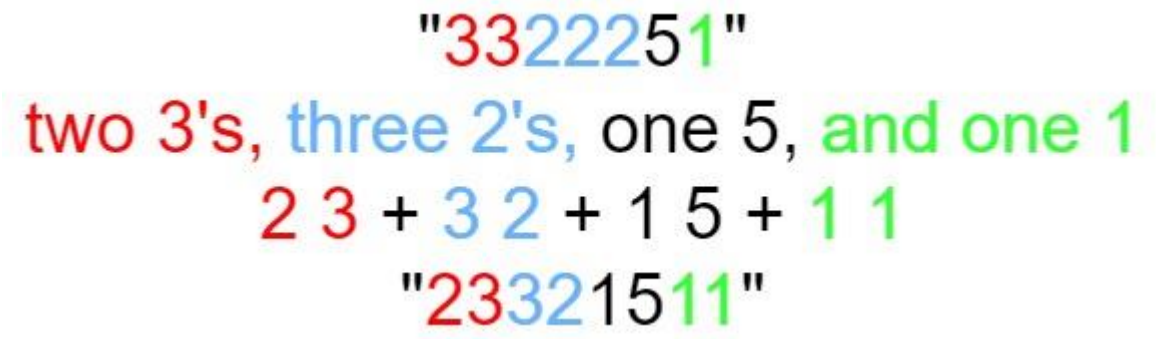
3.Count and Say

The count-and-say sequence is a sequence of digit strings defined by the recursive formula:

- **`countAndSay(1) = "1"`**
- **`countAndSay(n)` is the way you would "say" the digit string from `countAndSay(n-1)`, which is then converted into a different digit string.**

To determine how you "say" a digit string, split it into the minimal number of substrings such that each substring contains exactly one unique digit. Then for each substring, say the number of digits, then say the digit. Finally, concatenate every said digit.

For example, the saying and conversion for digit string `"3322251"`:



Given a positive integer `n`, return *the `nth` term of the count-and-say sequence*.

Example 1:

Input: n = 1

Output: "1"

Explanation: This is the base case.

Example 2:

Input: n = 4

Output: "1211"

Explanation:

countAndSay(1) = "1"

countAndSay(2) = say "1" = one 1 = "11"

countAndSay(3) = say "11" = two 1's = "21"

countAndSay(4) = say "21" = one 2 + one 1 = "12" + "11" = "1211"

Constraints:

- **1 <= n <= 30**

PROGRAM:

```
def count_and_say(n):

    if n == 1:
        return "1"

    prev = count_and_say(n - 1)
    result = ""
    count = 1

    for i in range(1, len(prev)):
        if prev[i] == prev[i - 1]:
            count += 1
        else:
            result += str(count) + prev[i - 1]
            count = 1

    result += str(count) + prev[-1]

    return result
print(count_and_say(1))
print(count_and_say(2))
print(count_and_say(3))
print(count_and_say(4))
print(count_and_say(5))
```

OUTPUT:

```
== RESTART: C:/User
1
11
21
1211
111221
```

39. Combination Sum

Given an array of distinct integers `candidates` and a target integer `target`, return *a list of all unique combinations of* `candidates` *where the chosen numbers sum to* `target`. You may return the combinations in any order.

The same number may be chosen from `candidates` an unlimited number of times. Two combinations are unique if the frequency of at least one of the chosen numbers is different.

The test cases are generated such that the number of unique combinations that sum up to `target` is less than `150` combinations for the given input.

Example 1:

Input: candidates = [2,3,6,7], target = 7

Output: [[2,2,3],[7]]

Explanation:

2 and 3 are candidates, and 2 + 2 + 3 = 7. Note that 2 can be used multiple times.

7 is a candidate, and 7 = 7.

These are the only two combinations.

Example 2:

Input: candidates = [2,3,5], target = 8

Output: [[2,2,2,2],[2,3,3],[3,5]]

Example 3:

Input: candidates = [2], target = 1

Output: []

Constraints:

- **`1 <= candidates.length <= 30`**
- **`2 <= candidates[i] <= 40`**
- **All elements of `candidates` are distinct.**
- **`1 <= target <= 40`**

PROGRAM:

```
def combination_sum2(candidates, target):

    candidates.sort()
    results = []

    def backtrack(curr, start, remaining_target):
        if remaining_target == 0:
            results.append(list(curr))
            return
        if remaining_target < 0:
            return
        for i in range(start, len(candidates)):
            if i > start and candidates[i] == candidates[i - 1]:
                continue
            curr.append(candidates[i])
            backtrack(curr, i + 1, remaining_target - candidates[i])
            curr.pop()

    backtrack([], 0, target)
    return results
print(combination_sum2([10,1,2,7,6,1,5], 8))
```

OUTPUT:

```
= RESTART: C:/Users/mahum/AppData/Local/Proc
[[1, 1, 6], [1, 2, 5], [1, 7], [2, 6]]
```

40. Combination Sum II

Given a collection of candidate numbers (candidates) and a target number (target), find all unique combinations in candidates where the candidate numbers sum to target.

Each number in candidates may only be used once in the combination.

Note: The solution set must not contain duplicate combinations.

Example 1:

Input: candidates = [10,1,2,7,6,1,5], target = 8

Output:

[

[1,1,6],

[1,2,5],

[1,7],

[2,6]

]

Example 2:

Input: candidates = [2,5,2,1,2], target = 5

Output:

[

[1,2,2],

[5]

]

Constraints:

- **1 <= candidates.length <= 100**
- **1 <= candidates[i] <= 50**
- **1 <= target <= 30**

PROGRAM:

```
def combination_sum2(candidates, target):

    candidates.sort()
    results = []

    def backtrack(curr, start, remaining_target):
        if remaining_target == 0:
            results.append(list(curr))
            return
        if remaining_target < 0:
            return
        for i in range(start, len(candidates)):
            if i > start and candidates[i] == candidates[i - 1]:
                continue
            curr.append(candidates[i])
            backtrack(curr, i + 1, remaining_target - candidates[i])
            curr.pop()

    backtrack([], 0, target)
    return results
print(combination_sum2([10,1,2,7,6,1,5], 8))
```

OUTPUT:

```
= RESTART: C:/Users/mahum/AppData/Local/Proc
[[1, 1, 6], [1, 2, 5], [1, 7], [2, 6]]
```

Permutations II

Given a collection of numbers, `nums`, that might contain duplicates, return *all possible unique permutations in any order.*

Example 1:

Input: nums = [1,1,2]

Output:

[[1,1,2],

[1,2,1],

[2,1,1]]

Example 2:

Input: nums = [1,2,3]

Output: [[1,2,3],[1,3,2],[2,1,3],[2,3,1],[3,1,2],[3,2,1]]

Constraints:

- **`1 <= nums.length <= 8`**
- **`-10 <= nums[i] <= 10`**

PROBLEM:

53. Maximum Subarray

Given an integer array `nums`, find the subarray which has the largest sum and return *its sum*.

Example 1:

Input: nums = [-2,1,-3,4,-1,2,1,-5,4]

Output: 6

Explanation: [4,-1,2,1] has the largest sum = 6.

Example 2:

Input: nums = [1]

Output: 1

Example 3:

Input: nums = [5,4,-1,7,8]

Output: 23

Constraints:

- **1 <= nums.length <= 105**
- **-104 <= nums[i] <= 104**

PROGRAM:

```
def max_subarray(nums):
    current_sum = max_sum = nums[0]
    for num in nums[1:]:
        current_sum = max(num, current_sum + num)
        max_sum = max(max_sum, current_sum)
    return max_sum

print(max_subarray([-2,1,-3,4,-1,2,1,-5,4]))
```

OUTPUT:

```
== RESTART: C:
6
```

Length of Last Word

Given a string `s` consisting of words and spaces, return *the length of the last word in the string.*

A word is a maximal substring consisting of non-space characters only.

Example 1:

Input: s = "Hello World"

Output: 5

Explanation: The last word is "World" with length 5.

Example 2:

Input: s = " fly me to the moon "

Output: 4

Explanation: The last word is "moon" with length 4.

Example 3:

Input: s = "luffy is still joyboy"

Output: 6

Explanation: The last word is "joyboy" with length 6.

Constraints:

- **`1 <= s.length <= 104`**
- **`s` consists of only English letters and spaces `' '`.**
- **There will be at least one word in `s`.**

Permutation Sequence

The set [1, 2, 3, ..., n] contains a total of n! unique permutations.

By listing and labeling all of the permutations in order, we get the following sequence for n = 3:

1. **"123"**
2. **"132"**
3. **"213"**
4. **"231"**
5. **"312"**
6. **"321"**

Given n and k, return the kth permutation sequence.

Example 1:

Input: n = 3, k = 3

Output: "213"

Example 2:

Input: n = 4, k = 9

Output: "2314"

Example 3:

Input: n = 3, k = 1

Output: "123"

Constraints:

- **1 <= n <= 9**
- **1 <= k <= n!**

PROGRAM:

```
def permute(nums):

    results = []

    def backtrack(curr):
        if len(curr) == len(nums):
            results.append(list(curr))
            return
        for num in nums:
            if num not in curr:
                curr.append(num)
                backtrack(curr)
                curr.pop()

    backtrack([])
    return results

print(permute([1,2,3]))
```

OUTPUT:

```
= RESTART: C:\Users\mahum\AppData\Local\Programs\Python\Python312\labtest.py
[[1, 2, 3], [1, 3, 2], [2, 1, 3], [2, 3, 1], [3, 1, 2], [3, 2, 1]]
```