



Experiment 4

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Subject Name: AP Lab - 2

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1. Aim: To improve problem-solving skills by solving diverse LeetCode problems, covering topics such as bit manipulation, dynamic programming, divide and conquer, binary search, and advanced data structures.

- i.) Longest Nice Substring
- ii.) Reverse Bits
- iii.) Number of 1 bits
- iv.) Max Subarray
- v.) Search 2d matrix 2
- vi.) Super Pow
- vii.) Beautiful Array
- viii.) The Skyline Problem
- ix.) Reverse Pairs

2. Objective:

- Understand and implement various algorithmic techniques.
- Improve proficiency in bit manipulation and dynamic programming.
- Solve problems involving binary search and divide & conquer.
- Enhance knowledge of advanced data structures.
- Optimize code for efficiency and performance.
- Strengthen logical reasoning and debugging skills.
- Gain hands-on experience with problem-solving on LeetCode.

3. Code:

Problem 1: Longest Nice Substring

```
class Solution {
public:
    string longestNiceSubstring(string s) {
        if (s.size() < 2) return "";
        unordered_set<char> charSet(s.begin(), s.end());
        for (int i = 0; i < s.size(); i++) {
```

```
char c = s[i];
if (charSet.count(tolower(c)) && charSet.count(toupper(c))) {
    continue;
}
// Split the string at the first character that breaks the nice condition
string left = longestNiceSubstring(s.substr(0, i));
string right = longestNiceSubstring(s.substr(i + 1));
return left.size() >= right.size() ? left : right;
}
return s;
}
};
```

Problem 2: Reverse Bits

```
class Solution {
public:
    uint32_t reverseBits(uint32_t n) {
        uint32_t result=0;
        for(int i=0;i<32;i++){
            result=(result<<1)|(n&1);
            n>>=1;
        }
        return result;
    }
};
```

Problem 3: Number of 1 bits

```
class Solution {
public:
    int hammingWeight(int n) {
        int count=0;
        while(n){
            n&=(n-1);
            count++;
        }
        return count;
    }
};
```

Problem 4: Maximum Subarray

```
class Solution {
public:
    int maxSubArray(vector<int>& nums) {
```

```
int max_sum=nums[0];
int curr_sum=nums[0];
for(int i=1;i<nums.size();i++){
    curr_sum=max(nums[i],curr_sum+nums[i]);
    max_sum=max(curr_sum,max_sum);
}
return max_sum;
}
};
```

Problem 5: Search a 2D Matrix II

```
class Solution {
public:
    bool searchMatrix(vector<vector<int>>& matrix, int target) {
        int m = matrix.size();
        if (m == 0) return false;
        int n = matrix[0].size();
        // Start from the top-right corner
        int row = 0, col = n - 1;
        while (row < m && col >= 0) {
            if (matrix[row][col] == target) {
                return true;
            } else if (matrix[row][col] > target) {
                col--; // Move left
            } else {
                row++; // Move down
            }
        }
        return false;
    }
};
```

Problem 6: Super Pow

```
class Solution {
public:
    const int MOD = 1337;

    // Function to calculate (x^y) % mod using modular exponentiation
    int powerMod(int x, int y, int mod) {
        int result = 1;
```

```
x %= mod; // Reduce base modulo

while (y > 0) {
    if (y % 2 == 1) { // If y is odd, multiply x with the result
        result = (result * x) % mod;
    }
    x = (x * x) % mod; // Square x
    y /= 2; // Reduce exponent
}
return result;
}
int superPow(int a, vector<int>& b) {
    a %= MOD; // Reduce base modulo 1337
    int result = 1;

    for (int digit : b) {
        // result = (result^10 * a^digit) % 1337
        result = powerMod(result, 10, MOD) * powerMod(a, digit, MOD) % MOD;
    }
    return result;
}
};
```

Problem 7: Beautiful Array

```
class Solution {
public:
    vector<int> beautifulArray(int n) {
        vector<int> result = {1}; // Base case: beautiful array of length 1
        while (result.size() < n) {
            vector<int> next;
            // Construct odd numbers (2 * x - 1)
            for (int x : result) {
                if (2 * x - 1 <= n) {
                    next.push_back(2 * x - 1);
                }
            }
            // Construct even numbers (2 * x)
            for (int x : result) {
                if (2 * x <= n) {
                    next.push_back(2 * x);
                }
            }
        }
    }
};
```

```

    }
    }
    result = next; // Update the result
}
return result;
}
};

```

Problem 8: The Skyline Birthday

```

class Solution {
public:
    vector<vector<int>> getSkyline(vector<vector<int>>& buildings) {
        vector<pair<int, int>> events;
        for (auto& b : buildings) {
            events.emplace_back(b[0], -b[2]); // Start of a building (negative height)
            events.emplace_back(b[1], b[2]); // End of a building (positive height)
        }
        // Sort events: If x-coordinates are the same, process by height
        sort(events.begin(), events.end());
        multiset<int> heights = {0}; // Max heap using multiset (auto-sorted)
        vector<vector<int>> skyline;
        int prevMax = 0;
        for (auto& [x, h] : events) {
            if (h < 0) {
                heights.insert(-h); // Add new building height
            } else {
                heights.erase(heights.find(h)); // Remove building height
            }
            int currMax = *heights.rbegin(); // Get current max height
            if (currMax != prevMax) { // If height changes, add a key point
                skyline.push_back({x, currMax});
                prevMax = currMax;
            }
        }
        return skyline;
    }
};

```

Problem 9: Reverse Pair

```

class Solution {
public:

```

```
int mergeAndCount(vector<int>& nums, int left, int mid, int right) {
    int count = 0, j = mid + 1;
    // Count reverse pairs
    for (int i = left; i <= mid; i++) {
        while (j <= right && nums[i] > 2LL * nums[j]) {
            j++;
        }
        count += (j - (mid + 1));
    }
    // Merge two sorted halves
    vector<int> temp;
    int i = left, k = mid + 1;
    while (i <= mid && k <= right) {
        if (nums[i] <= nums[k]) {
            temp.push_back(nums[i++]);
        } else {
            temp.push_back(nums[k++]);
        }
    }
    while (i <= mid) temp.push_back(nums[i++]);
    while (k <= right) temp.push_back(nums[k++]);

    // Copy sorted array back
    for (int i = left; i <= right; i++) {
        nums[i] = temp[i - left];
    }

    return count;
}

int mergeSortAndCount(vector<int>& nums, int left, int right) {
    if (left >= right) return 0;
    int mid = left + (right - left) / 2;
    int count = mergeSortAndCount(nums, left, mid) +
                mergeSortAndCount(nums, mid + 1, right) +
                mergeAndCount(nums, left, mid, right);
    return count;
}

int reversePairs(vector<int>& nums) { // <-- Only declared once
```



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```
        return mergeSortAndCount(nums, 0, nums.size() - 1);  
    }  
};
```

4. Output:

Accepted Runtime: 0 ms

• Case 1 • Case 2 • Case 3

Input

s =
"YazaAay"

Output

"aAa"

Expected

"aAa"

Fig 1. Longest Substring

• Case 1 • Case 2

Input

n =
00000010100101000001111010011100

Output

964176192 (00111001011110000010100101000000)

Expected

964176192 (00111001011110000010100101000000)

Fig 2. Reverse Bits



Accepted Runtime: 0 ms

• Case 1 • Case 2 • Case 3

Input

```
n =  
11
```

Output

```
3
```

Expected

```
3
```

Fig 3. Number of 1 bits

Accepted Runtime: 0 ms

• Case 1 • Case 2 • Case 3

Input

```
nums =  
[-2,1,-3,4,-1,2,1,-5,4]
```

Output

```
6
```

Expected

```
6
```

Fig 4. Maximum Subarray



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Accepted Runtime: 3 ms

• Case 1 • Case 2

Input

```
matrix =  
[[1,4,7,11,15],[2,5,8,12,19],[3,6,9,16,22],[10,13,14,17,24],[18,21,23,26,30]]
```

```
target =  
5
```

Output

```
true
```

Expected

```
true
```

Fig 5. Search a 2D matrix

Accepted Runtime: 0 ms

• Case 1 • Case 2 • Case 3

Input

```
a =  
2
```

```
b =  
[3]
```

Output

```
8
```

Expected

```
8
```

Fig 6. Super Pow



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Accepted Runtime: 0 ms

- Case 1
- Case 2

Input

```
n =  
4
```

Output

```
[1,3,2,4]
```

Expected

```
[2,1,4,3]
```

Fig 7. Beautiful Array

Accepted Runtime: 0 ms

- Case 1
- Case 2

Input

```
buildings =  
[[2,9,10],[3,7,15],[5,12,12],[15,20,10],[19,24,8]]
```

Output

```
[[2,10],[3,15],[7,12],[12,0],[15,10],[20,8],[24,0]]
```

Expected

```
[[2,10],[3,15],[7,12],[12,0],[15,10],[20,8],[24,0]]
```

Fig 8. The Skyline problem

Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

```
nums =  
[1,3,2,3,1]
```

Output

2

Expected

2

Fig 9. Reverse Pairs

5. Learning Outcomes:

- Mastered linked lists and advanced data structures like Fenwick Trees, segment trees, and heaps.
- Improved searching and sorting skills using binary search and merge sort-based counting.
- Learned bit manipulation techniques for efficient operations on binary representations.
- Applied modular arithmetic to handle large computations in problems like Super Pow.
- Solved complex computational geometry problems using priority queues and sweep line algorithms.