BINARY

Binary

- In C++, **std::bitset** represents a fixed-size sequence of N bits

- Example:

```
std::bitset<8> bitmask;

bitmask.reset(1)

bitmask.set(1)

if (bitmask.test(1)) { // true

…
```

- **reset** : set bit to false

- **set** : set a specific bit

- **test** : check a specific bit

- **count** : return the number of bits set to true

- **flip** : toggle the value of the bits (if true, set to false and vice-versa)

Problem 3 – Longest Substring Without Repeating Characters

LeetCode leetcode.com/problems/longest-substring-without-repeating-characters

Given a string, the goal is to find the longest substring without repeating characters.

For example, given a string "abcdb", it should return 4:

abcd since "b" is repeated

- Using bitset: create a bitmask with 128 bits where each bit represent a character

- Use sliding window represented by **left** and **right**

- Set the bit to true for each character found

- Check if it is repeated and reset the bit

```cpp
int lengthOfLongestSubstring(string s) {
    std::bitset<128> bitmask;
    uint32_t left = 0;
    uint32_t maxLength = 0;

    for (uint32_t right = 0; right < s.length(); ++right) {
        uint32_t bitIndex = s[right];
        // if char is already in the bitmask, move left until we reset the bits
        while (bitmask.test(bitIndex)) {
            bitmask.reset(s[left]);
            ++left;
        }

        bitmask.set(bitIndex);
        maxLength = std::max(maxLength, right - left + 1);
    }
    return maxLength;
}
```

Negabinary

- Non-standard positional numeral system that uses base of -2

- Allow representing negative numbers in binary

- Example:

  1101_{-2}

  $(-2)^3 + (-2)^2 + 0 + (-2)^0 = -8 + 4 + 0 + 1 = -3$

Summing Negabinary

- Add as a regular binary number, but with **negative carry**

  $0 + 0 = 0$

  $1 + 0 = 1$

  $1 + 1 = 0$ with a negative carry 1

  $\mathbf{1} + 1 = 0$ (subtract)

  $\mathbf{1} + 0 = 1$ with a positive carry 1

Negabinary

Example 1

11 1
1011
+ 1110
= 110001

1 + 0 = 1

1 + 1 = 0 with negative carry 1

1 + 1 = 0

1 + 1 = 0 with negative carry 1

1 + 0 = 1 with positive carry 1

1 + 0 = 1

red 1 = negative carry

green 1 = regular carry

Example 2

1111
101010
+ 101100
= 11110110

Reference

https://math.stackexchange.com/questions/3251605/how-to-add-negabinary-numbers

https://leetcode.com/problems/adding-two-negabinary-numbers

Given two numbers **arr1** and **arr2** in base -2, return the result of adding them together.

Each number is given in *array format*: as an array of 0s and 1s, from most significant bit to least significant bit.
For example, **arr = [1,1,0,1]** represents the number $(-2)^3 + (-2)^2 + (-2)^0 = -3$. A number **arr** in array, format is
also guaranteed to have no leading zeros: either **arr == [0]** or **arr[0] == 1**.

Return the result of adding **arr1** and **arr2** in the same format: as an array of 0s and 1s with no leading zeros.

Example 1

Input: arr1 = [1,1,1,1,1], arr2 = [1,0,1]

Output: [1,0,0,0,0]

Explanation: arr1 represents 11, arr2 represents 5, the output represents 16.

Example 2

Input: arr1 = [0], arr2 = [0]

Output: [0]

Example 3

Input: arr1 = [0], arr2 = [1]

Output: [1]

https://leetcode.com/problems/adding-two-negabinary-numbers