DOMAIN WINTER WINNING CAMP

DAY: 2

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Section: 620/A

Very Easy

1. **Given an array nums of size n, return the majority element.**
   Code:

```
#include <iostream>
using namespace std;

int majorityElement(int nums[], int n) {
   int candidate = 0, count = 0;

   // Phase 1: Find a potential candidate for the majority element
   for (int i = 0; i < n; i++) {
      if (count == 0) {
         candidate = nums[i];
         count = 1;
      } else if (nums[i] == candidate) {
         count++;
      } else {
         count--;
      }
   }

   // Phase 2: Verify if the candidate is the majority element
   count = 0;
   for (int i = 0; i < n; i++) {
      if (nums[i] == candidate) {
         count++;
      }
   }
```

```
    return count > n / 2 ? candidate : -1; // Return -1 if no majority element exists
}

int main() {
    int nums[] = {2, 2, 1, 1, 1, 2, 2};
    int n = sizeof(nums) / sizeof(nums[0]);

    int result = majorityElement(nums, n);
    if (result != -1) {
        cout << "Majority element: " << result << endl;
    } else {
        cout << "No majority element found." << endl;
    }

    return 0;
}
```

Output:

2. **Given a non-empty array of integers nums, every element appears twice except for one. Find that single one. You must implement a solution with a linear runtime complexity and use only constant extra space.**

Code:

```
#include <iostream>
using namespace std;

int singleNumber(int nums[], int n) {
    int result = 0;
    for (int i = 0; i < n; i++) {
        result ^= nums[i]; // XOR operation
    }
    return result;
}

int main() {
```

```
    int nums[] = {4, 1, 2, 1, 2};
    int n = sizeof(nums) / sizeof(nums[0]);

    cout << "The single number is: " << singleNumber(nums, n) << endl;

    return 0;
}
```

Output:

3. **Given an integer array nums where the elements are sorted in ascending order, convert it to a height-balanced binary search tree.**

Code:

```
#include <iostream>
using namespace std;

// Definition of a TreeNode
struct TreeNode {
    int val;
    TreeNode* left;
    TreeNode* right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};

// Helper function to construct a height-balanced BST
TreeNode* sortedArrayToBST(int nums[], int start, int end) {
    if (start > end) {
        return nullptr; // Base case: no elements to process
    }

    int mid = start + (end - start) / 2; // Find the middle element
    TreeNode* root = new TreeNode(nums[mid]); // Create a TreeNode with the middle element
```

```
    // Recursively construct the left and right subtrees
    root->left = sortedArrayToBST(nums, start, mid - 1);
    root->right = sortedArrayToBST(nums, mid + 1, end);

    return root;
}

// Main function to convert a sorted array to BST
TreeNode* sortedArrayToBST(int nums[], int n) {
    return sortedArrayToBST(nums, 0, n - 1);
}

// Helper function to print the BST in-order
void inOrderTraversal(TreeNode* root) {
    if (!root) return;
    inOrderTraversal(root->left);
    cout << root->val << " ";
    inOrderTraversal(root->right);
}

int main() {
    int nums[] = {-10, -3, 0, 5, 9};
    int n = sizeof(nums) / sizeof(nums[0]);

    TreeNode* root = sortedArrayToBST(nums, n);

    cout << "In-order traversal of the BST: ";
    inOrderTraversal(root);
    cout << endl;

    return 0;
}
```
Output:

Easy

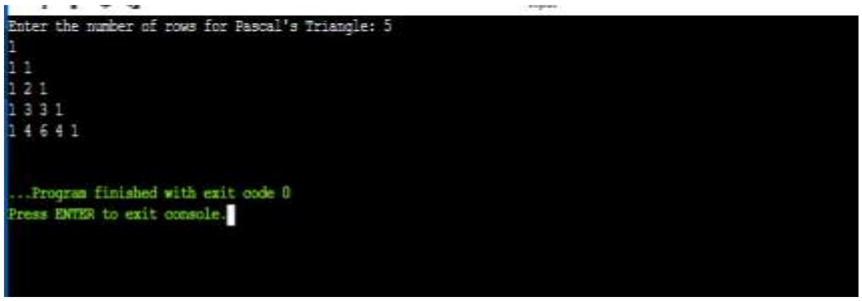
4. **Given an integer numRows, return the first numRows of Pascal's triangle.**

Code:

```
#include <iostream>
using namespace std;

// Function to generate Pascal's Triangle
void generatePascalsTriangle(int numRows) {
   int triangle[numRows][numRows];

   // Build the Pascal's Triangle
   for (int i = 0; i < numRows; i++) {
      for (int j = 0; j <= i; j++) {
         // The first and last elements in each row are 1
         if (j == 0 || j == i) {
            triangle[i][j] = 1;
         } else {
            // Every other element is the sum of the two elements above it
            triangle[i][j] = triangle[i - 1][j - 1] + triangle[i - 1][j];
         }
      }
   }

   // Print Pascal's Triangle
   for (int i = 0; i < numRows; i++) {
      for (int j = 0; j <= i; j++) {
         cout << triangle[i][j] << " ";
      }
      cout << endl;
   }
}

int main() {
   int numRows;
   cout << "Enter the number of rows for Pascal's Triangle: ";
   cin >> numRows;

   generatePascalsTriangle(numRows);
```

```
    return 0;
}
```

Output:



5. **Given an integer array nums sorted in non-decreasing order, remove the duplicates in-place such that each unique element appears only once. The relative order of the elements should be kept the same. Then return the number of unique elements in nums.**

Code:

```
#include <iostream>
using namespace std;

int removeDuplicates(int nums[], int n) {
    if (n == 0) return 0; // If the array is empty, return 0

    int k = 1; // The first unique element is at index 0
    for (int i = 1; i < n; i++) {
        if (nums[i] != nums[k - 1]) { // Compare with the last unique element
            nums[k] = nums[i];      // Update the position for the next unique element
            k++;
        }
    }
    return k; // Number of unique elements
}

int main() {
    int nums[] = {0, 0, 1, 1, 1, 2, 2, 3, 3, 4};
    int n = sizeof(nums) / sizeof(nums[0]);

    int k = removeDuplicates(nums, n);
```

```
    cout << "Number of unique elements: " << k << endl;
    cout << "Array after removing duplicates: ";
    for (int i = 0; i < k; i++) {
        cout << nums[i] << " ";
    }
    cout << endl;

    return 0;
}
```

Output:

6. **Given the head of a linked list and an integer val, remove all the nodes of the linked list that has Node.val == val, and return *the new head*.**

   Code:

```
#include <iostream>
using namespace std;

// Definition for a singly-linked list node
struct ListNode {
    int val;
    ListNode* next;
    ListNode(int x) : val(x), next(nullptr) {}
};

// Function to remove all nodes with the given value
ListNode* removeElements(ListNode* head, int val) {
    // Handle the case where the head itself needs to be removed
    while (head != nullptr && head->val == val) {
        ListNode* temp = head;
        head = head->next;
        delete temp; // Free memory of the removed node
    }
```

```
    // Pointer to traverse the list
    ListNode* current = head;

    // Traverse the list and remove nodes with the given value
    while (current != nullptr && current->next != nullptr) {
        if (current->next->val == val) {
            ListNode* temp = current->next;
            current->next = current->next->next; // Bypass the node
            delete temp; // Free memory of the removed node
        } else {
            current = current->next; // Move to the next node
        }
    }

    return head;
}

// Function to print the linked list
void printList(ListNode* head) {
    while (head != nullptr) {
        cout << head->val << " ";
        head = head->next;
    }
    cout << endl;
}

// Main function
int main() {
    // Create a sample linked list: 1 -> 2 -> 6 -> 3 -> 4 -> 5 -> 6
    ListNode* head = new ListNode(1);
    head->next = new ListNode(2);
    head->next->next = new ListNode(6);
    head->next->next->next = new ListNode(3);
    head->next->next->next->next = new ListNode(4);
    head->next->next->next->next->next = new ListNode(5);
    head->next->next->next->next->next->next = new ListNode(6);

    cout << "Original list: ";
```

```
    printList(head);

    int val = 6;
    head = removeElements(head, val);

    cout << "Modified list: ";
    printList(head);

    return 0;
}
```

Output:

Medium

7. **You are given an integer array height of length n. There are n vertical lines drawn such that the two endpoints of the ith line are (i, 0) and (i, height[i]). Find two lines that together with the x-axis form a container, such that the container contains the most water. Return the maximum amount of water a container can store. Notice that you may not slant the container.**

Code:

```
#include <iostream>
using namespace std;

int maxArea(int height[], int n) {
    int left = 0, right = n - 1; // Two pointers
    int max_area = 0;

    while (left < right) {
        // Calculate the current area
        int width = right - left;
        int h = (height[left] < height[right]) ? height[left] : height[right];
        int current_area = width * h;

        // Update the maximum area
```

```
        if (current_area > max_area) {
            max_area = current_area;
        }

        // Move the pointer pointing to the shorter line
        if (height[left] < height[right]) {
            left++;
        } else {
            right--;
        }
    }

    return max_area;
}

int main() {
    int height[] = {1, 8, 6, 2, 5, 4, 8, 3, 7};
    int n = sizeof(height) / sizeof(height[0]);

    int result = maxArea(height, n);
    cout << "Maximum amount of water a container can store: " << result << endl;

    return 0;
}
```

Output:

8. **Design your implementation of the circular queue. The circular queue is a linear data structure in which the operations are performed based on FIFO (First In First Out) principle, and the last position is connected back to the first position to make a circle. It is also called "Ring Buffer".**

   Code:

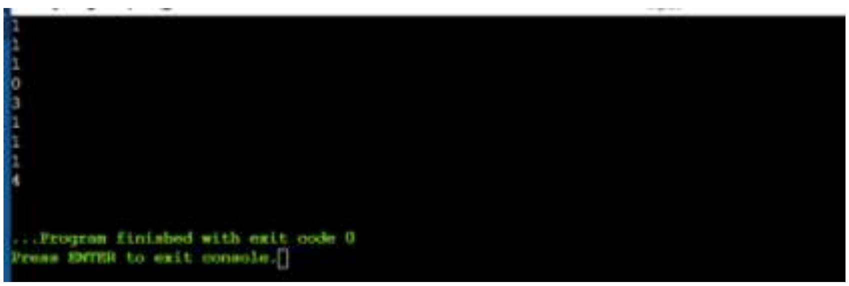
```
#include <iostream>
using namespace std;
```

```
class MyCircularQueue {
private:
   int *queue;       // Array to store elements
   int front;        // Index of the front element
   int rear;         // Index of the rear element
   int size;         // Maximum size of the queue
   int count;        // Current number of elements in the queue

public:
   // Constructor to initialize the circular queue with a size of k
   MyCircularQueue(int k) {
      size = k;
      queue = new int[size];
      front = 0;
      rear = -1;
      count = 0;
   }

   // Destructor to clean up allocated memory
   ~MyCircularQueue() {
      delete[] queue;
   }

   // Inserts an element into the circular queue
   bool enQueue(int value) {
      if (isFull()) {
         return false; // Queue is full
      }
      rear = (rear + 1) % size; // Move rear to the next position
      queue[rear] = value;
      count++;
      return true;
   }

   // Deletes an element from the circular queue
   bool deQueue() {
      if (isEmpty()) {
```

```
        return false; // Queue is empty
      }
      front = (front + 1) % size; // Move front to the next position
      count--;
      return true;
    }

    // Gets the front item from the queue
    int Front() {
      if (isEmpty()) {
        return -1; // Queue is empty
      }
      return queue[front];
    }

    // Gets the last item from the queue
    int Rear() {
      if (isEmpty()) {
        return -1; // Queue is empty
      }
      return queue[rear];
    }

    // Checks whether the circular queue is empty
    bool isEmpty() {
      return count == 0;
    }

    // Checks whether the circular queue is full
    bool isFull() {
      return count == size;
    }
  };

  // Main function to test the implementation
  int main() {
    MyCircularQueue q(3); // Initialize a circular queue with size 3
```

```
    cout << q.enQueue(1) << endl; // Returns true
    cout << q.enQueue(2) << endl; // Returns true
    cout << q.enQueue(3) << endl; // Returns true
    cout << q.enQueue(4) << endl; // Returns false (queue is full)

    cout << q.Rear() << endl; // Returns 3
    cout << q.isFull() << endl; // Returns true

    cout << q.deQueue() << endl; // Returns true
    cout << q.enQueue(4) << endl; // Returns true

    cout << q.Rear() << endl; // Returns 4

    return 0;
}
```

Output:



Hard

9. **Maximum Number of Groups Getting Fresh Donuts**

Code:

```
#include <iostream>
using namespace std;

int maxHappyGroups(int batchSize, int groups[], int n) {
  // Sort groups manually in descending order (bubble sort for simplicity)
  for (int i = 0; i < n - 1; ++i) {
    for (int j = 0; j < n - i - 1; ++j) {
      if (groups[j] < groups[j + 1]) {
        // Swap the elements
        int temp = groups[j];
        groups[j] = groups[j + 1];
        groups[j + 1] = temp;
```

```
        }
      }
    }

    int happyGroups = 0; // To store the number of happy groups
    int remainingDonuts = 0; // To store the remaining donuts after serving groups

    // Process each group in sorted order
    for (int i = 0; i < n; ++i) {
      int group = groups[i];

      // If the group size is less than or equal to the remaining donuts, serve it fresh
      if (group <= remainingDonuts) {
        happyGroups++;
        remainingDonuts -= group; // Decrease the number of remaining donuts
      } else {
        // Otherwise, we can't serve the group fresh donuts
        remainingDonuts = batchSize - group; // Store the leftover donuts after
serving
      }
    }

    return happyGroups;
}

int main() {
    int batchSize = 3;
    int groups[] = {1, 2, 3, 4, 5, 6};
    int n = sizeof(groups) / sizeof(groups[0]);

    int result = maxHappyGroups(batchSize, groups, n);
    cout << "Maximum number of happy groups: " << result << endl;

    return 0;
}
```

Output:

10. **Maximum number of Darts Inside of a Circular Dartboard**

Code:

```
#include <iostream>
using namespace std;

// Function to check if a point is within the circle
bool isInCircle(int x, int y, int cx, int cy, int r) {
   // Calculate the squared distance to avoid using sqrt
   return ( (x - cx) * (x - cx) + (y - cy) * (y - cy) ) <= r * r;
}

// Function to calculate the maximum darts that can be inside a circle of radius r
int maxDartsInCircle(int darts[][2], int n, int r) {
   int maxDarts = 0;

   // Check every pair of darts to find possible circle centers
   for (int i = 0; i < n; i++) {
      for (int j = i + 1; j < n; j++) {
         int x1 = darts[i][0], y1 = darts[i][1];
         int x2 = darts[j][0], y2 = darts[j][1];

         // Find the midpoint of the two darts
         int midX = (x1 + x2) / 2;
         int midY = (y1 + y2) / 2;

         // Count how many darts are within the circle with center (midX, midY)
         int count = 0;
         for (int k = 0; k < n; k++) {
            if (isInCircle(darts[k][0], darts[k][1], midX, midY, r)) {
               count++;
            }
         }
         maxDarts = maxDarts > count ? maxDarts : count; // Update max darts if
needed
      }
   }
```

```
    return maxDarts;
}

int main() {
    // Input: array of dart positions and radius of the dartboard
    int darts[][2] = {{-2,0},{2,0},{0,2},{0,-2}};
    int n = 4;  // Number of darts
    int r = 2;  // Radius of the dartboard

    // Call the function and display the result
    int result = maxDartsInCircle(darts, n, r);
    cout << "Maximum number of darts on the dartboard: " << result << endl;

    return 0;
}
```

Output: