

Course: Data Structures (CSE CS203A, 114-1)
Quiz I: Introduction to C Programming and Data Structures
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Q1: (20 pts; 5 pts for each) Complete the C Code

```
#include <stdio.h>
#include <stdlib.h>

int main() {
    ____①____ *array;
    int n = 10;

    // Allocate memory for n integers
    array = (int *) malloc(n * ____②____ );

    // Initialize array with values 1, 2, 3, ..., 10
    for(int i = 0; i < n; i++) {
        array[i] = i + 1;
    }

    // Print the original array
    printf("Original array: ");
    for (int i = 0; i < n; i++) {
        printf("%d ", array[i]);
    }
    printf("\n");

    // Double the array size
    n = n * 2;
    array = (int *) ____③____ (array, n * sizeof(int));

    // Initialize new elements (second half)
    for (int i = n/2; i < n; i++) {
        array[i] = i + 1;
    }

    // Print the resized array
    printf("Resized array: ");
    for (int i = 0; i < n; i++) {
        printf("%d ", array[i]);
    }
}
```

50 + 20

```
    }
    printf("\n");

    // Clean up memory
    ___④___
    array = NULL;

    return 0;
}
```

A1:

- ① int
- ② sizeof(int)
- ③ realloc
- ④ free(array)

✓ +20 .

Q2: (20 pts) Memory Management Code Review

You are conducting a code review for a junior developer who submitted the following C code for a production system that will handle user data processing. The code dynamically allocates memory for an integer array, processes the data, and then expands the array size as needed.

```
double *array;
int n = 10;

array = (double *) malloc(n * sizeof(double));

// ... processing code ...

n = n * 2;
array = (double *) realloc(array, n * sizeof(double));

// ... more processing ...

free(array);
```

As a senior developer responsible for code quality and system reliability, you notice several critical memory management issues that could lead to:

- Memory leaks
- Segmentation faults
- System crashes in production

- Data corruption
- Undefined behavior

printf("After realloc memory end address: %p\n", (void*)array
 $+n * \text{sizeof}(\text{int}) - 1))$; // 列印更新大小後的最後一個陣列元素的
 記憶體地址。

Task: Identify the specific memory management issues and provide solutions to ensure safe memory management.

A2:

第一段: printf("Initial memory address: %p\n", (void*)array); // 列印更新大小前的第一個
 陣列元素的記憶體地址。

printf("Initial memory end address: %p\n", (void*)(array + n * sizeof(int) - 1)); // 列印更新大小前
 的最後一個陣列元素的記憶體地址。

第二段: printf("After realloc memory address: %p\n", (void*)array); // 列印更新大小後的第一個
 陣列元素的記憶體地址。

Q3: (40 pts) Time Complexity Analysis

Fill in the blanks with the appropriate Big O notation: $O(1)$, $O(\log n)$, $O(n)$, $O(n \log n)$, $O(n^2)$, $O(n^3)$, $O(n!)$.

Q3-1: (5pts) If binary search is $O(\log n)$ and we perform it n times, the overall time complexity is $O(n \log n)$.

```
for(int i = 0; i < n; i++) {
    // Binary search operation on sorted array
    binarySearch(sortedArray, target, n);
}
```

Q3-2: (5 pts)

Accessing an element in an array by index (e.g., $\text{array}[5]$) has a time complexity of $O(1)$.

Q3-3: (15 pts; 5 pts for each)

Finding the maximum value in an unsorted array by checking every element has a time complexity of $O(n)$.

Traversing through all elements in an array of size n has a time complexity of $O(n)$.

Do these two operations have the same time complexity? Yes (Yes/No).

Q3-4: (5 pts)

Bubble sort algorithm for sorting an array of n elements has a time complexity of $O(n^2)$.

Q3-5: (10 pts)

Order the following Big O notations from fastest (most efficient) to slowest (least efficient):

Given: $O(n!)$, $O(1)$, $O(n^2)$, $O(\log n)$, $O(n \log n)$, $O(n)$, $O(n^3)$

A3-1: $O(n \log n)$

A3-2: $O(1)$

A3-3: $O(n) > O(n^2) > Yes$

130°

A3-4: $O(n^2)$

A3-5: $O(1) < O(\log n) < O(n) < O(n \log n) < O(n^2) < \cancel{O(n^3)} < O(n!) < O(n^4)$

Q4: (20 pts) Explain the difficulties in learning data structures.

Task: Discuss the main challenges students face when learning data structures and suggest approaches to overcome these difficulties.

A4: