Course: Data Structures (CSE CS203A, 114-1)
Quiz I: Introduction to C Programming and Data Structures
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76+14

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]);
```

```
    }
    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

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- Data corruption
- Undefined behavior

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

A2: 在 malloc 和 realloc 後寫 if (array == NULL) 確認是否有拿到記憶體空間.

```
if (array == NULL){
  exist(1);
}
```

+6.

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., array[5]) has a time complexity of O(n).

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? No (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(n)~~

A3-3: O(n) , O(n) , ~~No~~

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

A3-5: $O(1)$, $O(\log n)$, $O(n)$, $O(n \log n)$, $O(n^2)$, $O(n^3)$, $O(n!)$

**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: 到目前為止在學習上沒有遇到太大的困難，找題目練習後通常都可以解決。

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