

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]);
    }
}
```

```
}

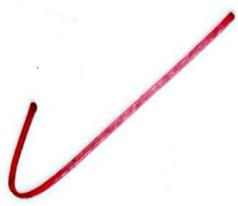
printf("\n");

// Clean up memory
____④____
array = NULL;

return 0;
}
```

A1:

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



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#### 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

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();
}
```

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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? 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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