Course: Data Structures (C...

Quiz I: Introduction to C Programming and Data Structures

September 30, 2025, 16:30~17:00

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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); +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

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

A2: array = NULL;

```
for(i=0; i < n; i++){
    array[i] = i+1
}
for(i=n/2; i < n; i++){
    array[i] = i+1
}
```

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(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 _____.

Traversing through all elements in an array of size n has a time complexity of _____.

Do these two operations have the same time complexity? _____ (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(nlogn) ✓

A3-2: O(1) ✓

A3-3: O(n), O(n), Yes ✓

~~105~~ +30

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

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

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: 學會 stack、queue 的實作方法，與在實際去編寫程式碼時該如何將資料結構中的概念運用在其中。

在大量的實作去實際操作練習應用，同時可以上傳至 github 讓同儕間去互相觀摩學習，看看其他人是如何應用這些概念。

+20.