

Graduate Comprehensive Exam: Data Structures and Algorithms (Spring 2004)

Answer all questions on the exam. You may use the back for additional space. Total: 100 points. Good Luck.

1. (20 pts) Given the following two functions:

```
int func1(int N) // N is assumed to be positive
{
    if (N > 1)
        return 1 + func1(N/2);
    else
        return 0;
}
```

```
int func2(int N) // N is assumed to be positive
{
    if (N > 0)
        return 2 * func2(N-1);
    else
        return 1;
}
```

- use the big-O notation and estimate the running time of `func1()` and `func2()` in terms of N which is a positive integer. Explain your answer.
 - which function (`func1()` or `func2()`) is slower according to their time complexity? Explain your answer.
 - assuming N is a power of 2, what do `func1()` and `func2()` try to calculate?
2. (15 pts) Comparing these two data structures: an array and a linked list
- with respect to time, what is an advantage *and* a disadvantage of an array over a linked list? Explain your answer.
 - with respect to space, what is an advantage *and* a disadvantage of an array over a linked list? Explain your answer.
3. (15 pts) Given these edges in a directed graph: $A \rightarrow B$, $A \rightarrow C$, $D \rightarrow B$, $E \rightarrow A$, $F \rightarrow A$, and $G \rightarrow D$, perform topological sort. Show your steps.

For Questions 4 and 5, you may use pseudocode or a high-level programming language (like C, C++, or Ada) to *write* a function.

4. (25 pts) The questions below relate to AVL trees:
- (5 pts) Define the structure of a tree node
 - (10 pts) State the condition of triggering one of the single rotations (the one of your choice). Write a procedure that implements the selected single rotation.
 - (10 pts) State the condition of triggering one of the double rotations (the one of your choice). Write a procedure that implements the selected double rotation.
5. (25 pts) The questions below relate to Quicksort
- (20 pts) Write the Quicksort procedure that works on an array. Make sure you write the partition procedure.
 - (5 pts) Demonstrate with an example whether or not your Quicksort procedure is stable.