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:

```c
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;
}
```

(a) 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.

(b) which function (func1() or func2()) is slower according to their time complexity? Explain your answer.

(c) 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

(a) with respect to time, what is an advantage and a disadvantage of an array over a linked list? Explain your answer.

(b) with respect to space, what is an advantage and a disadvantage of an array over a linked list? Explain your answer.


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:

(a) (5 pts) Define the structure of a tree node

(b) (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.

(c) (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

(a) (20 pts) Write the Quicksort procedure that works on an array. Make sure you write the partition procedure.

(b) (5 pts) Demonstrate with an example whether or not your Quicksort procedure is stable.