

Graduate Comprehensive Exam: Data Structures and Algorithms (Fall 2005)

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

1. **(15 points)** Using big-O notation, estimate the running time of `proc(N)`, where `N` is a positive integer (explain your answer and show your steps):

```
void proc(int x)
{
    int i;
    if (x >= 1)
    {
        proc(x/2);
        proc(x/2);
        for (i = 0; i < x; i++)
            /* constant-time operation */
    }
}
```

2. **(15 points)** Consider a 10x10 grid maze. Each cell can be empty or have an obstacle. At each cell, one can move up, down, right, or left to an adjacent empty cell. Given an empty cell to start (S) and another to end (E), the problem is to find a path from cell S to E .
- formulate the problem as a graph problem
 - state/name a graph algorithm that solves the problem

3. **(20 points)** Insertion Sort

- (a) For number of comparisons, describe when the worst case occurs and analyze the complexity.
- (b) For number of moves/swaps, describe when the worst case occurs and analyze the complexity.

For the following questions, you may use pseudocode (with sufficient details) or a high-level programming language (like C, C++, or Java) to *write* a function.

4. **(25 points)** Given an array of integers, implement the Quicksort algorithm.

5. **(25 points)** Consider a binary tree with integer values in its nodes.
- (a) Write the class/struct(s) that implement(s) a binary tree.
 - (b) Write a *recursive* function that takes such a binary tree and return the number of nodes with integer values that are even.