Final Exam
CSCIE 119 - Data Structures
Fall 2003
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Circle your TF’s name
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Place your answers to the multiple-choice questions in the boxes below

1  2  3  4  5  6  7  8  9  10
Multiple Choice [5 points each]

[1] Suppose we are sorting an array of eight integers using some quadratic sorting algorithm. After three iterations of the algorithm's main loop, the array elements are ordered as shown here:

2 4 5 7 6 1 3 8

Which statement is correct? (Note: Our selection sort picks largest items first.)

A. The algorithm might be either selection sort or insertion sort.
B. The algorithm might be selection sort, but it is not insertion sort.
C. The algorithm is not selection sort, but it might be insertion sort.
D. The algorithm is neither selection sort nor insertion sort.

[2] Which of the following statements is not true about the increments used in Shell sort?

A. The increments should be decreasing
B. The increments should be relatively prime
C. The final increment should be 1
D. The increments should be prime numbers
E. All the statements above are true

[3] Why is the state graph for tic-tac-toe a directed graph rather than an undirected graph?

A. Once a move is made, it cannot be unmade.
B. There are an odd number of vertices.
C. There are an odd number of edges.
D. There is more than one player in the game.

[4] If you are not careful in your choice of hash functions, it is possible to have a collision situation in which the search time goes to

A. O(1)
B. O(log(N))
C. O(N)
D. O(N!)
E. O(N^2)
F. none of the above!

[5] What is the maximum number of nodes in a binary tree of height k? A tree with one node has height 1.

A. 2 * k-1
B. 2 * k
C. 2^k
D. 2^k - 1
E. logk -1
[6] Ackerman’s function is defined as follows:

```c
int A(int m, int n) {
    if (m == 0) return n+1;
    if (n == 0) return A(m-1,1);
    return A(m-1, A(m, n-1));
}
```

A(2,1) is
A. 1  
B. 2  
C. 3  
D. 4  
E. 5  
F. 6  

[7] Here is an array that has just been partitioned by the first step of quicksort:

3, 0, 2, 4, 5, 8, 7, 6, 9

A. 5 could be the pivot, but 7 could not be
B. 7 could be the pivot, but 5 could not be
C. Neither 5 nor 7 could be the pivot
D. Either 5 or 7 could be the pivot

[8] The Depth First Search algorithm may be used

A. To find if an undirected graph is connected
B. To find a spanning Tree
C. To look for cycles in a directed graph
D. All of the above
E. None of the above

[9] Consider storing a heap in an array starting at location 0. If data[x] has a right child, where will the right child’s value be stored?

A. data[x+1]  
B. data[x+2]  
C. data[2*x]  
D. data[2*x + 1]  
E. data[2*x + 2]

[10] Which of the following statements are true about all efficient sorts?

A. They use complex data structures to store partial results.
B. They are stable: if two elements have matching keys, they remain in the same relative position before and after sorting.
C. They compare elements that are not adjacent in the array.
D. Once an element is placed in its proper slot, it is never moved again.
E. All of the above!
F. None of the above!
[11] [10 points] **Boyer-Moore** Use the Boyer-Moore string search algorithm to find all occurrences of the pattern **THREAT** in the text below

**THEY TELL ALL ABOUT MOBSTER THREATS**

Circle each character in the above text that will be looked up in the Boyer-Moore skip table.

[12] [15 points] **Path Length** We define the **path length** of a tree to be the sum of the levels of all the tree’s nodes. The level of the root is 0. The path length of the tree below is 1 + 0 + 2 + 1 + 2 = 6.

![Tree Diagram]

Write a Java function that computes the path length of a tree.

For full credit, the routine must take O(N) time to compute the path length for a tree with N nodes.

[13] [25 points] **Stars in Bars** Scientists have found a bar in Boston where everyone knows your name. However, Hollywood is a different world.

**Assumptions** Every bar in Hollywood has a star. A star is someone everyone knows, but who knows no one except himself or herself.

a) [5 points] Restate the paragraph above in graph-theoretic terms.

b) [5 points] Prove that a bar cannot have two stars.

c) [10 points] Write a Java function to find the star in a bar. You are given a two-dimensional Boolean array `knows[a,b]`. We define `knows[x,y]` to be true if x knows y, and false otherwise. You may assume that `knows[x,x]` is true for all x.

d) [5 points] For full credit, your function should take O(N) time on a bar with N patrons.