BITS, Pilani – Dubai Campus
Knowledge Village, Dubai

III Year (Computer Science & Engg.)
First Semester, 2005-2006

Comprehensive Examination Question Paper

Course No: CSUC341 **Course Title: Data Structures and Algorithms**
Date: 28th Dec 2005 **Time: 10.00 AM to 01.00 PM** **Total Marks: 40**

Data provided and complete. Closed book. Number of pages: 2

(Answer ALL questions)

1. (a) Write an algorithm for **in-place** Quick-Sort. Derive the worst-case complexity of your algorithm. Suggest a method to get a good average time complexity for Quick-sort. **(2+1.5+0.5 marks)**
   (b) Assume the ADT List is implemented by doubly linked linear list. Give the node declaration and write an algorithm for the following operation
   swapElements(p, q). **(0.5+1.5 marks)**

2. (a) Define the height of a (general, not binary) tree. Write an algorithm for finding the height of such a tree. What is the complexity of your algorithm? **(0.5+1.0+0.5 marks)**
   (b) Write an algorithm for printing a **fully parenthesized** arithmetic expression of an expression tree. Using the standard priorities for arithmetic operations, draw the binary tree for the expression
   (3+1) * 3 / ((9–3) +2) – (3 * (7–4)+6)
   What will be the output of your algorithm for this expression? **(1.0+0.5+0.5 marks)**
   (c) Explain any two methods of collision handling in the context of hash tables. **(2 * 1.0 marks)**

3. (a) Use a counter example to show that greedy method does not solve the 0-1 knapsack problem. **(2 marks)**
   (b) Derive is the complexity of the dynamic programming algorithm for 0-1 knapsack problem. Why is this algorithm called a pseudo-polynomial time algorithm? **(1.5+0.5 marks)**

4. (a) Give an example of a real world problem that can be modeled using graphs. Mention one graph algorithm that is useful in this context. **(0.5+0.5 marks)**
   (b) Describe two data structures that can be used to represent graphs. Compare their advantages and disadvantages. **(3 * 1.0 marks)**

5. (a) Draw an AVL tree with minimum 8 internal nodes, which are clearly marked by their key values. **(1 mark)**
   (b) Illustrate, with an example, insertion into a (2, 4) tree that causes an overflow and its handling. **(2 marks)**
   (c) Explain the concept of amortized analysis of algorithms. Give an example of an algorithm where amortized analysis gives better results than worst-case analysis. Your answer should state the results of both methods, but need not prove them. **(1+1 marks)**

6. (a) Trace Boyer-Moore algorithm for the text "aaabaadaabaaa" and the pattern "aabaaa". **(2 marks)**
   (b) Draw the compact representation of the suffix trie for the string "malayalam". **(1 mark)**
   (c) Draw the frequency table and Huffman tree for the following string:
   "dogs do not spot hot pots or cats".
   What are the binary codes for the characters 'd' and 'h'?
   (0.5+2.0+0.5 marks)

7. Explain the significance of NP-Completeness. State very briefly and clearly the two steps required to show that a problem is NP-complete. Prove that a problem of your choice is NP-Complete. **(1.0+1.0+2.0 marks)**

8. If $S = \{a_i \mid i = 1, .., n\}$ is a sequence of distinct numbers, then a sequence $T = \{a_{ik} \mid k = 1, .., m\}$, where $1 \leq i1 < i2 < \ldots < im \leq n$ is a subsequence of S of length m. This subsequence is monotone increasing if $a_{i1} < a_{i2} < \ldots < a_{im}$.
   (a) What is the longest monotone subsequence of
   {5, 10, 1, 2, 9, 4, 7, 3, 11, 8, 14, 6}?
   (b) Is the longest monotone subsequence of a sequence of distinct numbers unique? Prove your answer.
   (c) Design an algorithm to find the longest monotone subsequence of a sequence of distinct numbers.
   (d) Find the worst-case run time complexity of the algorithm you designed in part (c). **(0.5+0.5+3.0+1.0 marks)**

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TEST II Question Paper

Course No: CSUC341
Date: 20th Nov 2005
Course Title: Data Structures and Algorithms
Time: 8.00 to 8.50
Total Marks: 20

Open Book / Notes

(Answer ALL questions)
(All questions carry EQUAL marks)

1. Draw the 11-item hash table resulting from hashing the keys 12, 44, 13, 88, 23, 94, 11, 39, 20, 16, and 5 using the hash function h(i) = (2i+5) mod 11 and assuming collisions are handled by linear probing.

2. Insert items with the following keys (in the given order) into an initially empty binary search tree: 30, 40, 24, 58, 48, 26, 11, 13. Draw the tree after each insertion.

3. Let S = {a, b, c, d, e, f, g} be a collection of objects with benefit-weight values as follows: a:(12, 4), b:(10, 6), c:(8, 5), d:(11, 7), e:(14, 3), f:(7, 1), g:(9, 6). What is an optimal solution to the fractional knapsack problem for S assuming we have a sack that could hold objects with total weight of 18? Show the detailed steps.

4. What is the best way to multiply a chain of matrices with dimensions that are 10x5, 5x2, 2x20, 20x12, 12x4, and 4x60? Show the detailed steps.

5. Suppose we represent a graph G having n vertices and m edges with the edge list structure. Why, in this case, does insertVertex() method run in O(1) time while the removeVertex() method runs in O(m) time?

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TEST I Question Paper

Course No: CS UC341
Date: 2nd Oct 2005

Course Title: Data Structures and Algorithms
Total Marks: 20

Data Provided and complete. Closed book.

(Answer ALL questions)
(All questions carry EQUAL marks)

1. Give a big-Oh characterisation, in terms of n, of the running time of the loop method given below.

```
Algorithm Loop(n):
  s ← 0
  for i ← 1 to n do
    p ← 1
    for j ← 1 to i do
      p ← p*j
    s ← s+p
```

2. What is the minimum number of external nodes for a binary tree with height h? Justify your answer.

3. Describe, using pseudo-code, implementation of the following method for the list ADT, assuming the list is implemented by using a doubly linked list with header and trailor nodes.

   insertBefore(p, e)

4. Show that the best-case running time of quick-sort on a sequence of size n with distinct elements is O(nlogn).

5. Write algorithms in pseudo-code for **push** and **pop** operations on a stack that is implemented by a singly linked linear list having a header node.

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