

香港中文大學
The Chinese University of Hong Kong

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Course Examinations 2012-2013 (2nd term)

Course Code & Title : CSCI2100-D Data Structures

Time allowed : 2 hours 0 minutes

Student I.D. No. : Seat No. :

The questions ask for explanations. The explanations should be concise descriptions of your understanding.

Greater marks will be awarded for answers that are simple, short and concrete than for answers of a sketchy and rambling nature. Marks will be lost for giving information that is irrelevant to a question.

Question 1 [14 marks] Abstract Data Type (ADT)

- (a) What is a data structure and what is a data type? [4 marks]
- (b) What is an ADT and what are the two separations for an ADT? [4 marks]
- (c) Why are the two separations in ADTs so important? Justify your answer. [6 marks]

Question 2 [16 marks] Performance Analysis

- (a) Give a precise definition of the Big-Oh notion $g(n) = O(f(n))$. [4 marks]
- (b) Explain the main concerns behind the Big-Oh notation in brief. [4 marks]
- (c) Let $g(n) = n^2 + 7 \times n - 3$ be a function defined for a positive integer n . Following the Big-Oh notation,
 - Show that the Big-Oh of $g(n)$ is not $O(n)$.
 - Show that $g(n) = O(n^2)$. What are the two constant values used for this Big-Oh?[8 marks]

Question 3 [15 marks] Priority Queue

Maintain a priority queue using a max heap. Create such an empty priority queue, and insert (enqueue) nodes in order whose keys are the integers 4, 9, 11, 5, 7, 15, 16, and 18. Draw the priority queue as a binary tree after each insertion. Then, draw the priority queue as a binary tree after a dequeue operation has been applied to this priority queue.

Question 4 [10 marks] Hash Tables

Consider a hash table, ht , with $b = 11$ buckets where each bucket is with one slot. Insert all integers 10, 20, 8, 11, 19, 22, 30, and 14 into the hash table h using a hash function $h(k) = k \% 11$, and handle overflows using the linear probing. Draw the hash table after each insertion using the linear probe function. What is the problem with the linear probing?

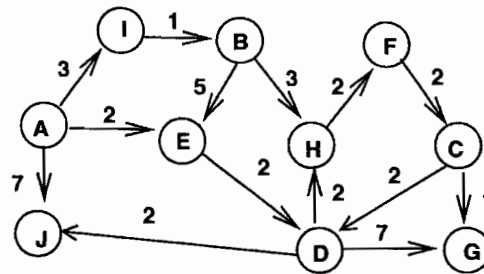


Figure 1: A weighted directed graph.

Question 5 [45 marks] Graph

- (a) Consider the weighted directed graph shown in Figure 1, and consider computing the single source all shortest paths.
- Explain the main ideas behind Dijkstra's algorithm in brief. [5 marks]
 - Show how Dijkstra's algorithm works step by step from the single source node A to all others for the graph shown in Figure 1. [20 marks]
 - Show the shortest paths from the node A to all other nodes based on your answer of (ii). [5 marks]

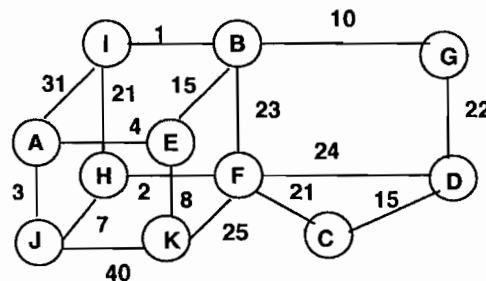


Figure 2: A weighted undirected graph.

- (b) Show step-by-step how a minimum cost spanning tree is computed for the undirected graph as depicted in Figure 2 using the Kruskal's algorithm. [15 marks]

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