Semester Two of Academic Year (2014---2015) of BJUT

《Data Structures and Algorithms 2》 Resit Exam Paper

Exam Instructions： **Answer any TWO questions**

Honesty Pledge：

I have read and clearly understand the Examination Rules of Beijing University of Technology and am aware of the Punishment for Violating the Rules of Beijing University of Technology. I hereby promise to abide by the relevant rules and regulations by not giving or receiving any help during the exam. If caught violating the rules, I would accept the punishment thereof.

Pledger： _____ **Class No:** _____________

BJUT Student ID： _____ **UCD Student ID:** ___________

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Notes：
The exam paper has 3 parts on 5 pages, with a full score of 100 points. You are required to use the given scratch paper attached only.

Total Score of the Exam Paper（For teachers' use only）

Item	Q1	Q2	Q3		**Total Score**
Full Score	50	50	50		
Obtained Score					

Obtained score

Question 1:

(a) Briefly explain the differences between a *tree*, a *binary tree*, a *proper binary tree* and a *binary search tree*.

(5 marks)

(b) Explain how you would implement a *link-based binary tree*. In your answer, describe the internal structure of a node, identify what key data you must keep track of, and illustrate your description with a diagram of an example tree that contains three nodes.

(9 marks)

(c) One application of a binary search tree is a *heap*. Heaps make use of two key properties: the *order property* and the *structural completeness property*. Define each of these properties.

(4 marks)

(d) Draw the heap that would be obtained after the following operations. Show the state of the heap after each operation.

insert(12), insert(5), insert(7), insert(14), remove(), insert(17), remove(), remove(), insert(26), remove()

(10 marks)

(e) Draw the binary search tree that would be obtained after the following items have been inserted in the given order. Show the state of the tree after each insertion.

2, 27, 14, 1, 16, 21, 9, 11, 18, 20

(10 marks)

(f) The Boyer-Moore algorithm is a well-known pattern matching algorithm.

i) What are the two heuristics that underpin the design of the Boyer-Moore algorithm?

ii) Give the pseudo code for this algorithm.

iii) Show how it would find the pattern “rithm” in the text “a pattern matching algorithm”.

(12 marks)

(50 marks total)

Obtained score

Question 2:

(a) What is an *AVL Tree*? Explain any properties that an *AVL tree* must satisfy.

(4 marks)

(b) Explain the reasons why you might use an AVL Tree instead of a Binary Search Tree.

(4 marks)

(c) What is *tri-node restructuring*? Describe each possible restructuring. Include a diagram illustrating the restructuring for each scenario.

(10 marks)

(d) Describe in detail how a value is inserted into a Splay Tree. Include in your answer a discussion of how the tree is restructured. Illustrate your answer by constructing the Splay Tree that is generated by the performing each of the following operations:

insert(4), insert(6), find(4), insert(8), remove(6), insert(6), insert(5)

(18 marks)

(e) Merge Sort and Quick Sort are examples of sorting algorithms that are based upon an algorithmic design pattern called *divide-and-conquer*. Describe this design pattern, and use it to outline the main steps involved in both the Merge Sort and Quick Sort algorithms.

(14 marks)

(50 marks total)

Obtained score

Question 3:

(a) An *adjacency list structure* is one way in which a graph can be implemented. For each of the following graph methods, state what the time complexity performance is when using an adjacency list. Explain the reasons for this complexity in each case.

i) incidentEdges(v)
ii) areAdjacent(v,w)
iii) insertEdge(v, w, o)
iv) removeVertex(v)

(8 marks)

(b) In graph theory, explain what is meant by a *path* and a *cycle*. Explain how they are different.

(4 marks)

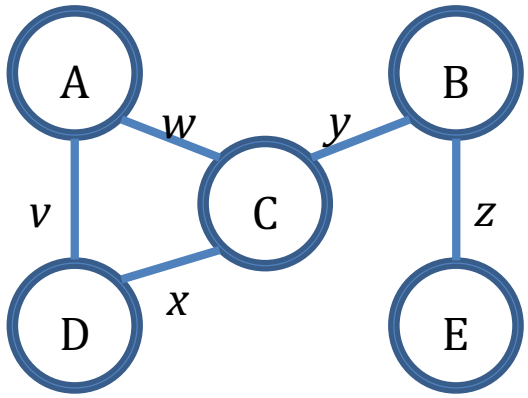
(c) Give definitions of the following graph concepts: *undirected graph*, *adjacent vertices*, *forest* and *degree of a vertex*.

(8 marks)

(d) Describe in detail how an *edge list structure* can be used to represent a graph. For each object type and data structure, explain its purpose and what data it stores.

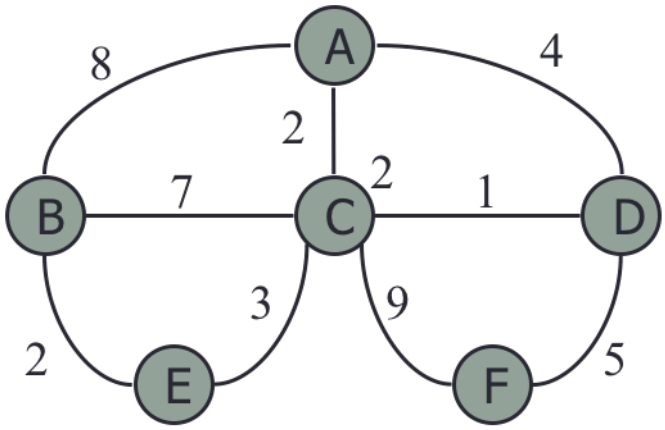
(8 marks)

(e) Draw a diagram to show how the following graph can be represented using an edge list structure.



(7 marks)

(f) Give psuedo code for the *Dijkstra's Shortest Path* graph algorithm. Using the graph below, show how a shortest path tree can be created, starting at vertex F.



(15 marks)

(50 marks total)