國立清華大學資訊系統與應用研究所博士班資格考－資料結構

1. (7%) Assume that you have a data file consisting of 100 million records on a computer with an internal memory capable of sorting at most one million records. How would you sort the data? Please describe your algorithm in detail.

2. (12%)

(a) Please define binary search trees. (3%)

(b) Please write the pseudo code of each of the following three functions for a binary search tree: search, insertion, and deletion. (9%)

3. (14%)

(a) How would you efficiently find the shortest paths from a vertex to all other vertices in a directed graph with nonnegative edge lengths? (7%)

(b) If some of the edges of the directed graph have negative length, how would you solve the problem of finding the shortest path? Assume that the length of any cycle in the graph is nonnegative. Please describe the data structures and algorithms in detail. (7%)

4. (10%)

(a) After the following statements execute, what are the contents of the *dequeue*? (5%)

```
DequeInterface myDeque = new LinkedDeque();
myDeque.addToFront("James");
myDeque.addToFront("Jessica");
myDeque.addToBack("John");
myDeque.addToBack("Janet");
String name = myDeque.removeFront();
myDeque.addToBack(name);
myDeque.addToBack(myDeque.getFront());
myDeque.addToFront(myDeque.removeBack());
myDeque.addToFront(myDeque.getBack());
```

(b) After the following statements execute, what are the contents of the *queue*? (5%)

```
QueueInterface myQueue = new LinkedQueue();
myQueue.enqueue("Janet");
myQueue.enqueue("Jessica");
myQueue.enqueue("John");
```

```
myQueue.enqueue(myQueue.dequeue());
myQueue.enqueue(myQueue.getFront());
myQueue.enqueue("James");
String name = myQueue.dequeue();
myQueue.enqueue(myQueue.getFront());
```

5. (14%)

(a) Briefly state the advantages and disadvantages of an array-based implementation of the ADT stack as compared to a linked implementation. (6%)

(b) Imagine a linked implementation of the ADT stack that places the top of the stack at the end of a chain of linked nodes. Please describe how you can define the stack operations *push* and *pop* so that they do not traverse the chain. (8%)

6. (10%) Let A and B be two lower triangular matrices, each with n rows. The total number of elements in the lower triangles is $n(n+1)$. Devise a scheme to represent both the triangles in an array C(1:n, 1:n+1). Please write algorithms to determine the values of $A(i,j)$, $B(i,j)$ $1 \le i, j \le n$ from the array C.

7. (13%)

(a) What is a heap? Please define it. (5%)

(b) Let B[1..16] be an array that represents a heap, what is the minimal number of heap elements that can occupy an array of size 16? (8%)

8. (20%) The Tower of Hanoi problem is as follows: We are given a tower of $\boldsymbol{n}$ disks, initially stacked in increasing size on the first peg. We have three pegs. The objective is to transfer the entire tower to the third peg, moving only one disk at a time and never put a larger one onto a smaller one.

(a) Please write a recursive algorithm in pseudo code to solve the Tower of Hanoi problem. (10%)

(b) Assume that you have 4 pegs, you need to move the entire tower from the first peg to the fourth peg . Please design a recursive algorithm in pseudo code to solve the Tower of Hanoi problem with four pegs. The total moving steps in your algorithm must be as small as possible. (10%)