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COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2

Friday 9 November 2012 (morning)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- A clean copy of the **Computer Science** *case study* is required for this paper.
- The maximum mark for this examination paper is *[100 marks]*.

*Answer **all** the questions.*

1. A geologist uses a computer program to keep track of the various rock samples that she
    has collected. The program has a `Sample` class and creates a new `Sample` object for
    each rock sample.

    ```
    public class Sample
    {
      int sampleNumber;
      String rockType;
      String placeCollected;
      double sampleWeight;//Weight of sample in kilograms

      Sample nextSample;
      ...
    }
    ```

    To allow the geologist to rapidly identify a sample of a particular rock type,
    the program uses a simple hash table to store all the sample objects. The hash function
    is a method named `rockHash()` that produces a key value in the range 0 to 127 based
    on the sample's `rockType`.

    ```
    public int rockHash(String rockType)
    {
      ...
    }
    ```

    The key value can then be used as an index to retrieve a `Sample` object from
    `allSamples`, an array of 128 `Sample` objects.

    (a) Define the term *collision*.   *[1 mark]*

    (b) Explain why `sampleWeight` has type **double**.   *[2 marks]*

    To deal with collisions, objects in the `Sample` class have been designed to allow them
    to be arranged into linked lists.

    (c) Identify the element of the `Sample` class that allows `Sample` objects to be made
         into a linked list.   *[1 mark]*

    (This question continues on the following page)

(Question 1 continued)

Each element of the `allSamples` array can be treated as the head of a linked list of `Sample` objects having the same key value. The elements of the array are initialized to **null**.

(d)   Construct the method, `insertSample(Sample rockSample)` that uses the `rockHash()` method and then adds the sample at the beginning of the appropriate linked list in `allSamples`.   *[6 marks]*

(e)   Construct the method, `findBigSample(String rockType)` that returns the sample number of the heaviest sample having the specified rock type.   *[7 marks]*

(f)   Outline how all the samples collected from a particular place could be output.   *[3 marks]*

2. Within a tree, a leaf node is one that has no child nodes.
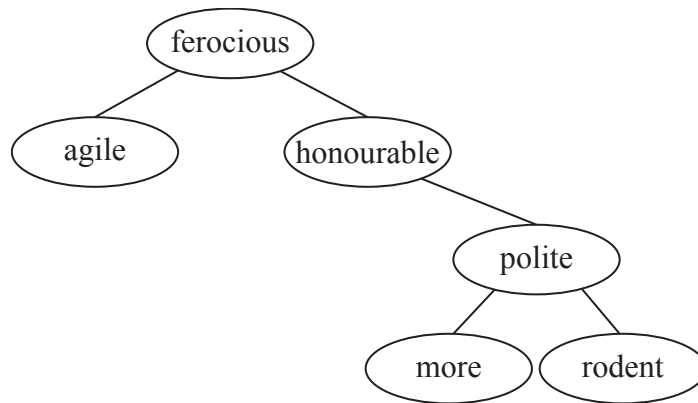
(a) State the number of leaf nodes in the tree shown above.   *[1 mark]*

(b) State the word contained in the right child of the node containing the word "honourable".   *[1 mark]*

(c) Identify the left subtree and the right subtree of the node "honourable".   *[3 marks]*

(d) State the words in the order that they would be retrieved using *pre-order* traversal.   *[1 mark]*

(e) State the type of tree traversal that would retrieve the words in alphabetical order.   *[1 mark]*

(This question continues on the following page)

(Question 2 continued)

All of the words from a large dictionary are stored in a binary tree. The tree is constructed from objects of the `WordNode` class.

```
public class WordNode
{
  String word;
  WordNode leftChild;
  WordNode rightChild;

  WordNode(String theWord)
  {
    word = theWord;
    leftChild = null;
    rightChild = null;
  }

  int countLeaves()
  {
    // lines of code missing
  }
}
```

The method `countLeaves(WordNode w)` returns the number of leaf nodes in the subtree, for example, in the diagram above, if node `w` has no child nodes `countLeaves(w)` will return `1`.

(f)   State the condition to test if `WordNode w` is a leaf node.   *[1 mark]*

(g)   Construct the method `countLeaves()` using recursion.   *[6 marks]*

(h)   Identify **two** disadvantages of using recursion to implement `countLeaves()`.   *[2 marks]*

(i)   Outline **two** ways that the tree could be modified to allow access to the definition of the word.   *[4 marks]*

3. The inventory of spare parts on a large ship is stored on the ship's computer as a single sequential master file. Each type of part has a unique ID number.

Type of Part	Quantity	Re-order Level	Maximum Quantity
322	23	10	30
411	4	8	20

(a) Identify the key field in the record. *[1 mark]*

Each record contains the quantity of spares onboard the ship for that type of part. Inventory changes are recorded by different members of the ships personnel, each of whom has a small, handheld device. Once a day the changes, which are stored in transaction files, are downloaded to the ship's computer and used to update the master file.

(b) State the type of processing used to update the master file. *[1 mark]*

(c) State how the records in the master file should be ordered. *[1 mark]*

(d) Describe the process by which the master file can be updated when the changes recorded in the handheld devices are downloaded. *[4 marks]*

A wireless network is installed so that the handheld devices can communicate continuously with the ship's computer.

(e) Explain how handshaking is involved in this process. *[3 marks]*

(f) Identify **two** data items that need to be sent each time parts are taken from the inventory. *[2 marks]*

(g) Explain how the introduction of the wireless network, together with a reorganization of the master file, can keep the inventory current rather than only being updated once per day. *[4 marks]*

When the ship reaches port a list of all the parts that need restocking is generated. Parts need to be restocked if the Quantity is less than the Re-order Level. A sufficient number of parts should be purchased to bring the Quantity up to the Maximum Quantity.

(h) Outline the processing that would take place to produce the list of parts to be purchased, including the quantities to purchase. *[4 marks]*

4. *This question requires the use of the case study.*

    (a)   State **two** differences between Wi-Fi and WiMAX. *[2 marks]*

    (b)   State **two** differences between Wi-Fi and Bluetooth. *[2 marks]*

    (c)   Explain **two** reasons why a mobile phone designer might choose to provide a keyboard instead of a touch screen. *[4 marks]*

    (d)   Explain **two** ways in which using a mobile phone to link an ambulance to a hospital could compromise the privacy of a patient. *[4 marks]*

    (e)   Outline **two** ways in which data interception can occur when using a mobile device. *[4 marks]*

    (f)   Outline **two** advantages of not restricting the development of apps to the manufacturers of mobile devices. *[3 marks]*

    (g)   Describe how social engineering is used to persuade mobile device users to reveal personal information. *[4 marks]*

Many employers are providing their employees with mobile devices so that they can be connected to their work 24/7.

    (h)   Discuss the effects of this on the employee. *[6 marks]*

All 4G networks use IP packet-switching for all services.

    (i)   Describe the purpose and structure of a data packet. *[3 marks]*

    (j)   Compare the transfer of data in a 4G cellular network to that of a wired Internet connection. *[4 marks]*

    (k)   Explain how the demands of the mobile phone user create challenges that the designers of smartphone operating systems must resolve. *[4 marks]*

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