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COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2

Friday 15 November 2013 (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 program is written to help farm management. The following class is used to create objects representing fields in a farm.

```
public class FarmField
{
  String fieldName;     // Unique name for the field
  int fieldSize;        // Size of the field in square metres
  int soilType;         // A value indicating soil acidity
  int fertilizerType;   // A value indicating the type of fertilizer
  int cropType;         // Crop type: 1=Corn, 2=Soybeans, 3=Alfalfa, etc.
}
```

(a) (i) Construct an empty `FarmField` object named `firstField`.   *[1 mark]*

     (ii) Construct the statements that will assign values of a 12,000 square metre field named "Back forty" to the `firstField` object.   *[2 marks]*

The class `Farm` is used to store the information for each farm.

Each `Farm` object contains:
* the name of the farmer
* an ID number for the farm
* the number of fields in that farm
* an array of `FarmField` objects called `theFields`.

(b) Construct the class `Farm`.   *[3 marks]*

The data for a number of farms is stored in the array `allFarms[]`. The array contains more elements than there are `Farm` objects. The first part of the array contains `Farm` objects and the remainder of the array contains `null` elements.

(c) Construct the method `findLargest` that will return the size of the largest field from all of the farms that have data stored in the array. It has been started below.

```
int findLargest(Farm[] allFarms)
{
        …
}
```
    [6 marks]

(d) Describe, with the help of diagrams, how a new `Farm` object can be inserted at the beginning of the array `allFarms[]`.   *[4 marks]*

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(Question 1 continued)

The `FarmPasture` class is used to create objects representing fields in which animals are kept.

```
public class FarmPasture
{
  String fieldName;      // Unique name for the field
  int fieldSize;         // Size of the field in square metres
  int animalType;        // Animal type: 1=Cow, 2=Sheep, 3=Hog, etc.
  int animalNumber;      // The number of animals in the pasture
}
```

(e) Suggest, with the use of code, how inheritance could be used to avoid duplication of common elements between the `FarmField` and `FarmPasture` classes. *[4 marks]*

2. A large collection of names is stored in a binary search tree of `NameNode` objects.

```
public class NameNode
{
    public String name;
    public NameNode leftChild;
    public NameNode rightChild;

    public NameNode(String newName)
    {
        name = newName;
        leftChild = null;
        rightChild = null;
    }
}
```

(a)   Explain why, in the above class, the variable `leftChild` is of type `NameNode`.   *[2 marks]*

The binary search tree is an instance of the `Tree` class.

```
public class Tree
{
    public NameNode treeRoot;

    public Tree()
    {
        treeRoot = null;
    }

    void addNode(NameNode newNode)
    {
        ... // Adds a node to a tree
    }

    boolean findName(String givenName)
    {
        ...
    }

    void displayNames(NameNode root)
    {
        ...
    }
}
```

(b)   Outline the result of executing the following code.

```
Tree myTree = new Tree();
myTree.addNode(new NameNode("Charley"));
```
[2 marks]

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(Question 2 continued)

Further nodes are added to the tree.

(c)   In parts (i) and (ii) below, you can assume that the corresponding method was passed the variable `searchName`.

      (i)   Outline the steps required to delete the appropriate node if the node containing `searchName` was found to be a leaf node.   *[4 marks]*

      (ii)   Explain how the process becomes more complex if the node to be deleted has a single child (which is a leaf node).   *[2 marks]*

(d)   Construct the method `findName()` that will return **true** if `givenName` is already in the tree `myTree` and **false** otherwise.   *[4 marks]*

(e)   Construct the recursive method `displayNames()` that outputs in alphabetical order the list of names stored in an instance of the `Tree` class.   *[6 marks]*

3. A team of marine biologists is tracking the movements of a large number of whales. Each whale has a device attached to it that transmits the whale's identifier number and location every time it surfaces after a dive. A computer in a research lab receives all of these location reports.

The lab computer also maintains a direct access master file that includes a record for each whale being tracked. These records contain:

- an identifier number for the whale
- the number of dives the whale has made
- the last recorded location of the whale
- the total distance the whale has travelled
- the date and time of the last location report.

(a) Identify the key field of the master file. *[1 mark]*

(b) (i) Suggest how the direct access master file should be organized, including any conditions that should be placed on the key field. *[3 marks]*

   (ii) Describe the processing that would take place to allow a particular record to be accessed. *[3 marks]*

Each time a whale surfaces, its device sends the whale's identifier number and current location.

(c) Outline how the appropriate record in the master file will be updated each time a location report is received. *[5 marks]*

As each location report is received it is added to an archive file. Over a period of time, this archive file will contain far more data than could be loaded into the lab computer's memory.

(d) Describe how the archive file could be sorted by the lab computer. *[4 marks]*

(e) Discuss any ethical issues that should be considered before deciding whether to release this information into the public domain. *[4 marks]*

This question requires the use of the Case Study.

4. (a) Outline **two** precautions that a mobile device user can take to prevent their data from being compromised if they lose their mobile device. *[4 marks]*

(b) Outline **two** reasons why a phone designer might choose to integrate a solar power panel into a mobile device. *[4 marks]*

(c) Identify **three** reasons why many Bluetooth devices can operate in the same office building without interfering with one another. *[3 marks]*

(d) Compare the use of Ethernet with Bluetooth for data communication in smartphones. *[3 marks]*

Many mobile phones now have GPS integrated into them so that the user's location can be sent to data services.

(e) Discuss the advantages and disadvantages of letting a mobile device transmit the user's location. *[6 marks]*

(f) Smartphones contain several different kinds of memory.

(i) State the type of memory in which applications ("apps") would be stored when the mobile device is powered off. *[1 mark]*

(ii) Describe the function of cache memory. *[3 marks]*

(g) The use of smartphone devices and apps has the potential to affect the health of mobile phone users.

(i) Outline **two** ways in which this use can help mobile phone users to be healthy. *[4 marks]*

(ii) Outline **one** way in which this use can harm the health of mobile phone users. *[2 marks]*

(h) Explain **two** consequences of the change of protocols for 4G phones. *[4 marks]*

(i) Discuss the effects that the widespread ownership of smartphones is having on students. *[6 marks]*