Computer Science HL P2

2007 May

School Level 12th IB Diploma Programme

Board Exam

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IBO

IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2

Wednesday 9 May 2007 (morning)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.

*Answer **all** the questions.*

1. Consider the following array of positive real numbers (type double):

element:	[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]
contents	3.9	2.3	6.5	2.2	5.8	-1.0	-	-

The values in elements 6 and 7 are undefined, the value in element 5 is not a data value but is an end-of-data marker or *sentinel* value and must be present.

(a) State the number of data values that can be stored in this array.   *[1 mark]*

The following algorithm attempts to add a value to the end of this array:

```
public void append(double[] n, double d)
{
    int x = 0;
    while (n[x] != -1.0)
    {
        x = x + 1;
    }
    n[x] = d;
    n[x+1] = -1.0;
}
```

(b) Outline a problem that could occur with this algorithm.   *[2 marks]*

(c) Construct an algorithm to return the position of the smallest data value in this array, you may assume there is at least 1 valid value in the array.   *[6 marks]*

The array could be used to represent a *stack* with element zero always containing the *top value* in the stack.

(d) Draw the array as it would appear when it represents an empty stack.   *[2 marks]*

One of the operations that can be carried out on a stack is a *pop* operation.

(e) Construct the algorithm that pops a value from the stack. This algorithm may return the value -1.0 if the stack is empty but the end-of-data marker should never be removed from the array.   *[4 marks]*

(f) State the *BigO efficiency* of a pop operation on the given data structure.   *[1 mark]*

Another operation that can be carried out is a push operation. The push and pop algorithms on this data structure are not as efficient as they might be.

(g) Discuss how this array could be used in an alternate, more efficient, way to represent a stack.   *[4 marks]*

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2. The following code represents a Class that can be used to create a linked list:

```
public class ListNode
{
  private char ch;
  private ListNode next;

  public ListNode()
  {
    // initialize data members to null
    ch = 0;
    next = null;
  }
  public ListNode(char c, ListNode n)
  {
    setCh(c);
    setNext(n);
  }
  public void setCh( char c ) { ch = c; }
  public char getCh() { return ch; }
  public void setNext( ListNode n ) { next = n; }
  public ListNode getNext() { return next; }
}
```

(a) Explain the concept of a constructor using the above code as an example.   *[3 marks]*

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(Question 2 continued)

The following method adds items to a *linked list* and calls a method to display the list after a '*' character is input.

```
public void addItem ()
{
  char ch;
  ListNode root = null;
  do
  {
    ch = inputChar("Char to add: ");
    ListNode list = new ListNode(ch, null);
    list.setNext(root);
    root = list;
  } while (ch != '*');
  display(root);
}
```

If the character sequence a b c d * is input:

(b)   Draw and clearly label a diagram of the resulting list.   *[5 marks]*

The following method displays the list.

```
public void display(ListNode r)
{
if (r != null)
{
display(r.getNext());
output(r.getCh());
}
```

(c)   State the output produced by the call to display(root) in the last line of the addItem() method in part (a).   *[2 marks]*

(d)   Construct the algorithm which creates a String representing the characters in the list without the '*' character. Use **either** of the following *method signatures*:   *[6 marks]*

      public String theWord(ListNode r, String word)

      Or

      public String theWord2(ListNode r)

      Given the input a, b, c, d *, the string "abcd" should be returned.

(e)   Outline the changes to the ListNode Class which would be required to implement a *doubly-linked list*.   *[4 marks]*

3. Consider the following diagram of a file and an index, each entry is unique:

INDEX

[0]	anh	0
[1]	ben	6
[2]	chan	9
[3]	danh	14
	...	
[N]	...	

FILE

[0]	anh
[1]	anz
[2]	ast
[3]	att
[4]	axt
[5]	azt
[6]	ben
[7]	bun
[8]	byn
[9]	chan
[10]	chen
[11]	chun
	...
	...
	...
[N]	...

(a) State the type of *file organization* being used. *[1 mark]*

(b) Outline how the record for chun would be retrieved using this system. *[4 marks]*

(c) Explain the changes required to the following, if the record adz is added to the data file.

    (i) the file *[3 marks]*

    (ii) the index *[3 marks]*

(d) Outline a change in the file which would make inserting records faster. *[2 marks]*

(e) Assuming the data file is read into an array, retaining its sorted order, describe the steps required to search for a specific record efficiently without using the index. *[5 marks]*

The data file is re-located to a tape storage system.

(f) Explain why the above indexing system can no longer be used. *[2 marks]*

4. *This question requires the use of the Case Study.*

A computer laboratory has been specifically equipped for use by visually impaired students.

(a) Outline how an electronic reading aid will enable these students to access printed
notes handed out on paper by teachers.   *[3 marks]*

(b) Apart from an electronic reading aid, describe how another hardware feature of this laboratory
could allow better access to information for students with

    (i)   limited sight   *[2 marks]*

    (ii)   no sight.   *[2 marks]*

The company that designed the laboratory used a *prototyping approach* when designing the user
interfaces for these computers.

(c) Outline how this approach would involve the intended users.   *[3 marks]*

(d) Outline how the following users could reliably enter text into a computer system:

    (i)   A person who is unable to see.   *[2 marks]*

    (ii)   A person who is unable to use their hands to enter text.   *[2 marks]*

A student is designing a stock control system for a small shop. The system is designed to read
barcodes from products. When a barcode is successfully scanned, the system issues a beep.

(e) Compare **two** different ways in which the student could collect information at
the analysis stage from one of the staff who is hearing impaired.   *[6 marks]*

(f) Explain how the system might need to be modified for the hearing impaired.   *[2 marks]*

(g) For the following prototypes, outline how each one could be used by operators with a range of
disabilities.

    (i)   A series of screen drawings showing the user interface.   *[2 marks]*

    (ii)   A programmed prototype (eg Java, Visual Basic) which uses a normal
keyboard.   *[2 marks]*

    (iii) A programmed prototype which uses physical switches to operate the *user
interfaces*.   *[2 marks]*

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(Question 4 continued)

(h)   Outline **three** ways in which *voice recognition systems* can assist disabled computer users.   *[6 marks]*

An engineer is developing a voice-activated system for control of a wheelchair.

(i)   Describe **three** situations or environments which the engineer should include when testing the system.   *[6 marks]*