

Please fill in your Student Number and Name.

Student Number : _____

Name:

Student Number:

University of Cape Town ~ Department of Computer Science
Computer Science 1016S / 1011H ~ 2009
January Exam

Question	Max	Internal	External	Question	Max	Internal	External	
1	4			7	10			
2	4			8	10			
3	10			9	20			
4	2			10	20			
5	8							
6	12							
					TOTAL	100		

Marks : 100
Time : 180 minutes
Instructions:

- a) Answer all questions.
- b) Write your answers in pen in the spaces provided.
- c) Show all calculations where applicable.

Question 1 [4]

Write the recursive function **evaluate** that returns the n^{th} number in the following sequence:

3 4 7 11 18 29 47 ...

The first two numbers of this sequence – $F_0=3$ and $F_1=4$ - are given.

In general,

$$F_{i+2}=F_i + F_{i+1}$$

(This is very similar to the Fibonacci sequence.)

[4]

Note: No recursion means no marks.

```
public int calculate(int n)
{
    if (n==0)    [1]
        return 3;
    if (n==1)    [1]
        return 4;
    return (evaluate(n-1)+evaluate(n-2)); [2]
}
```

Question 2 [4]

Examine the following Java application. It uses a Binary search algorithm to find the position of a key in an array.

```
public class Exam2Demo {  
  
    public static void main ( String [] args ) {  
        int [] a = {2, 6, 8, 19, 21, 30, 38};  
        int result, no=25;  
        System.out.println ("First Last Middle");  
        result = search (a, 0, 6, no);  
        if (result >= 0)  
            System.out.println (no+" in element "+result);  
        else  
            System.out.println (no+" not found");  
    }  
  
    public static int search( int[]a, int first, int last, int item)  
    {  
        int result = 0;  
        if (first > last)  
        {  
            System.out.println (first+" "+last);  
            result = -1;  
        }  
        else  
        {  
            int centre = (first + last)/2;  
            System.out.println (first+" "+last +" "+ centre);  
            if (item == a[centre])  
                result = centre;  
            else if (item < a[centre])  
                result=search(a, first, centre-1, item);  
            else if (item > a[centre])  
                result=search(a, centre+1, last, item);  
        }  
        return result;  
    }  
}
```

a) What is the output from this program?

[4]

First Last Middle

0 6 3

4 6 5

4 4 4

5 4

25 not found

Question 3 [10]

You are given the Java program below:

```
import java.util.Scanner;
public class Test
{
    public static void main (String args[])
    {
        Scanner keyboard = new Scanner(System.in);

        int[] x = {20,30,50,60,10,70,31,53,62,25}; // 10 integer values

        System.out.print("Pick an integer from 1 to 10: ");
        int guess = keyboard.nextInt();
        int box_number = guess - 1;
        System.out.println("You have won R" + x[box_number] + "!");
    }
}
```

a) In this program, the following 2 errors could easily occur:

A float rather than an integer could be input; or

A “guess” greater than 10 could be input.

Show how exceptions can be used to indicate these errors by adding appropriate code into the program. [3]

```
try {
    System.out.print("Pick a box from 1 to 10: ");
    int guess = keyboard.nextInt();
    int box_number = guess - 1;
    System.out.println("You have won R" + x[box_number] + "!");
}
catch (InputMismatchException e) {
    System.out.println("That was not an integer!");
}
catch (ArrayIndexOutOfBoundsException e) {
    System.out.println("The integer must be between 1 and 10");
}
catch (Exception e) {
    System.out.println(e.getMessage());
}
```

b) Assume that the 10 integer values are stored in a file called “data.dat”, instead of being specified within the program.

Complete the following Java program that reads these values into the **x[]** array from the file. [7]

```
import java.util.Scanner;
import java.io.*;

public class Test
```

```

{
    public static void main (String args[])
    {
        Scanner keyboard = new Scanner(System.in);

        int [] x = new int[10];

try {
    Scanner fin = new Scanner (new FileInputStream ("data.dat"));
    int i = 0;
    while (fin.hasNextInt ())
    {
        x[i++] = fin.nextInt();
    }
    fin.close ();
} catch (FileNotFoundException e) {
    // some error message
};

    System.out.print("Pick an integer from 1 to 10: ");
    int guess = keyboard.nextInt ();
    int box_number = guess - 1;
    System.out.println("You have won R" + x[box_number] + "!");
}
}

```

Question 4 [2]

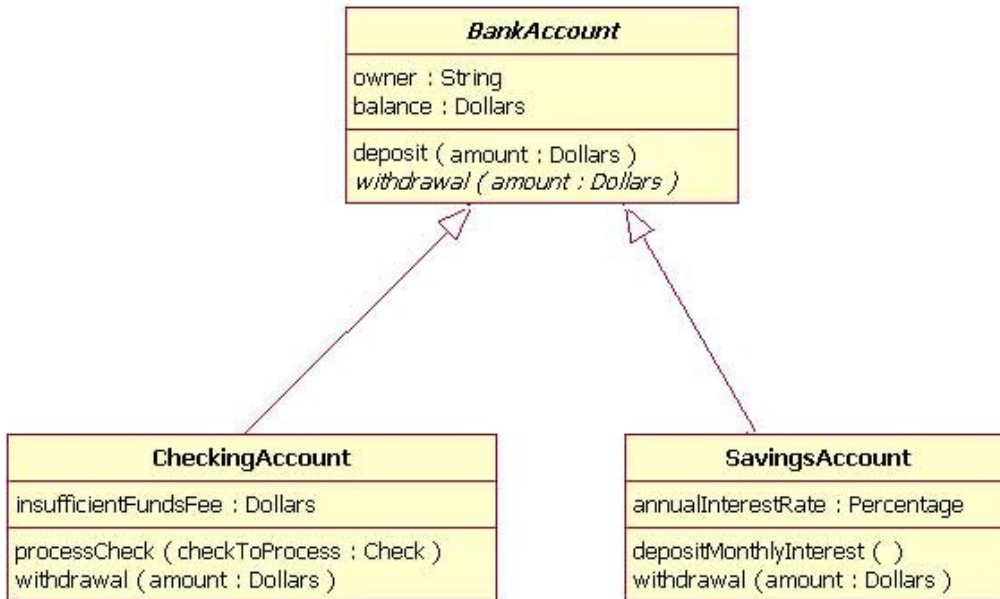
Describe 2 advantages of using binary files instead of text files.

[2]

Faster, file usually smaller

Question 5 [12]

Use the following UML diagram to answer the questions that follow.



- a) What principle of OOP design is illustrated in the inter-class relationships? What are the exact relationships among each set of related classes? [2]

It is inheritance/generalization

BankAccount is a super class; CheckingAccount and SavingsAccount are derived classes from BankAccount

- b) Which of the classes are abstract and which are concrete? How can you determine this from the UML? [2]

Italics is abstract therefore BankAccount is an abstract class. Both CheckingAccount and SavingsAccount are concrete classes

- c) Explain the differences among the withdrawal methods in the three classes. Provide a code example to illustrate the benefit of this way of coding. [4]

Withdrawal in BankAccount is abstract, it has only heading definition without body implementation. Withdrawal in CheckingAccount and SavingsAccount provide code implementation.

This is not for code re-usage but polymorphism. Without defining the abstract method, we cannot access the method which will be defined in the subclasses.

For example in the above diagram, without abstract method withdrawal(), we cannot declare

BankAccount account;

account = new CheckingAccount(); //this assignment is done later

account.withdrawal(100);

d) In the following sequence of statements that appears in a method in an unrelated class, indicate which statements will result in a compile-time error. [4]

1. `BankAccount ba = new BankAccount();`
2. `BankAccount ba = new CheckAccount();`
3. `CheckingAccount ca = new BankAccount();`
4. `CheckingAccount ca = new SavingAccount();`
5. `CheckingAccount ca = new CheckingAccount();`
6. `BankAccount ba = new SavingAccount();`
7. `ba.withdrawal(100);`
8. `ba.depositMonthlyInterest();`
9. `ba.deposit(200);`

10. BankAccount ba = new BankAccount(); F

11. BankAccount ba = new CheckAccount(); T

12. CheckingAccount ca = new BankAccount(); F

13. CheckingAccount ca = new SavingAccount(); F

14. CheckingAccount ca = new CheckingAccount(); T

15. BankAccount ba = new SavingAccount();

16. ba.withdrawal(100); T

17. ba.depositMonthlyInterest(); F

18. ba.deposit(200); T

Question 6 [8]

Use the following program to answer the questions that follow.

```
1 public class ASorter {
2     public void sort(double[] a, int begin, int end) {
3         if ((end - begin) >= 1) {
4             int splitPoint = split(a, begin, end);
5             sort(a, begin, splitPoint);
6             sort(a, splitPoint + 1, end);
7             join(a, begin, splitPoint, end);
8         }
9     }
10
11     protected int split(double[] a, int begin, int end)
12     {
13         double[] temp;
14         int size = (end - begin + 1);
15         temp = new double[size];
16
17         double splitValue = a[begin];
18         int up = 0;
19         int down = size - 1;
20
21         for (int i = begin + 1; i <= end; i++)
22         {
23             if (a[i] <= splitValue)
24             {
25                 temp[up] = a[i];
26                 up++;
27             }
28             else
29             {
30                 temp[down] = a[i];
31                 down--;
32             }
33         }
34
35         temp[up] = a[begin];
36
37         for (int i = 0; i < size; i++)
38             a[begin + i] = temp[i];
39
40         return (begin + up);
41     }
42
43     protected void join(double[] a, int begin, int splitPoint,
44                         int end)
45     {
46         //Nothing to do.
47     }
```

a) What is the name of this sorting algorithm? [2]

Quick sort

b) What is the complexity of the sort ? [2]

$O(N \cdot \log N)$

- c) How would you change the above program so that it can sort an array of objects of a class that implements the Comparable interface? (Indicate precisely which lines of code need to be changed and how) [4]

```
1 public class ASorter {
2     public void sort(Comparable[] a, int begin, int end) {
3         if ((end - begin) >= 1) {
4             int splitPoint = split(a, begin, end);
5             sort(a, begin, splitPoint);
6             sort(a, splitPoint + 1, end);
7             join(a, begin, splitPoint, end);
8         }
9     }
10
11     protected int split(Comparable[] a, int begin, int end)
12     {
13         Comparable[] temp;
14         int size = (end - begin + 1);
15         temp = new Comparable[size];
16
17         double splitValue = a[begin];
18         int up = 0;
19         int down = size - 1;
20
21         for (int i = begin + 1; i <= end; i++)
22             {
23                 if (a[i].compareTo(splitValue) <= 0)
24                     {
25                         temp[up] = a[i];
26                         up++;
27                     }
28                 else
29                     {
30                         temp[down] = a[i];
31                         down--;
32                     }
33             }
34
35         temp[up] = a[begin];
36
37         for (int i = 0; i < size; i++)
38             a[begin + i] = temp[i];
39
40         return (begin + up);
41     }
42
43     protected void join(Comparable[] a, int begin, int splitPoint,
```

```
        int end)  
44 {  
45     //Nothing to do.  
46 }  
47 }
```

Question 7 [10]

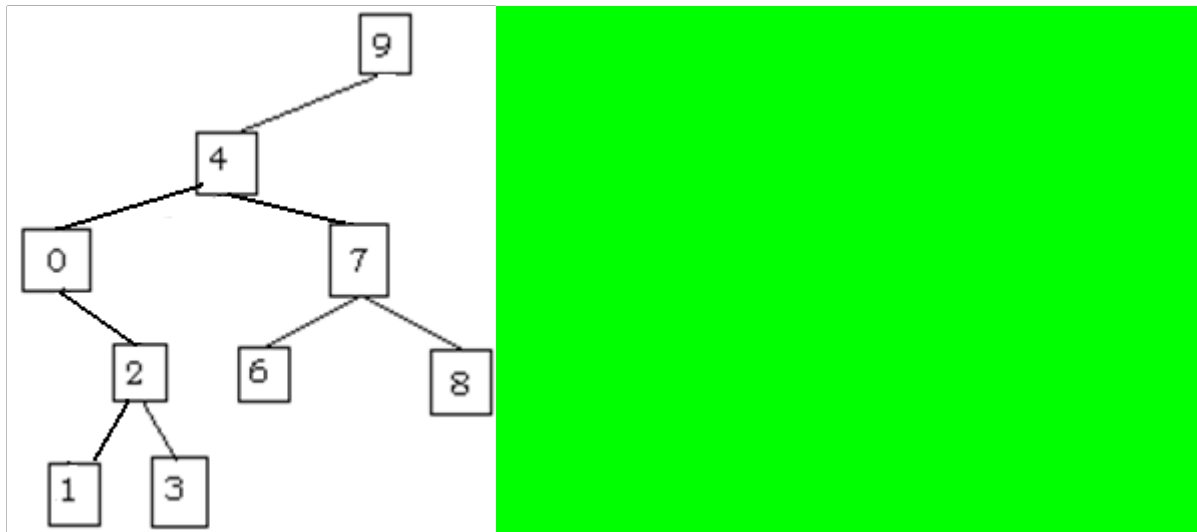
- a) State the binary search tree storage rule. [2]

*All the values in the left subtree must be less than the value in the root node
All the values in the right subtree must be greater than or equal to the value in the root node*

- b) Build a binary search tree for the following data:

{9 4 0 2 7 1 6 3 8}

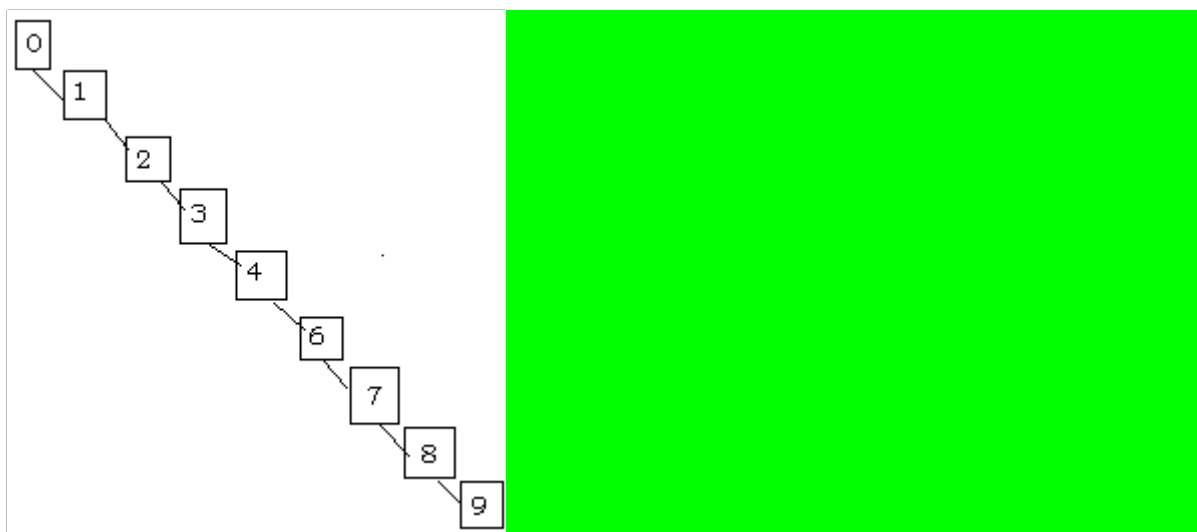
[3]



- c) Build a binary search tree for the following data:

{0 1 2 3 4 6 7 8 9}

[3]



- d) Is there a difference in the search efficiency of the two trees? Why or why not? [2]

Yes there is. We take at most 3 steps to find an item in the first tree and in the second tree we can take up to 7 steps because the data came in sorted and the tree is not balanced.

Question 8 [10]

Use the code below to answer this question.

```
import javax.swing.*;
import java.awt.*;
import java.awt.event.*;

public class Buttons extends JFrame implements ActionListener
{
    public static final int WIDTH = 300;
    public static final int HEIGHT = 200;
    private JButton[] buttons = new JButton[12];

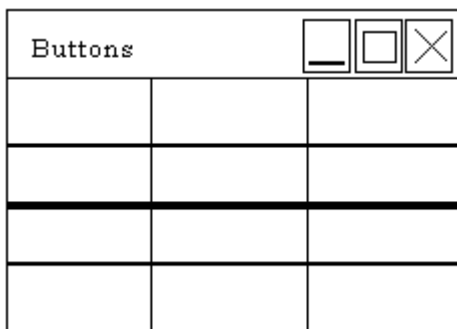
    public static void main(String[] args)
    {
        Buttons gui = new Buttons( );
        gui.setVisible(true);
    }

    public Buttons( )
    {
        super("Buttons");
        setSize(WIDTH, HEIGHT);
        setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        setLayout(new GridLayout(4, 3));
        setResizable(false);
        for (int i=0; i<12; i++)
        {
            buttons[i] = new JButton();
            buttons[i].setActionCommand(Integer.toString(i));
            buttons[i].addActionListener(this);
            add(buttons[i]);
        }
    }

    public void actionPerformed(ActionEvent e)
    {
        JButton button = (JButton)e.getSource( ); // See question (b)
        button.setBackground(Color.PINK);
        button.setText("Button " + e.getActionCommand());
        button.setForeground(Color.WHITE);
    }
}
```

a) Draw the GUI that is displayed when the program is run.

[3]



b) What does the the first line in the **actionPerformed** method do? [2]

The getSource method returns a reference to the object that fired the event. This reference is saved in the variable button so that it can be used several times.

c) Draw the GUI again, showing what happens when all the buttons have been clicked and describe what you cannot draw, e.g. colours. [5]

Buttons			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Button 0	Button 1	Button 2			
Button 3	Button 4	Button 5			
Button 6	Button 7	Button 8			
Button 9	Button 10	Button 11			

It becomes pink with white text appearing on it. The text is "Button N" where N is the index of the button in the array.

Question 9 [20]

- a) How is ethics related to morality? [1]

Ethics is the philosophical study of morality. [1]

- b) What would be one possible drawback or problem with using the ethical philosophy of “ubuntu” as a basis for computer ethics? [2]

ubuntu is based on transparency and communal interest in each other. Thus there is a (potential) conflict with notions of privacy

- c) Consider the following passage from “Little Brother” by Cory Doctorow (p 11):

“The answer is something ingenious called TOR The Onion Router. An onion router is an Internet site that takes requests for webpages and passes them onto other onion routers, and on to other onion routers, until one of them finally decides to fetch the page and pass it back through the layers of the onion until it reaches you. The traffic to the onion routers is encrypted, which means that the school can't see what you're asking for, and the layers of the onion don't know who they're working for. There are millions of nodes the program was set up by the US Office of Naval Research to help their people get around the censor ware in countries like Syria and China, ...”

Why would anyone want to use a service like TOR? Please consider the needs of the user as well as the way in which the technology (for example, routers, encryption) works together to provide it. [5]

People want to avoid having their online browsing activities tracked, because they are fearful of being found out (e.g., for political reasons) [2] The frequent re-routing makes it impossible to find which website they are going to [2] and the encryption makes it impossible to see what information they are getting or sending [2]. (max 5).

- d) Professor Peter Sommer from the London School of Economics, says he changed his mind about the sort of technology that allows people anonymity and he is no longer in favour of it because: “really nasty people, who were using precisely the same sort of technology in order to conceal their activities”.

Are you in favour of technologies that enable online anonymity (that is, the ability to hide who they are)? Discuss arguments in favour and against and come to a conclusion. [8]

This is completely open ended! Introducing their own position and providing a good conclusion [2]. The arguments for [3] and against [3]. (but with some flexibility so that a really good argument on one side or the other can get 4).

- e) What is the Digital Divide? Explain fully. [4]

The term Digital Divide refers to the major disparities in the penetration of the Information Society in the developing world [1]. Digital Divide is the growing gap that exists between

those who have access to the Information Society and those who are deprived of such access [1] due to cultural bias in the applications and contents, gaps in their education (for example, illiteracy), personal handicap, poor digital infrastructure, or lack of appropriate computer equipment [2 for some of these]

Question 8 [20]

Multimedia Sharing Kiosks

Information kiosks are desktop computers placed in secure locations for members of the public to access various forms of information.

You have been hired as a consultant to develop additional software for existing kiosks to allow users to swap multimedia files such as images, movies and audio clips.

The multimedia files will be stored on the disk in sequentially numbered files. A description of each file will then be stored in a listing file (named "listing.txt"), with the following format:

```
1.jpg image 2009-10-01 picture of UCT buildings
3.avi movie 2008-06-21 students writing exams
4.avi movie 2009-04-02 more students writing exams
2.mp3 audio 2009-05-10 sounds of despair
```

The first field is the filename; the second field is one of {image, movie, audio}; the third field is the date; and the rest of the line is the title for the file.

- a) Write a Java method to read the contents of this listing file into a singly linked list of objects of type `Entry` (without using the built-in methods for linked lists). Assume that there is a `head` instance variable, already initialised to null. [5]

```
class Entry
{
    public String filename;
    public String type;
    public String date;
    public String title;
    public Entry next;
}

try {
    fileIn = new Scanner (new FileInputStream("listing.txt"));
    while (fileIn.hasNext ())
    {
        Entry e = new Entry ();
        e.filename = fileIn.next();
        e.type = fileIn.next();
        e.date = fileIn.next();
        e.title = fileIn.nextLine();
        e.next = head;
        head = e;
    }
    fileIn.close ();
```

- a) Users will want to browse through the list of files that are available, by sorting the list on any of the 4 fields. Describe how you would adapt a standard sorting algorithm implementation to

cater for sorting by one of the specified fields. How does the time complexity for this new algorithm compare to the fixed field sorting algorithm? [5]

Note: Do NOT write code – simply describe the changes you would make.

*use a comparing method that takes a second parameter to indicate the field.
within the comparing method, use an if-ladder to determine which fields to compare.
in the sorting method, pass the field to be sorted on to the comparing method.
irrespective of algorithm used, this modification should result in the same time complexity as the original sorting algorithm.*

b) Sketch a user interface for your application and explain how a user will interact with this application. [5]

any reasonable interface with sorting/scrolling buttons and space to display a listing and view and/or download the files.

c) Discuss 2 major professional issues that arise in designing this application. [5]

*Copyright: files may not be publicly sharable because of licensing rules
Privacy: multimedia may be of a personal nature
Legalities: files could contain content that is illegal by the governing law
etc.*