0. Name (2 pts):

CS 2334: Programming Structures and Abstractions

Final Exam

Solution Set

Monday, December 13, 2010

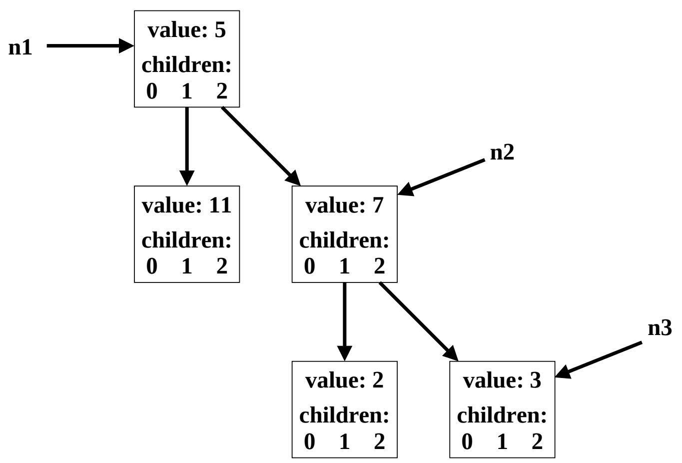
Problem	Topic	Max	Grade
0	Name	2	
1	Recursion	40	
2	Ethics	25	
3	Exceptions and Assertions	30	
4	Inheritance and Polymorphism	30	
5	Generic Programming and Generics	15	
6	Graphical User Interfaces and Event-Driven Programming	40	
7	Collections Framework	20	
Total		200	

1. **Recursion** (40 pts)

Consider the following class definition:

```
public class Node {
  private int value;
  private Node[] children = new Node[3];

  public Node(int value) {
    this.value = value;
  };

  public void addChild(Node c, int i) {
    if(i >= 0 && i < children.length){
      children[i] = c;
    };
  };

  public int baz() {
    int current = 0;
    boolean flag = false;

    for(int i = 0; i < children.length; ++i) {
      if(children[i] != null) {
        if(flag) {
          current = Math.min(current, children[i].baz());
        }else{
          current = children[i].baz();
          flag = true;
        }
      }
    }
    return(current + value);
  };
```

Assume that the following tree has already been constructed using the constructor and the **addChild()** methods, and that **n1, n2,** and **n3** are variables containing references to the indicated nodes. You may also assume that when arrows are not shown for children, their value is **null**.



(a) (5 pts) What is the value returned by **n3.baz()**?

3

(b) (10 pts) What is the value returned by **n2.baz()** ?

$7+2 = 9$

(c) (10 pts) What is the value returned by **n1.baz()**?

$2+5+7=14$

(d) (5 pts) **baz()** is a recursive method, what is(are) the base case(s)?

There are no children: return the value of the node.

(e) (5 pts) What is(are) the recursive case(s)?

There is at least one child: return the value of the node + the minimum baz over the children.

(f) (5 pts) In one sentence: what is the meaning of the integer that **baz()** returns?

The method returns the minimum sum from the current node to the leaf nodes (or the base case nodes).

2. **Ethics in Computer Science** (25 pts)

(a) (15 pts) *Build-A-Bear Workshop* is a chain of stores located in many malls. Customers move through a series of stations in which they select a "skin" for a stuffed animal (called a *friend*), have a heart inserted, have the stuffing inserted, select clothing, and finally create a "birth certificate" for the friend. Creating the certificate involves sitting down at a computer terminal clearly designed for young children: the keyboard and screen are at a very low height and have a "cute" aesthetic. At this interface, the customer enters a variety of information, including: friend name, and customer name, birth date, home address and email address. Briefly describe **three** ethical principles/ideas that *should* be brought to "bear" in the design of this computer system.

i. Privacy: these data could be used for many things, including targeted advertising, and, when combined with other data, the theft of identity. This idea comes from a variety of sources, including the ACM code of ethics, *natural rights*, and the privacy protections in the US constitution.
ii. Security: because of the sensitivity of these data, we as designers are compelled to properly safeguard the data. ACM code of ethics.
iii. Opacity: it is important that it be made clear to the customers how these data will be used. ACM code of ethics; natural rights (do not deceive)
iv. Opacity: the design of the workstations is clearly aimed at having the children perform this step. They are not necessarily able to make appropriate judgments about protecting their privacy or that of their parents. (in the US, children are not legally able to enter into contracts, it is reasonable to assume that this extends into the release of private data). ACM code of ethics; natural rights (do not deceive)

A few notes about what BaB actually does:

i. At adult viewing height, a small sign is visible that explains that entering any information is optional.
ii. The BaB website (which is not posted in the store) does state a privacy policy. On this policy, it does include the statements "We do NOT share your information with unrelated third parties for their marketing purposes" (good) and "We use personal information consistent with the purpose you provided it to us" (grammatically incorrect and rather broad).

(b) (10 pts) Bob works for company Bazfoo as a software architect. In order to meet an impending software release deadline, Bob is considering the use of the OpenStreetMap package, which is licensed under a *Creative Commons* license. What factors should Bob consider in deciding whether he should move forward with this plan?

The Creative Commons license has several different options. The answer depends on what these options are, specifically. In particular:

- Is commercial use allowed?
- Share a-like: would his own code (presumably the property of Bazfoo) be subject to the Creative Commons license?

Also - an important issue that Bob must take into account is Bazfoo's position on this type of license. It could very well be legal for him to use the package, but Bazfoo's policies may prevent it.

3. Exceptions and Assertions (30 pts)

Consider the following code in which Exception1 and Exception2 are checked exceptions:

```java
public class exceptionTest
{
    static public void methodA() throws Exception2 { ...   // Do some stuff
    };

    static public void methodB() throws Exception1 { ...   // Do some other stuff
    };

    static public void bar() throws Exception1, Exception2{
        try {
            System.out.println("A");
            methodB();
            System.out.println("B");
        }catch(Exception1 e){
            System.out.println("C");
            throw e;
        }finally{
            System.out.println("D");
        };
        System.out.println("E");
    }

    static public void main(String[] args) {
        try {
            try {
                System.out.println("F");
                bar();
                methodA();
                System.out.println("G");
            }catch(Exception2 e){
                System.out.println("H");
            };
        }catch(Exception1 e){
            System.out.println("I");
        };
        System.out.println("J");
    };
}
```

(a) (10 pts) Suppose that methodB() throws Exception1 during execution. What output does this program produce and does the program terminate with or without an error? (assume that output is only produced by the println() calls that you see)

F
A
C
D
I
J
(program terminates normally)

(b) (10 pts) Suppose that methodA() throws Exception2 during execution. What output does this program produce and does the program terminate with or without an error?

F
A
B
D
E
H
J
(program terminates normally)

(c) (10 pts) True or False and briefly explain: Assertions can be addressed in code using try/catch statements.

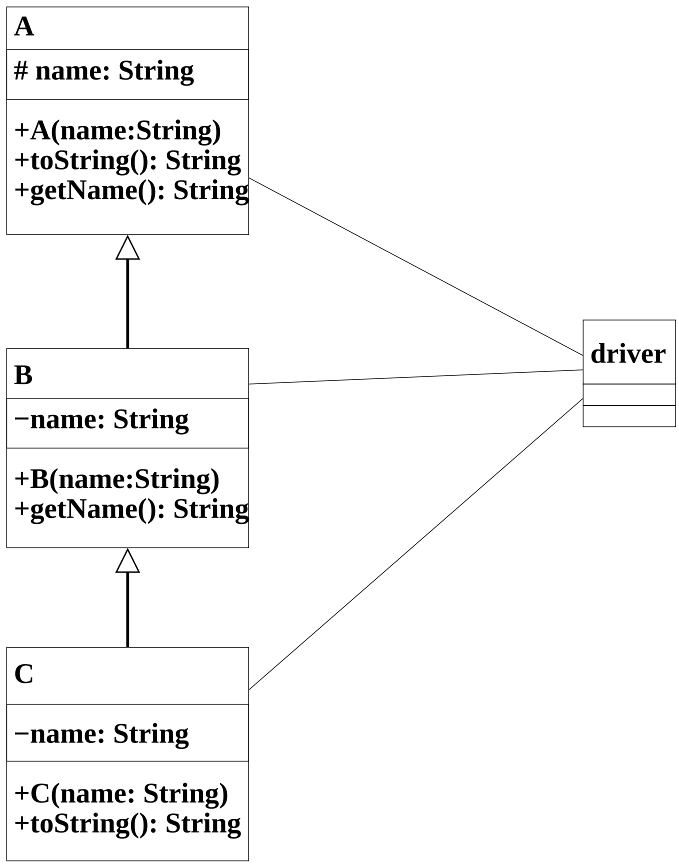
False. Catch statements can only address Exceptions or subclasses of Exception.

4. **Inheritance and Polymorphism** (30 pts)

Consider the following implementation:

```
public class A
{
    protected String name;

    public A(String name){
      this.name = name;
    }

    public String toString(){
      return("A: " + getName());
    };

    public String getName() {
      return name;
    };
}

public class B extends A
{
    private String name;

    public B(String name) {
      super("SUPER-B");
      this.name = name;
    }

    public String getName() {
      return "Name: " + name;
    };
}

public class C extends B
{
    private String name;

    public C(String name){
      super("SUPER-C");
      this.name = name;
    };

    public String toString() {
      return "C: " + super.toString();
    };
};

public class driver
{
    public static void main(String args[]) {
      A[] objects = new A[4];

      objects[0] = new A("foo");
      objects[1] = new B("bar");
      objects[2] = new C("baz");

      for(int i = 0; i < objects.length; ++i) {
        System.out.println(objects[i]);
      };
    };
};
```

(a) (15 pts) Draw the corresponding UML diagram.



(b) (15 pts) What output does this program produce?

A: foo
A: Name: bar
C: A: Name: SUPER-C
null

5. **Generic Programming and Generics** (15 pts)

(15 pts) Assume that classes A, B, and C are the same as from the previous question. Explain whether each of the three **display()** method calls will compile or not.

```
public class genericTest
{
    public static <E1, E2 extends E1> void display(E1 c1, E2 c2){
      System.out.println(c1 + " * " + c2);
    };

    public static void main(String[] args) {
      A a = new A("foo");
      B b = new B("bar");
      C c = new C("baz");

      display(a, b);        // Does it compile?




      display(c, b);        // Does it compile?




      display(b, b);        // Does it compile?

    };
}
```

The definition of **display()** requires that c2 be a subclass of c1.

The first one will compile because all B's are A's.

The second one will **not** compile because all B's are not C's.

The third one will compile because all B's are B's.

6. **Graphical User Interfaces and Event-Driven Programming** (40 pts)

(a) (10 pts) True or False and briefly explain: the getPreferredSize() method of a JPanel requires information from its associated layout manager.

True. In order for the JPanel to compute its preferred size, it must first know what the layout is of the sub-components and what their preferred sizes are.

(b) (10 pts) Suppose you were to implement your own class, MyButton, that extends JButton. Briefly describe the conditions under which you would provide an implementation of paintComponent() and the types of method calls that you would make inside of this method.

If we wanted our button to have a look that was different than what JButton provides, we would provide our own implementation. Within this implementation, we could make calls to methods provided by the Graphics class, such as drawRect() or drawOval().

(c) (10 pts) Suppose we wish to implement a program that shows an **EyeFrame**, a class that extends JFrame. A pair of eyes are painted in one corner of this frame. The eyes will: 1) blink at regular intervals and 2) appear to follow the location of the cursor. Suppose that EyeFrame has two properties: eyesOpen (boolean) and eyeOrientation (a set of doubles that indicate which direction each eye is looking). What two event source classes will be used to implement this functionality?

i. An instance of the Timer class will be used to create the events for the blinking.
ii. The EyeFrame class will be used to create the events to track the cursor.

(d) (10 pts) At least three methods are required to implement this functionality. What are their names, what do they do and to which classes do they belong? Hint: the method names and signatures are already determined for you.

i. EyeFrame.paintComponent(): will use the EyeFrame properties to render the current state of the eyes by calling the necessary methods in the Graphics class.
ii. (anonymous)ActionListener.ActionPerformed(): change the state of the eyesOpen property and call repaint().

iii. (anonymous)MouseMotionListener.mouseMoved(): update the eye positions based on the cursor position and then call repaint().

7. **Java Collections Framework** (20 pts)

Consider the following code:

```
import java.util.*;

public class driver2 {

    public static void displayMap(Map m) {
      System.out.println("#");
      for(Object o: m.keySet()) {
        System.out.println(o + ": " + m.get(o));
      };
    };

    public static void addMaps(Map<Integer, String> m_i_s,
                               Map<String, Integer> m_s_i,
                               Integer i,
                               String s) {
      m_i_s.put(i, s);
      m_s_i.put(s, i);
    };

    public static void main(String[] args) {
      Map<Integer, String> m_i_s = new TreeMap<Integer, String>();
      Map<String, Integer> m_s_i = new TreeMap<String, Integer>();

      addMaps(m_i_s, m_s_i, 1138, "THX");
      addMaps(m_i_s, m_s_i, 3417, "LUH");
      addMaps(m_i_s, m_s_i, 1042, "THX");
      addMaps(m_i_s, m_s_i, 5241, "SEN");

      displayMap(m_i_s);

      displayMap(m_s_i);
    };
}
```

(20 pts) What output does the program produce?

```
#
1042: THX
1138: THX
3417: LUH
5241: SEN
#
LUH: 3417
SEN: 5241
THX: 1042
```

Note: the map keys form a proper set. A put of a duplicate key results in the existing value being replaced with the new value.