Instituto Superior Técnico

Programação Avançada – 2008/2009

First Exam – 27/6/2009

Número: _____

Nome: _____

Write your number on every page. Your answers should not be longer than the available space. You can use the other side of the page for drafts. The exam has **6** pages and the duration is **2.0 hours**. The grade for each question is written in parenthesis. Good luck.

1. (2.0) Consider the concepts of **Computational System** and **Computational Meta-System**.

   (a) (1.0) Define **Computational System**. What is the relation between a program and a computational system?

   (b) (1.0) Define **Computational Meta-System**. Provide **three** examples of computational meta-systems.

2. (2.0) Distinguish between **introspection** and **intercession** and provide one example for each of them.

3. (1.0) **Self-modification** is a extremely powerful capability that is provided by certain programming languages. However, this capability also causes certain problems. Discuss two of those problems.

4. (3.0) We plan to implement an interconnection mechanism for Java that allows a program written in a different language to crate Java object, obtain references to those objects in its own address space and use those references to make Java method calls with the corresponding objects, obtaining the results of those calls (that might be references to other Java objects).

   Describe a possible implementation of this interconnection mechanism. It is not necessary to provide code examples but do provide all the relevant information that allows another programmer do implement it.

5. (3.0) Consider the implementation of a computational *undo* mechanism for Java programs. This mechanism allows, at any moment of the execution of a Java program, to undo a given number of updates that were done in the fields of the objects created by the program.

   This mechanism is invoked from a static method that has, as parameter, the number of updates that we want to undo and these updates are undone in reverse chronologial order, i.e., the last update done is the first to be undone.

   Suggest an intercession mechanism based on Javassist that implements this undo. It is not necessary to exhaustively describe the implementation of your mechanism but do provide all the relevant information that allows another programmer to implement it.

6. (1.0) Explain the following concepts of the CLOS language: generic function, method, primary method, auxiliary method, applicable method and effective method.

7. (2.0) What is a cross-cutting concern? What are the problems caused by cross-cutting concerns? Explain.

8. (3.0) Consider the following aspect:

```
aspect ShapeListening {
    private Vector<Screen> Shape.listeners = new Vector<Screen>();

    public void Shape.addListener(Screen sc) {
        listeners.add(sc);
    }

    pointcut changeShape(Shape s):
      call(void Shape+.set*(..)) && target(s);

    after(Shape sh): changeShape(sh) {
        for(Screen sc : sh.listeners) {
            sc.redraw(sh);
        }
    }
}
```

(a) (2.0) AspectJ is an extension of Java for aspect-oriented programming and it uses a series of new concepts, such as *join point*, *pointcut*, *advice*, *inter-type declaration* e *aspect*. Explain these concepts and point them (using arrows and circles) in the above example.

(b) (1.0) Describe, in plain language, the effects of the presented aspect.

9. (3.0) A meta-circular evaluator allows the experimentation of different semantics for programming languages.

   (a) (1.0) What is a meta-circular evaluator? Explain.

   (b) (1.0) The presence of higher-order functions in a dinamically scoped language can cause two serious problems, one when a function is passed as an argument and another when a function is returned as a result. Which problems are these and under which conditions do they occur? Explain.

   (c) (1.0) What is a macro? What is its purpose?