CS3723 Homework #13, Due: 9AM, 12/1/10

C++ (Chapter 12)

1. C++ allows more control of memory allocation than most other Object-Oriented languages. Suppose class A is defined as follows:  
   ```cpp
   class A { int x; public: A(int _x) {x = _x;};
   ```  
   (a) What statement/declaration would you use in C++ to create a stack-allocated (local) variable o that contains an object of class A.  
   (b) How might a pointer to that object become a dangling pointer?  
   (c) What statement/declaration would you use in C++ to create a pointer variable p that refers to a dynamically allocated object of class A.  
   (d) How might a pointer to that object become a dangling pointer?  

2. Do exercise 12.1 from Mitchell.  

3. C++ allows a class's member functions to be optionally declared as virtual.  
   (a) Which of the four object-oriented concepts is provided by 'virtual functions' in C++?  
   (b) What is the effect of not marking a member function as virtual?  
   (c) What is the name of data structure used to facilitate calls to virtual functions?  
   (d) Describe how a virtual function call is carried out in C++?  
   (e) How would you compare this to messages in SmallTalk? What is the asymptotic complexity in terms of the height of the class hierarchy (i.e., the longest chain of classes that inherit from other classes)?  
   (f) What differences in design goals of C++ and SmallTalk do you think lead to these differences in mechanisms? Why?  

4. Unlike Java or C#, C++ allows multiple inheritance.  
   (a) What are some of the problems with multiple-inheritance?  
   (b) How does C++ solve the problem with name clashes?  
   (c) What are virtual base classes?  
   (d) How does C++ represent classes with diamond inheritance if virtual base classes are not used?  

Java (Chapter 12)

5. Mitchell discusses several goals that shaped the design of the Java language.  
   (a) List seven design goals for the Java programming language.  
   (b) How do these goals and their priority in the design of Java compare to those for C++? (Which of these goals were not high-priority goals for C++? Which of these goals are of a lower priority for Java than for C++? Which goals for C++ are not goals for Java?)  
   (c) How do these goals and their priority compare to those of SmallTalk?  

6. Why was Java designed to use a virtual machine? (What benefits does this provide?)  

7. Early implementations of the Java Virtual Machine relied on interpretation (as described on the text book). Modern implementations of Java also use just-in-time compilation (especially for methods that are called many time and methods containing loops that repeat many times). What design goal of Java does just-in-time compilation further?  

8. There are two ways to create a subtyping relationship in Java.
(a) What are they? (Mention specific Java keywords.)

(b) How do these two mechanisms vary with respect to code reuse?

(c) Which of these can be used to subtype a class?

(d) Which of these can be used to subtype an interface?

9. There are four different bytecode operations for invoking a method. They along with their implementation in old JVM's is described in Mitchell.

(a) What are they?

(b) Explain what three of the four are used for?

(c) Describe the steps involved in invokevirtual (assume it has been rewritten to use an offset in what Mitchell calls the “mtable”)?

10. The Java Virtual Machine platform supports dynamic loading.

(a) What is the role of the ClassLoader in dynamic loading in the JVM platform?

(b) Rewrite these steps in their correct order:

- the class is prepared,
- the class is initialized,
- the virtual machine verifies the class file (type-safety),
- the loading of a class is requested by name,
- an instance of the class can be created and
- the class file for the class is found by the class loader and submitted to the virtual machine,

(c) Why does the virtual machine specification allow lazy resolution of symbolic names?

Note: If you collaborated with your classmates or used their notes, please note which classmates you collaborated with. If you use an external source, besides the text book, lectures, notes provided by the instructor, and your own intellect, please cite that source. Use quote marks if you are quoting material word-for-word from any source (including the text book).