Engr 5895 Software Design — Final Exam

T. S. Norvell (c) 2015

2015 April 8. 13:00–16:00.

Instructions: Answer all questions. Write your answers in the space provided. Request a yellow booklet if more space is required or you simply want paper to doodle on. This is an **closed** book test: Textbooks, notes, calculators, cell phones, and other whatnots must not be used. However, paper inter-language dictionaries are permitted. Cell phones shall not ring during the exam.

Total points: 106

Duration: 180 minutes

Name:

Student #:

A belated happy birthday to the IBM 701. Introduced to the public, 1953 April 7.

Q0 [10] Draw a UML class diagram corresponding to the following description of entities in the real-world. Show attributes and operations. Show navigability and multiplicities.

The Sharemobile automobile sharing agency runs a service that allows its members to use cars for periods of time. Each member has a membership number, address, and credit card number. Members may request a car for a given time period; a request consists of a start time, an end time, a start location, an end location, and a set of acceptable sizes. Car sizes are small, mid-size, SUV, and minivan. Each car has a schedule which, for each point in time, indicates whether the car is rented, between rentals, available, or out of service. When a car is rented, it is rented to one member. When a car is between rentals or available, it is associated with a particular location.

Q1 [16] The Composite pattern
(a) [4] Explain the circumstances when it is most appropriate to use the Composite pattern.

(b) [4] Use a class diagram to illustrate the Composite pattern

(c) [4] Use a sequence diagram to illustrate the Composite pattern

(d) [4] Given an example of the Composite pattern.

Q2 [12] Liskov Substitution Principle
(a) [6] Explain what is meant by the Liskov Substitution Principle (LSP).

(b) [6] Give an example that illustrates the LSP.

Q3 [6] Consider the following Java class, instances of which I intend to use to mediate communication between two or more threads. One thread repeatedly calls send; the other repeatedly calls get. The intention is that a number of messages can be passed from the sender to the receiver.

```java
public class BlockingSend {
    // State 0: no message. State 1: message sent, not received. State 2: message received.
    private int state = 0;
    private String message ;
    // invariant 0 <= state && state < 2

    public synchronized void send( String m ) {
        while( state != 0 ) pause() ;
        message = m ; state = 1 ;
        while( state != 2 ) pause() ;
        state = 0 ;}

    public synchronized String get( ) {
        while( state != 1 ) pause() ;
        String m = messsage ;
        state = 2 ;
        return message ; }

    private void pause() { // Wait a while
        for( int i=0 ; i < 1000000 ; ++i ) { } }
}
```

(a)[1] Is there a problem with this class?

(b)[3] Explain why or why not.

(c)[2] If there is a problem, how would you fix it?

Q4 [12] Consider the following declarations .
public class X { **public** X() { ... } **public void** f(X p) { ... } ... }
public class Y **extends** X { **public** Y() { ... } **public void** g(Y q) { ... } ... }
... X x ; Y y ;

Say whether each of the following statements has a compile-time error or not. In each case explain the error or why there is no error.

(a)[2] y = x ;

(b)[2] x = y ;

(c)[2] x = **new** Y() ;

(d)[2] y = **new** X() ;

(e)[2] y.f(y) ;

(f)[2] x.g(y) ;

Q5 [10]

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class A {

    private B b = **new** B( ) ;
    void f() { b.g(**this**) ;}
    void h() { ... }
    void i() { ... }

}
class B() {

    void g(A x) { ... x.h() ; x.i() ; ... }

}

Give a sequence diagram for the following code.

A a = **new** A() ;
a.f() ;

Be sure to indicate each method invocation (execution) with a box.

Q6 [30]

The Universal Browser (UniBrow) has the following characteristics. It provides a tabbed interface. Each tab contains an editor or viewer for a different 'document'. A document might be an html page, a document in any of a number of XML formats (e.g., DocBook or OpenMath), a directory of the file system, a word processing document, a spreadsheet, a diagram, and so on. Documents might be stored locally or remotely. Furthermore some document types will allow embedding of other documents within them, for example a diagram might be embedded within a word processing document and conversely. As you might expect, extensibility is an important consideration. Portability between OSs is also important, but largely solved by the choice of the JRE as the platform.

The menus of the system and other aspects of the UI need to adapt to the document type currently being edited or viewed.

Using English prose, UML, Java, and/or pseudo code, as appropriate, sketch out a design for your browser. Feel free to note any patterns or principles you are using.

(Continue question 6 here.)

(There is more room on the next page.)

(Continue question 6 here.)

(If you need more space, continue in a yellow book.)

All the best in the rest of your exams. It's been a pleasure instructing you this term.