Instructions

This quiz is 50 minutes long. It contains 8 pages (including this page) for a total of 100 points. The quiz is closed-book, closed-notes.

Please check your copy to make sure that it is complete before you start. Turn in all pages, together, when you finish. Write your name on the top of every page. Please write neatly. No credit will be given if we cannot read what you write. Good luck!

<table>
<thead>
<tr>
<th>Question Name</th>
<th>Page</th>
<th>Maximum Points</th>
<th>Points Given</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Patterns</td>
<td>2</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Interpreter/Visitor</td>
<td>3</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Map/Filter/Reduce</td>
<td>4</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Concurrency</td>
<td>5</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Deadlock</td>
<td>6</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Thread Safety</td>
<td>7-8</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>
Design Patterns [20 pts]

For each of the following statements, name the design pattern that it best describes, from the list below.

- Interpreter
- Visitor
- Event Listener
- Map/Filter/Reduce
- Client/Server
- Model/View/Controller
- Composite

You may use a design pattern more than once in your answers. If you’re torn between two best answers, you can give both, but in that case you should justify both answers.

(a) This design pattern produces tree-like data structures.

(b) This design pattern is used for operating over sequences of elements.

(c) This design pattern uses higher-order functions.

(d) This design pattern is used to separate concerns in user interfaces.

(e) This design pattern is used for message passing over a network.
Interpreter/Visitor [16 pts]

You want to write a program to perform operations on all your Foos.

A Foo can perform lots of different tricks, like *bazzle* and *glibble*.

There are (and will always be) exactly 4 types of Foo, each of which does something different when they *bazzle* or *glibble*.

But every so often your Foos learn a new trick, and you must update your program to include the new operation.

For example, last week your Foos learned how to *joople*.

a) Would it be better to use the interpreter pattern or the visitor pattern for implementing the datatype representing a Foo?

b) Assuming you designed your program according to your choice in part (a), now you want to add the *joople* operation. Explain what classes and methods you will change, or what classes and methods you would add, in order to support the *joople* operation.
Suppose you want to rewrite the following Python code using map, filter, and reduce:

```python
def ssp(list):  # sum of squares of positive numbers in list
    result = 0
    for x in list:
        if x > 0:
            result += x*x
    return result
```

Fill in the blanks in the map/filter/reduce version below.

```python
def ssp(list):  # sum of squares of positive numbers in list
    return reduce(r, map(m, filter(f, list)), 0)

def f(______________):
    return ________________

def m(______________):
    return ________________

def r(______________):
    return ________________
```
Concurrency [16 pts]

Read the following code:

```java
public static void main() {
    Thread t1 = new Thread(new Runnable() {
        public void run() {
            System.out.print("O");
            System.out.print("Y");
        }
    });
    Thread t2 = new Thread(new Blue());
    System.out.print("R");
t1.start();
    System.out.print("G");
t2.start();
    System.out.print("I");
t1.join();
    System.out.print("V");
t2.join();
    System.out.print("K");
}

public static class Blue implements Runnable {
    public void run() {
        System.out.print("B");
    }
}
```

Assume that `print()` is threadsafe and atomic. Which of the following sequences can be printed by this code? Circle possible or impossible.

- ROYGBIVK possible impossible
- ROYBGIVK possible impossible
- RGOYIBVK possible impossible
- OYBRGIVK possible impossible
Deadlock [16 pts]

You have two threads (T0 and T1) and two locks (X and Y). Which of the following situations can lead to deadlock? If deadlock can occur, circle the method call in each thread where the thread would stop in the event of deadlock. If deadlock is impossible, circle “no deadlock.”

a)

```
T0:
X.acquire();
Y.acquire();
Y.release();
X.release();

T1:

X.acquire();
Y.acquire();
Y.release();
X.release();
```

no deadlock

b)

```
T0: (same as T0 above)
X.acquire();
Y.acquire();
Y.release();
X.release();

T1:

Y.acquire();
X.acquire();
X.release();
Y.release();
```

no deadlock

c)

```
T0: (same as T0 above)
X.acquire();
Y.acquire();
Y.acquire();
Y.release();
X.release();

T1:

Y.acquire();
X.acquire();
X.acquire();
X.release();
```

no deadlock
Thread Safety [20 pts]

Consider the following code, and answer the questions on the next page.

```java
public class Widget extends Thread {
    public static List<String> strings = new ArrayList<String>();
    public int count;
    public List<Integer> numbers;

    public Widget() {
        count = 0;
        numbers = new ArrayList<Integer>();
    }

    public void run() {
        for (int i = 0; i < 1000; ++i) {
            synchronized (this) {
                count++;
                synchronized (numbers) {
                    numbers.add(i);
                }
                synchronized (Widget.strings) {
                    Widget.strings.add("x");
                }
            }
        }
    }

    public static void main(String[] args) {
        List<Widget> widgets = new ArrayList<Widget>();
        for (int i = 0; i < 1000; ++i) {
            Widget w = new Widget();
            widgets.add(w);
            w.start();
        }
        for (Widget w : widgets) {
            synchronized (w) {
                w.count++;
                synchronized (w.numbers) {
                    w.numbers.add(1000);
                }
            }
            synchronized (Widget.strings) {
                Widget.strings.clear();
            }
        }
        for (Widget w : widgets) {
            w.join();
        }
    }
}
You are reviewing a concurrency argument about this code. Circle whether you agree or disagree with each of the following statements in the concurrency argument, and add a brief (1 sentence) justification of your answer.

(a) Accesses to the widgets list are safe because the list is confined to the main thread.

AGREE  DISAGREE

(b) Accesses to the numbers list are safe because they acquire the list’s lock.

AGREE  DISAGREE

(c) Assuming that the program terminates without throwing an exception, count for every widget is 1001 at the end of main.

AGREE  DISAGREE

(d) Assuming that the program terminates without throwing an exception, strings has size 0 at the end of main.

AGREE  DISAGREE

END OF QUIZ