



ALBERT-LUDWIGS-  
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30.11.2011

Hand in solutions via email to  
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until 07.12.2011 (only Java sources and  
PDFs accepted).

Paper submissions possible after the lecture.

## Tutorials for “Formal methods for Java” Exercise sheet 6

### Exercise 1: Friendship

Consider the following classes.

```
class LogManager {
    Vector<String> buf;
    public LogManager() {
        buf = new Vector<String>();
    }
    public void add(String msg) {
        buf.add(msg);
    }
}

class LogWriter extends Thread {
    Vector<String> buf;
    int pos;
    public LogWriter(LogManager m) {
        buf = m.buf;
        pos = 0;
        setDaemon(true);
        start ();
    }
    public void run() {
        try {
            while (true) {
                Thread.sleep(100);
                if (pos != buf.size ()) {
                    String msg = buf.get(pos++);
                    System.err.println(msg);
                }
            }
        }
    }
}
```

```

        } catch (InterruptedException ie) {}
    }
}

```

These classes are an abstraction of a logging system. The system comprises of a LogManager that can serve multiple LogWriter instances. The desired invariant for the LogWriter class is  $\text{pos} \leq \text{buf.size}()$ .

- (a) Explain why this invariant cannot be established with the ownership model.
- (b) Explain how these problems are solved by the friendship model

### Exercise 2: Logical operators

From the logical operators `false`,  $\rightarrow$  and  $\forall$ , all other logical operators are definable. For example  $\neg F$  can be defined as  $\neg F := F \rightarrow \text{false}$ . Find formulas defining

- (a)  $\neg F$
- (b) `true`,
- (c)  $F \vee G$
- (d)  $F \wedge G$
- (e)  $\exists x F$

in terms of `false`,  $\rightarrow$  and  $\forall$ . Prove the validity of these definitions in sequent calculus, e.g.  $\neg F \implies F \rightarrow \text{false}$  and  $F \rightarrow \text{false} \implies \neg F$ .