ALBERT-LUDWIGS-
UNIVERSITÄT FREIBURG

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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 pos <= 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 $\neg F := F \rightarrow \mathsf{false}$. 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. $\neg F \Longrightarrow F \rightarrow \mathsf{false}$ and $F \rightarrow \mathsf{false} \Longrightarrow \neg F$.