Assignment 1

This assignment consists of 3 problems, and should be handed in at the latest by Thursday, April 5. Work in pairs. (in the first problem, disregard the small stars (⋆) in the figures).

Problem 1 In the below figures you find three suggestions for action systems that are intended to implement mutual exclusion between two processes. In all action systems, locations $l_1$ and $m_1$ are intended to represent the section of a process which is not interested in the critical section, locations $l_2$ and $m_2$ are intended to represent the section where the process is interested in entering the critical section, and locations $l_3$ and $m_3$ represent the critical sections themselves. The purpose of a mutual exclusion algorithm is to ensure that

1. At most one process is in its critical section at any time

2. A process that intends to enter its critical section should be allowed to do so eventually, or after some reasonable waiting time

For each of the action systems you should determine how well it satisfies these two criteria. You are also welcome to criticize some of the solutions on other grounds, and possibly improve them (this last part is not required).

Action System $mutex1$

\begin{verbatim}
declare $s$ : integer
initially $s = 1$

end
\end{verbatim}

$$s := s + 1$$

$$s \geq 1 \rightarrow s := s - 1$$

$$s := s + 1$$

$$s \geq 1 \rightarrow s := s - 1$$
Action System \textit{mutex2}

\texttt{declare } y_1, y_2 : \text{integer} \\
\texttt{initially } y_1 = y_2 = 0

\texttt{end}

Action System \textit{mutex3}

\texttt{declare } t : \text{integer} \\
\texttt{initially } t = 1

\texttt{end}

\textbf{Problem 2.} Make a Promela model of the Dining Philosophers Problem. Use a version where there are (say) five philosophers who alternatively think and eat. The philosophers are seated at a large round table on which are a large number of Chinese foods. Between each pair of philosophers is one chopstick. In order to eat food, a philosopher needs two chopsticks: the one on his left and the one on his right. Thus, when a philosopher stops thinking and starts eating, he picks up both the chopstick on his left and the chopstick on his right. When a philosopher stops eating and starts thinking, he puts
down both his chopsticks in their original positions on the table. Make a model which is as compact as possible.

**Problem 3.** The following is an action system with two integer variables $x$ and $y$. It does not perform too many useful things.

```
Action System Foo1
variables x, y : integer
initially x = y = 0
actions
  x ≤ y → x := x + 1
  x ≥ y → y := y + 1
  x > y + 1 → y := y + 10
end
```

For each of the three actions, there is a (weak) fairness constraint, defined by letting each action be a (weak) fairness set. Which of the following properties are satisfied by the program? Motivate your answers:

a) $△(x ≥ y)$
b) $x = 0$ leads to $x = 10$
c) $x > y ∪ x < y$
d) $x ≥ y ∪ x < y$
e) $x ≥ y W x < y$
f) $(x > y + 1) W (y = x + 20)$