Problems and Exercises
"Model Checking", SS06
Part 3

Prof. Helmut Veith
Dipl.-Inf. Johannes Kinder
Dipl.-Ing. Robert Stepanek

SMV

Use NuSMV to solve the following exercises. NuSMV can be obtained from `http://nusmv.irst.itc.it`

1. Write an SMV program that implements an 8 bit comparator. Given two binary strings $a_1a_2\cdots a_8$ and $b_1b_2\cdots b_8$, the program outputs 1 if $(a_1a_2\cdots a_8)_2 \leq (b_1b_2\cdots b_8)_2$, where $(s)_2$ denotes the number that results from interpreting s in binary notation, and zero otherwise. Simulate the program in the interactive SMV environment.

2. Write an SMV program that implements an 8 bit adder and simulate the program in the interactive SMV environment.

3. *Token ring.* A token ring consists of m independent processors which are arranged in a cycle, where each processor is connected to its left and right neighbors. The processes of the token ring use a token (represented as a Boolean flag) to synchronize each other. After each processing step, the token is passed on to one of its neighbors.

   - Implement the token ring for $m = 4$, where the token is passed to one of the neighbors nondeterministically. Simulate the token ring in the interactive environment.
   - Use SMV to check whether it is guaranteed that each processor gets access to the token infinitely often. Check the same specification for the case where the processors pass on the token only to its right neighbors.

- In both setups, show that no two processors have access to the token at the same time.
- Suppose now that there are two tokens in the token ring; each processor can hold up to two tokens simultaneously. After each processing step, the processor passes all its tokens nondeterministically to the neighbors. Answer the following questions: Does every processor get at least one token infinitely often? Does each processor get hold of both tokens simultaneously infinitely often? Evaluate these questions also in the case one token is always passed to the right neighbor whereas the second token is always passed to the left one.

4. * *The Ferryman.* A ferryman has to transport a goat, a cabbage and a wolf from one side of a river to the other. The ferryman can cross the river with at most one passenger in his boat. There is a behavioural conflict between:

   (a) the goat and the cabbage

   (b) the goat and the wolf

   if they are on the same river bank but the ferryman crosses the river or stays on the other bank. Can the ferryman transport all goods to the other side, without any conflicts occuring? Model the program in NuSMV.

5. * Use SMV to find a path from A to B in the following labyrinth (it is possible to move horizontally and vertically):