Problems and Exercises
“Nichtsequentielle Systeme und nebenläufige Prozesse”, SS04
Part 3
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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 and only if $a_i = b_i$ for $1 \leq i \leq 8$ and zero otherwise. Hint: the program should be deterministic!
   - Simulate the program in the interactive SMV environment.
   - Use SMV to prove the correctness of the program.

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 $m = 8$, 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.

• Test the same specifications for $m = 32$.

4. *Dining Philosophers (due to Dijkstra, 1968).* Five philosophers sit around a circular table. One fork is placed between each pair of philosophers; one fork will be shared between exactly two philosophers. In the center of the table there is a large plate full with spaghetti. A philosopher spends his life either eating spaghetti or thinking. To eat, the philosophers need to pick up both forks that are immediately right and left to their plates separately (unfortunately, both forks cannot be picked up concurrently). Philosophers are very patient—they might hold a fork to the end of times.

Model the dining philosophers problem in SMV. We want to assure that no philosopher starves to death. More precisely, check whether each philosopher eats infinitely often in any possible future.

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