Homework 7:
LTL and Büchi Automata

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Due: 2 Mar 2010

receive () =
val : int
if bgn < end
  then {
    val := read(buff[bgn]);
    bgn := bgn+1;
    return(some, val)
  }
else return(none, 0)

send (val : int) =
if end < 1
  then {
    write(buff[end], val);
    end := end+1;
    return(success)
  }
else return(failure)

reset () =
if bgn = 1 and end = 1
  then { bgn := 0; end := 0 }
return (ok)

Figure 1: Reader-writer example with one location

Fig. 1 is an example from class with two changes. One is that I have replaced 3 everywhere by 1, and renamed start to bgn. The other is that I have changed the order of a pair of actions.

Use the atomic formula \( b_0 \) to mean that the variable bgn has the value 0, so \( \neg b_0 \) means that bgn has the value 1. Likewise for \( e_0 \) and the variable end. Use the atomic formula \( w \) to be true in a state if a write is occurring when the system is in that state. Use \( r \) to be true in a state if a read is occurring when the system is in that state.

Think of every assignment as a separate action.
1. Construct a directed graph representing the Kripke system of this system. Assume that there’s one start state, and that $b_0$ and $e_0$ are true then, and that $r, w$ are false.

2. Construct a Büchi automaton by hand (don’t use the general algorithm I described in class) that accepts a sequence $\pi$ of states iff $\pi$ satisfies

$$(-r) \mathcal{W} w.$$  \hspace{1cm} (1)

3. Construct a Büchi automaton by hand that accepts a sequence $\pi$ of states iff $\pi$ satisfies

$$G(r \rightarrow X((-r) \mathcal{W} w))$$ \hspace{1cm} (2)

and one for

$$G(w \rightarrow X((-w) \mathcal{W} r))$$ \hspace{1cm} (3)

4. Find counterexamples to Eqns (1), (2), (3) if there are any.

5. Write a corrected version of the “wrong” procedure in Fig. 1, and construct its Kripke system.

Extra credit: Use NuSMV to verify your solution in Part 5. Hand in a printout of the your inputs to NuSMV and its outputs. Five points of homework extra credit.