Problem Set 3, Part a

Due: Thursday, October 20, 2011

Readings:

Section 8.5
Chapter 14 (skim).
Chapter 15

For next week: Chapter 16.

Coding collaboration policy: For coding exercises in this assignment, you may collaborate on the design and debugging of code. You must, however, credit all code co-authors, and must individually write any accompanying text, proofs, and analysis.

Problems:

1. Consider the following channel $D$, which is similar to channel $C$ on p. 204, but allows internal message duplication. In addition to the send and receive actions, $D$ has two internal actions, duplicate and discard. When a send($m$) occurs, the message $m$ is added to the end of the queue along with a Boolean tag. Tags for successive messages that are sent alternate, 1, 0, 1, 0, . . .. A duplicate causes an arbitrary message in the queue to be duplicated in place, along with its tag. The channel also keeps track of the tag of the last message delivered. A receive delivers the first message on the queue, as before, but only if the tag is unequal to that of the last message delivered. A discard discards the first message on the queue, provided the tag is the same as that of the last message delivered.

(a) Write Tempo code for automaton $C$.
(b) Write Tempo code for automaton $D$.
(c) Prove carefully (by hand) that $D$ implements $C$, in the sense of inclusion of sets of traces. Use a simulation relation.

2. Exercise 15.11.

3. (Based on Exercise 15.20.) Design an algorithm that allows a distinguished process $i_0$ in an asynchronous network based on an arbitrary connected undirected graph $G$ to determine the number of nodes in $G$.

(a) Explain the algorithm in words.
(b) Write it using Tempo.
(c) Analyze its message and time complexity.

4. (Based on Exercise 15.30.) Design an algorithm to find the shortest paths from a fixed source node $i_0$ to all other nodes in the network. Your algorithm should have a much better time bound than the AsynchBellmanFord algorithm, say $O(n(\ell + d))$.

(a) Explain the algorithm in words.
(b) Write it using Tempo.
(c) Analyze its time complexity.