2002 Paper 8 Question 15

Topics in Concurrency

(a) Describe concisely a model checking algorithm for judgements of the form $p \models A$, where p is a finite-state process and A is an assertion of the modal μ-calculus. [4 marks]

(b) Show how to express a minimum fixed point assertion $\mu X.A$ in terms of a maximum fixed point assertion. [2 marks]

(c) Let $\mu X\{p_1, \cdots, p_n\}A$ mean $\mu X.(\neg\{p_1, \cdots, p_n\} \wedge A)$. From ($a$), or otherwise, show that:

(i) when $q \in \{p_1, \cdots, p_n\}$, the judgement $q \models \mu X\{p_1, \cdots, p_n\}A$ is false;

(ii) when $q \notin \{p_1, \cdots, p_n\}$,

$$q \models \mu X\{p_1, \cdots, p_n\}A \;\Leftrightarrow\; q \models A[\mu X\{q, p_1, \cdots, p_n\}A/X] \;.$$

[7 marks]

(d) From the algorithm you have described in (a), using (c) if it is helpful, decide whether or not the following judgement holds:

$$P \models \mu X.([a]F \vee \langle a \rangle X)$$

where P is the CCS process defined by

$$P \stackrel{\text{def}}{=} a.Q \qquad Q \stackrel{\text{def}}{=} a.P + a.\mathbf{nil} \;.$$

[7 marks]