p 8q 15
GW

Topics in Concurrency (Modal μ-calculus 2001)

(a) Algorithm for model-checking the modal μ-calculus as a reduction system:

$p \models Atom \rightarrow$ true iff the atomic assertion Atom denotes a set of states containing p

$p \models A \wedge B \rightarrow (p \models A)$ and $(p \models B)$

$p \models \neg A \rightarrow$ not $(p \models A)$

$p \models \langle a \rangle A \rightarrow (q_1 \models A$ or $\cdots$ or $q_n \models A)$

where $\{q_1, \cdots q_n\} = \{q \mid p \xrightarrow{a} q\}$

$p \models \langle \cdot \rangle A \rightarrow (q_1 \models A$ or $\cdots$ or $q_n \models A)$

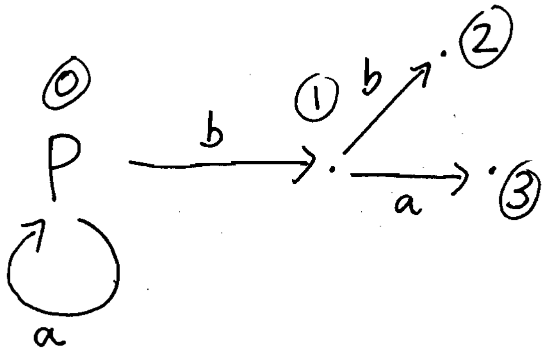
where $\{q_1, \cdots, q_n\} = \{q \mid p \xrightarrow{\cdot} q\}$

$p \models \nu X \{r_1, \cdots r_n\} A \longrightarrow$ true, if $p \in \{r_1, \cdots, r_n\}$

$p \models \nu X \{r_1, \cdots r_n\} A \longrightarrow p \models A[\nu X \{r_1, \cdots, r_n, p\} A / X]$

if $p \notin \{r_1, \cdots r_n\}$.

(b) $P \stackrel{def}{=} a.P + b.(b.nil + a.nil)$



(c) $0 \models \nu X\,([b]F \vee (\langle a\rangle T \wedge [\cdot]X))$

$\longrightarrow 0 \models [b]F \vee (\langle a\rangle T \wedge [\cdot](\nu X\{0\} —))$

$\longrightarrow 0 \models \langle a\rangle T \wedge [\cdot](\nu X\{0\} —)$, as $P \not\models [b]F$

$\longrightarrow 0 \models [\cdot](\nu X\{0\} —)$, as $P \models \langle a\rangle T$

$\longrightarrow 0 \models (\nu X\{0\} —)$ and $1 \models (\nu X\{0\} —)$

$\longrightarrow 1 \models \nu X\{0\}\,([b]F \vee (\langle a\rangle T \wedge [\cdot]X))$

$\longrightarrow 1 \models [b]F \vee (\langle a\rangle T \wedge [\cdot](\nu X\{0,1\} —))$

$\longrightarrow 1 \models \langle a\rangle T \wedge [\cdot](\nu X\{0,1\} —)$ as $1 \not\models [b]F$

$\longrightarrow 1 \models [\cdot](\nu X\{0,1\} —)$, as $1 \models \langle a\rangle T$

$\to\ 2 \models \nu X\{0,1\}$ — and $3 \models \nu X\{0,1\}$ —

$\to\ 2 \models [b]F \vee (\langle a\rangle T \wedge [\cdot]\, \nu X\{0,1,2\}$ — $)$

and

$3 \models [b]F \vee (\langle a\rangle T \wedge [\cdot]\, \nu X\{0,1,3\}$ — $)$

$\to$ true and true, as $2 \stackrel{b}{\not\to}$ and $3 \stackrel{b}{\not\to}$.

$\to$ true.

(d) Assertion A means $\langle a\rangle T$ until $[b]F$: along any path; allowing for $\langle a\rangle T$ to hold always along an infinite path.