Concurrency Theory

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Sheet 9

Due: Monday, 2026-01-19

Exercise 9.1 (Petri Nets)

Consider the alternating mutual exclusion system described by the Petri net $N = (P, T, F)$, where:

$$P = \{\text{local}_L, \text{waiting}_L, \text{critical}_L, \text{local}_R, \text{waiting}_R, \text{critical}_R, \text{key}_{LR}, \text{key}_{RL}\}$$
$$T = \{\text{lw}_L, \text{wc}_L, \text{cl}_L, \text{lw}_R, \text{wc}_R, \text{cl}_R\}$$
$$F = \begin{cases} (\text{local}_i, \text{lw}_i), (\text{lw}_i, \text{waiting}_i), (\text{waiting}_i, \text{wc}_i), (\text{wc}_i, \text{critical}_i), (\text{critical}_i, \text{cl}_i), (\text{cl}_i, \text{local}_i) & i \in \{L, R\} \\ (\text{cl}_L, \text{key}_{LR}), (\text{key}_{LR}, \text{wc}_R), (\text{cl}_R, \text{key}_{RL}), (\text{key}_{RL}, \text{wc}_L) \end{cases}$$

(a) Draw the Petri net.

(b) Define the pre-set ${}^\bullet\text{wc}_L$ and the post-set $\text{wc}_L{}^\bullet$.

(c) Consider the initial marking:

$$M_0 = \{(p, 1) \mid p \in \{\text{local}_L, \text{key}_{LR}\}\} \cup \{(p, 0) \mid p \in P \setminus \{\text{local}_L, \text{key}_{LR}\}\}$$

Is this marking one bounded?

(d) Draw the initial marking M_0 onto the Petri net.

(e) Which transitions are enabled at M_0? Fire a sequence until process L is in the critical section. List the step sequence and resulting markings.

(f) Can this system deadlock?

(g) Draw the complete marking graph (interleaving semantics). Is this graph unique up to isomorphism with respect to other reachable markings?

(h) List all actions of the net.

(i) List all pairs of actions that are causally related ($A < B$) or independent ($A \perp\!\!\!\perp B$).

(j) Provide the true concurrency semantics for a full cycle as a causal net.

(k) Attach depth information to all nodes in your causal net.

If you have questions, please post a message in the dedicated chat.