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Problem Set 2
Due: May 2, 2007, 11:14 am

Embedded Systems

Problem 1 (Statecharts) — 60 points

The chess clock handout

`http://react.cs.uni-sb.de/fileadmin/user_upload/react/es07/ho01.pdf`

implements a chess clock with *blitz time control*, that is, 5 minutes per player. This problem asks you to implement other time controls.

(a) *Classic time control.* Each player has 2 hours for the first 40 moves, followed by 1 hour for another 20 moves, followed by 1 hour for another 20 moves, followed by 1 hour for another 20 moves, and so on forever.

(b) *Quick play finish time control.* Each player has 2 hours for the first 40 moves, followed by 1 hour to complete the game.

(c) *Fischer time control.* Each player has 5 minutes to complete the game, but whenever a player moves, 12 seconds are added to her clock.

(d) Implement an interface that allows the user to select the wished time control. You are encouraged to be as creative as you want here, allowing for different parameters in the above time controls.

Problem 2 (Petri nets) — 10 points

Draw the Petri net $N = (C, E, F)$ where:

$$C = \{c_1, c_2, c_3, c_4\},$$
$$E = \{e_1, e_2, e_3\},$$
$$F = \{(c_1, e_1), (c_1, e_2), (e_1, c_2), (e_1, c_3), (e_2, c_3), (e_2, c_4), (c_2, e_3), (c_3, e_3), (c_4, e_3), (e_3, c_1)\}.$$

Compute the preconditions of e_3 and the postconditions of e_1. Is N simple? Is N pure? Justify your answers.

Problem 3 (Petri nets) — 10 points

Draw a Petri net modelling the coordination of trains and ships between Milan and Sicily.

- Train X travels from Milan to Villa San Giovanni
- Train X boards inside ship S
- Ship S navigates from Villa San Giovanni to Messina Marittima
- Train X exits ship S and goes to Messina Centrale
- Train X disconnects into two trains, Y and Z

- Train Y travels from Messina Centrale to Siracusa
- Train Z travels from Messina Centrale to Palermo
- Train Z travels back from Palermo to Messina Centrale
- Train Y travels back from Siracusa to Messina Centrale
- Train Y and Z connect into train X, and go to Messina Marittima
- Train X boards ship S
- Ship S navigates from Messina Marittima to Villa San Giovanni
- Train X exits ship S and travels to Milan

Problem 4 (Petri nets) 10 points

We say that a Petri net $N_k = (P, T, F, K, W, M_k)$ is reachable from a Petri net $N_0 = (P, T, F, K, W, M_0)$ if there exists a finite sequence of firing transitions that leads from N_0 to N_k, that is, $M_{i+1} = M'_i$, for $i = 0, 1, \ldots, k-1$.

Construct a Petri net from which it is possible to reach an infinite number of Petri nets.

Problem 5 (Petri nets) 10 points

(a) Construct a Petri net that implements addition in the following sense. Assume places x and y are initially marked as $M(x) = a$, $M(y) = b$. All other places are also initially marked with 0. Then, after a finite number of firing transitions, the net enters a deadlock (no transition is activated). Moreover, at the end we have $M(z) = a + b$, for some fixed place z.

(b) Construct a Petri net implementing natural subtraction $\dot{-}$, where:

$$a \dot{-} b = \begin{cases} a - b & \text{if } a \geq b \\ 0 & \text{otherwise} \end{cases}$$

(c) Construct a Petri net implementing division by 7, as in $\lfloor \frac{x}{7} \rfloor$