This form is a summary description of the model entitled “CircadianClock” proposed for the Model Checking Contest @ Petri Nets. Models can be given in several instances parameterized by scaling parameters. Colored nets can be accompanied by one or many equivalent, unfolded P/T nets. Models are given together with property files (possibly, one per model instance) giving a set of properties to be checked on the model.

Description

The abstract circadian clock model of Barkei and Leiber [BL00] shows circadian rhythms which are widely used in organisms to keep a sense of daily time. The stochastic Petri net of the circadian clock is based on the ODE model of [Vilar2002]. The bounded version of the net was used in [SH2009] and the unbounded version in [Rohr2010].

Graphical representation with parameter N. The left hand side represents the unbounded model from [Vilar2002]. It was made bounded using capacity places on the right hand side. The gray coloured transitions are logic/fusion transitions.

References


Scaling parameter

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Parameter description</th>
<th>Chosen parameter values</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>initial number of tokens on places</td>
<td>1, 10, 100, 1000, 10000, 100000</td>
</tr>
</tbody>
</table>
Size of the model

Although the model is parameterized, its size does not depend on parameter values.

number of places: 14
number of transitions: 16
number of arcs: 58

Structural properties

free choice — all (different) transitions with a shared input place have no other input place

state machine — every transition has exactly one input place and exactly one output place

marked graph — every place has exactly one input transition and exactly one output transition

connected — there is a undirected path between every two nodes (places or transitions)

strongly connected — there is a directed path between every two nodes (places or transitions)

source place(s) — one or more places have no input transitions

sink place(s) — one or more places have no output transitions

source transition(s) — one or more transitions have no input places

sink transition(s) — one or more transitions have no output places

loop-free — no transition has an input place that is also an output place

conservative — for each transition, the number of input arcs equals the number of output arcs

subconservative — for each transition, the number of input arcs equals or exceeds the number of output arcs

Behavioural properties

safe — in every reachable marking, there is no more than one token on a place

deadlock — there exists a reachable marking from which no transition can be fired

reversible — from every reachable marking, there is a transition path going back to the initial marking

quasi-live — for every transition \( t \), there exists a reachable marking in which \( t \) can fire

live — for every transition \( t \), from every reachable marking, one can reach a marking in which \( t \) can fire

(a) 23 arcs are not free choice, e.g., the arc from place “p2” (which has 2 outgoing transitions) to transition “t0” (which has 2 input places).
(b) 12 transitions are not of a state machine, e.g., transition “t0”.
(c) 12 places are not of a marked graph, e.g., place “p2”.
(d) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(e) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(f) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(g) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(h) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(i) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(j) 6 transitions are not loop free, e.g., transition “t10”.
(k) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(l) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(m) stated by CÆSAR.BDD version 2.0 to be true for \( N = 1 \), and false on the remaining 5 instance(s).
(n) checked by Marcie on 2013-12-13.
(o) true for \( N = 1 \) and false for \( N > 1 \) – checked by Marcie on 2013-12-13.
(p) stated by CÆSAR.BDD version 2.0 on all 6 instances (1, 10, 100, 1000, 10000, and 100000).
(q) checked by Marcie on 2013-12-13.
### Size of the marking graphs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number of reachable markings</th>
<th>Number of transition firings</th>
<th>Max. number of tokens per place</th>
<th>Max. number of tokens per marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>( N = 1 )</td>
<td>128</td>
<td>?</td>
<td>( N )</td>
<td>( \in [7, 14] ) (r)</td>
</tr>
<tr>
<td>( N = 10 )</td>
<td>644 204 (s)</td>
<td>?</td>
<td>( N )</td>
<td>( \geq 52 ) (t)</td>
</tr>
<tr>
<td>( N = 100 )</td>
<td>42 040 402 004 (u)</td>
<td>?</td>
<td>( N )</td>
<td>( \geq 502 )</td>
</tr>
<tr>
<td>( N = 1000 )</td>
<td>4 020 040 040 020 004 (v)</td>
<td>?</td>
<td>( N )</td>
<td>( \geq 5002 )</td>
</tr>
<tr>
<td>( N = 10000 )</td>
<td>400 200 040 004 000 200 004 (w)</td>
<td>?</td>
<td>( N )</td>
<td>( \geq 50 002 )</td>
</tr>
<tr>
<td>( N = 100000 )</td>
<td>?</td>
<td>?</td>
<td>( N )</td>
<td>( \geq 500 002 )</td>
</tr>
</tbody>
</table>

**(r)** lower and upper bounds given by the number of initial tokens and the number of places.

**(s)** computed by Marcie on 2013-12-13.

**(t)** lower bound given by the number of initial tokens.

**(u)** computed by Marcie on 2013-12-13.

**(v)** computed by Marcie on 2013-12-13.

**(w)** computed by Marcie on 2013-12-13.