This form is a summary description of the model entitled “Lamport’s fast mutual exclusion algorithm” 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

This net models Lamport’s fast mutual exclusion algorithm designed for multi-processor architectures with a shared memory. The pseudo code of this algorithm is given in file \texttt{code.pdf}. Each transition of the net has a name of the form \textit{XXX}_N where \textit{XXX} is a description of the statement executed and \textit{N} is the corresponding line number of the statement in the pseudo-code of the algorithm.

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>Number of processes competing to access the critical section.</td>
<td>2,3,4,5,6,7,8</td>
</tr>
</tbody>
</table>

Size of the colored net model

- number of places: 18
- number of transitions: 17
- number of arcs: 68

Size of the derived P/T model instances

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number of places</th>
<th>Number of transitions</th>
<th>Number of arcs</th>
</tr>
</thead>
<tbody>
<tr>
<td>( N = 2 )</td>
<td>69</td>
<td>96</td>
<td>402</td>
</tr>
<tr>
<td>( N = 3 )</td>
<td>100</td>
<td>156</td>
<td>664</td>
</tr>
<tr>
<td>( N = 4 )</td>
<td>135</td>
<td>230</td>
<td>990</td>
</tr>
<tr>
<td>( N = 5 )</td>
<td>174</td>
<td>318</td>
<td>1380</td>
</tr>
<tr>
<td>( N = 6 )</td>
<td>217</td>
<td>420</td>
<td>1834</td>
</tr>
<tr>
<td>( N = 7 )</td>
<td>264</td>
<td>536</td>
<td>2352</td>
</tr>
<tr>
<td>( N = 8 )</td>
<td>315</td>
<td>666</td>
<td>2934</td>
</tr>
</tbody>
</table>

Structural properties

- \textbf{free choice} — all (different) transitions with a shared input place have no other input place \hfill \( X \) (a)
- \textbf{state machine} — every transition has exactly one input place and exactly one output place \hfill \( X \) (b)
- \textbf{marked graph} — every place has exactly one input transition and exactly one output transition \hfill \( X \) (c)

\( (a) \) stated by \texttt{CÆSAR.BDD} version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
\( (b) \) stated by \texttt{CÆSAR.BDD} version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
\( (c) \) stated by \texttt{CÆSAR.BDD} version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).

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connected — there is a undirected path between every two nodes (places or transitions) ........................................ (d)
strongly connected — there is a directed path between every two nodes (places or transitions) ................................. (e)
source place(s) — one or more places have no input transitions .............................................................. (f)
sink place(s) — one or more places have no output transitions ............................................................... (g)
source transition(s) — one or more transitions have no input places ......................................................... (h)
sink transitions(s) — one or more transitions have no output places ....................................................... (i)
loop-free — no transition has an input place that is also an output place ........................................................... (j)
conservative — for each transition, the number of input arcs equals the number of output arcs .................... (k)
subconservative — for each transition, the number of input arcs equals or exceeds the number of output arcs .... (l)

Behavioural properties

safe — in every reachable marking, there is no more than one token on a place .............................................. (m)
deadlock — there exists a reachable marking from which no transition can be fired ........................................ (n)
reversible — from every reachable marking, there is a transition path going back to the initial marking ................ (o)
quasi-live — for every transition \( t \), there exists a reachable marking in which \( t \) can fire .................................... (p)
live — for every transition \( t \), from every reachable marking, one can reach a marking in which \( t \) can fire .......... (q)

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 = 2 )</td>
<td>380 (q)</td>
<td>?</td>
<td>1</td>
<td>( \in [6, 69] )</td>
</tr>
<tr>
<td>( N = 3 )</td>
<td>19 742 (g)</td>
<td>?</td>
<td>1</td>
<td>( \in [8, 100] )</td>
</tr>
<tr>
<td>( N = 4 )</td>
<td>( 1.915 \times 10^6 (t) )</td>
<td>?</td>
<td>1</td>
<td>( \in [10, 135] )</td>
</tr>
<tr>
<td>( N = 5 )</td>
<td>( 5.307 \times 10^6 (u) )</td>
<td>?</td>
<td>?</td>
<td>( \geq 12 )</td>
</tr>
<tr>
<td>( N = 6 )</td>
<td>( \geq 3.0 \times 10^8 (v) )</td>
<td>?</td>
<td>?</td>
<td>( \geq 14 )</td>
</tr>
<tr>
<td>( N = 7 )</td>
<td>( \geq 5.1 \times 10^8 (w) )</td>
<td>?</td>
<td>?</td>
<td>( \geq 16 )</td>
</tr>
<tr>
<td>( N = 8 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 18 )</td>
</tr>
</tbody>
</table>

(d) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(e) from place “P-start” one cannot reach place “P-wait”.
(f) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(g) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(h) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(i) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(j) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(k) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(l) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(m) stated by CÆSAR.BDD version 2.0 to be true on 3 instance(s) out of 7, and unknown on the remaining 4 instance(s).
(n) stated by CÆSAR.BDD version 2.0 to be false on 3 instance(s) out of 7, and unknown on the remaining 4 instance(s).
(o) stated by CÆSAR.BDD version 2.0 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(p) the net is not quasi-live and, thus, not live.
(q) computed by alpina, ITS-Tools, marcie, neco, and pnxdd at MCC’2013; confirmed by CÆSAR.BDD 1.8.
(r) lower and upper bounds given by the number of initial tokens and the number of places.
(s) computed by alpina, ITS-Tools, marcie, neco, and pnxdd at MCC’2013; confirmed by CÆSAR.BDD 1.8.
(t) computed by ITS-Tools, and pnxdd at MCC’2013; confirmed by CÆSAR.BDD 1.8.
(u) computed by ITS-Tools, and pnxdd at MCC’2013.
(v) lower bound given by the number of initial tokens.
(w) stated by CÆSAR.BDD version 2.0.
(x) stated by CÆSAR.BDD version 2.0.