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 code.pdf. Each transition of the net has a name of the form XXX_N where XXX is a description of the statement executed and 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

- ordinary — all arcs have multiplicity one ................................................................. ✔
- simple free choice — all transitions sharing a common input place have no other input place ........................................... ❌ (a)
- extended free choice — all transitions sharing a common input place have the same input places ..................... ❌ (b)

(a) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(b) transitions “T-setbi_2,3” and “T-setbi_2,4” share a common input place “P-start_1,1”, but only the former transition has input place “P-b_1_false”.
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 an 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
nested units — places are structured into hierarchically nested sequential units

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

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 (e)</td>
<td>716 (c)</td>
<td>1 (g)</td>
<td>8 (v)</td>
</tr>
<tr>
<td>N = 3</td>
<td>19,742 (w)</td>
<td>58,272 (x)</td>
<td>1 (f)</td>
<td>14 (y)</td>
</tr>
<tr>
<td>N = 4</td>
<td>1.9148E+6 (aa)</td>
<td>9.0461E+6 (ab)</td>
<td>1 (ac)</td>
<td>22 (bd)</td>
</tr>
<tr>
<td>N = 5</td>
<td>5.3068E+8 (ab)</td>
<td>?</td>
<td>1 (a1)</td>
<td>32 (b2)</td>
</tr>
<tr>
<td>N = 6</td>
<td>≥ 3.0E+8 (ab)</td>
<td>?</td>
<td>?</td>
<td>≥ 14</td>
</tr>
<tr>
<td>N = 7</td>
<td>≥ 5.1E+11 (ab)</td>
<td>?</td>
<td>?</td>
<td>≥ 16</td>
</tr>
<tr>
<td>N = 8</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>≥ 18</td>
</tr>
</tbody>
</table>

(c) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).  
(d) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).  
(e) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).  
(f) from place “P-start_11” one cannot reach place “P-wait_0_0”.  
(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 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).  
(n) the definition of Nested-Unit Petri Nets (NUPN) is available from http://mcc.1isp6.fr/nupn.php  
(o) 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).  
(p) 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); confirmed at MCC’2014 by Helena on 3 colored instances (N = 2, N = 3, and N = 4) and by GreatSPN and Lola on the 3 corresponding P/T instances.  
(q) 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); confirmed at MCC’2014 by Helena on 3 colored instances (N = 2, N = 3, and N = 4) and by GreatSPN and Lola on the 3 corresponding P/T instances.  
(r) the net is not quasi-live and, thus, not live.  
(s) computed by Alpina, ITS-Tools, Marcie, Neco, and PNXDD at MCC’2013; confirmed by CÆSAR.BDD 1.8; confirmed at MCC’2014 by GreatSPN and Helena on the colored net instance, and by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal on the P/T net instance.  
(t) confirmed at MCC’2014 by Helena on the colored net instance, and by Marcie on the P/T net instance.  
(u) computed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal on the P/T net instance.  
(v) computed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal on the P/T net instance.