This form is a summary description of the model entitled “DatabaseWithMutex” 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 model is an extension of the well-known distributed database example. A database containing files is distributed among different servers; when a file is modified the database must synchronized on all servers. This model adds atomic transitions (in black in the figure) and global mutex for each file. This model is particularly interesting in performance evaluation context, where atomic transitions are supposed to be instantaneous, whereas other requires time.

Graphical representation with four servers and two files

References

This model is described in:

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>The model has two natural parameters: The number of servers on which the database is distributed and the number of files in the database. To obtain a single scaling parameter, these two parameters are set to ( N )</td>
<td>2, 4, 10, 20, 40</td>
</tr>
</tbody>
</table>

Size of the colored net model

- number of places: 11
- number of transitions: 8
- number of arcs: 22

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>38</td>
<td>32</td>
<td>88</td>
</tr>
<tr>
<td>( N = 4 )</td>
<td>140</td>
<td>128</td>
<td>416</td>
</tr>
<tr>
<td>( N = 10 )</td>
<td>830</td>
<td>800</td>
<td>3800</td>
</tr>
<tr>
<td>( N = 20 )</td>
<td>3260</td>
<td>3200</td>
<td>23200</td>
</tr>
<tr>
<td>( N = 40 )</td>
<td>12920</td>
<td>12800</td>
<td>156800</td>
</tr>
</tbody>
</table>

Structural properties

free choice — all (different) transitions with a shared input place have no other input place ................................. \( \checkmark \) (a)
state machine — every transition has exactly one input place and exactly one output place ................................. \( \checkmark \) (b)
marked graph — every place has exactly one input transition and exactly one output transition ................................. \( \checkmark \) (c)
connected — there is a undirected path between every two nodes (places or transitions) ................................. \( \checkmark \) (d)
strongly connected — there is a directed path between every two nodes (places or transitions) ................................. \( \checkmark \) (e)
source place(s) — one or more places have no input transitions ................................. \( \times \) (f)
sink place(s) — one or more places have no output transitions ................................. \( \times \) (g)
source transition(s) — one or more transitions have no input places ................................. \( \times \) (h)
sink transition(s) — one or more transitions have no output places ................................. \( \times \) (i)
loop-free — no transition has an input place that is also an output place ................................. \( \checkmark \) (j)
conservative — for each transition, the number of output arcs equals the number of input arcs ................................. \( \checkmark \) (k)
subconservative — for each transition, the number of input arcs equals or exceeds the number of output arcs ................................. \( \times \) (l)

\( \checkmark \) stated by CÆSAR.BDD version 2.0 on all 5 instances (2, 4, 10, 20, and 40).
\( \times \) stated by CÆSAR.BDD version 2.0 on all 5 instances (2, 4, 10, 20, and 40).
Behavioural properties

**safe** — in every reachable marking, there is no more than one token on a place ........................................  \( \times \) \( (m) \)

**deadlock** — there exists a reachable marking from which no transition can be fired ........................................  \( \times \) \( (n) \)

**reversible** — from every reachable marking, there is a transition path going back to the initial marking  ..............  \( \checkmark \) \( (o) \)

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

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

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>153 (p)</td>
<td>?</td>
<td>( N^2 ) (q)</td>
<td>( \in [6, 38] ) (r)</td>
</tr>
<tr>
<td>( N = 4 )</td>
<td>( \geq 1.23375e+08 ) (s)</td>
<td>?</td>
<td>( N^2 )</td>
<td>( \geq 12 ) (t)</td>
</tr>
<tr>
<td>( N = 10 )</td>
<td>?</td>
<td>?</td>
<td>( N^2 )</td>
<td>( \geq 30 )</td>
</tr>
<tr>
<td>( N = 20 )</td>
<td>?</td>
<td>?</td>
<td>( N^2 )</td>
<td>( \geq 60 )</td>
</tr>
<tr>
<td>( N = 40 )</td>
<td>?</td>
<td>?</td>
<td>( N^2 )</td>
<td>( \geq 120 )</td>
</tr>
</tbody>
</table>

\( (m) \) false for the colored net, true for its unfolded P/T nets; the latter was confirmed by C\( \xi \)SAR.BDD version 2.0 to be true on 1 instance(s) out of 5, and unknown on the remaining 4 instance(s).

\( (n) \) stated by C\( \xi \)SAR.BDD version 2.0 to be false on 1 instance(s) out of 5, and unknown on the remaining 4 instance(s).

\( (o) \) stated by C\( \xi \)SAR.BDD version 2.0 to be true on 1 instance(s) out of 5, and unknown on the remaining 4 instance(s).

\( (p) \) stated by C\( \xi \)SAR.BDD version 2.0.

\( (q) \) 1 for the unfolded P/T net, which is safe – stated by C\( \xi \)SAR.BDD version 2.0.

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

\( (s) \) stated by C\( \xi \)SAR.BDD version 2.0.

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