This form is a summary description of the model entitled “A variant of Dekker’s algorithm for mutual exclusion” 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

A Place-Transition net representing a variant of the Dekker’s mutual exclusion algorithm for $N > 2$ processes. Each process has three states, $p_0$, $p_1$, and $p_3$. $p_0$ is initial. From there, the process executes try and raises its flag, reaching $p_1$. In $p_1$, if at least one of the other process has a high flag, it withdraws its intent and goes back to $p_0$. In $p_1$, it enters the critical section if all other process’ flag is zero. From $p_3$, the process can only exit the critical section.

References

https://code.google.com/p/cunf/source/browse/tools/mkdekker.py

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</td>
<td>10, 15, 20, 50, 100, 200</td>
</tr>
</tbody>
</table>
Size of the model

<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</td>
<td>5N</td>
<td>N^2 + 2N</td>
<td>O(N^2)</td>
</tr>
<tr>
<td>N = 10</td>
<td>50</td>
<td>120</td>
<td>820</td>
</tr>
<tr>
<td>N = 15</td>
<td>75</td>
<td>255</td>
<td>1830</td>
</tr>
<tr>
<td>N = 20</td>
<td>100</td>
<td>440</td>
<td>3240</td>
</tr>
<tr>
<td>N = 50</td>
<td>250</td>
<td>2600</td>
<td>20100</td>
</tr>
<tr>
<td>N = 100</td>
<td>500</td>
<td>10200</td>
<td>80200</td>
</tr>
<tr>
<td>N = 200</td>
<td>1000</td>
<td>40400</td>
<td>320400</td>
</tr>
</tbody>
</table>

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) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(b) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(c) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(d) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(e) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(f) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(g) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(h) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(i) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(j) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(k) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(l) stated by CÆSAR.BDD version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
(m) stated by CÆSAR.BDD version 2.0 to be true on 3 instance(s) out of 6, and unknown on the remaining 3 instance(s).
(n) stated by CÆSAR.BDD version 2.0 to be false on 3 instance(s) out of 6, and unknown on the remaining 3 instance(s).
(o) stated by CÆSAR.BDD version 2.0 to be true on 3 instance(s) out of 6, and unknown on the remaining 3 instance(s).
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 = 10)</td>
<td>6144 (^{(p)})</td>
<td>?</td>
<td>1</td>
<td>(\in [20, 50]) (^{(q)})</td>
</tr>
<tr>
<td>(N = 15)</td>
<td>278 528 (^{(r)})</td>
<td>?</td>
<td>1</td>
<td>(\in [30, 75])</td>
</tr>
<tr>
<td>(N = 20)</td>
<td>(1.153 \times 10^7) (^{(s)})</td>
<td>?</td>
<td>1</td>
<td>(\in [40, 100])</td>
</tr>
<tr>
<td>(N = 50)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>(\geq 100) (^{(t)})</td>
</tr>
<tr>
<td>(N = 100)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>(\geq 200)</td>
</tr>
<tr>
<td>(N = 200)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>(\geq 400)</td>
</tr>
</tbody>
</table>

Other properties

Mutual exclusion is guaranted: no reachable marking covers any two places \(p_{3/i}, p_{3/j}\) with \(i \neq j\) and \(i, j \in \{1, \ldots, N\}\). Unfair runs are however possible.

\(^{(p)}\) computed by ITS-Tools, marcie, neco, and pxndd at MCC’2013; confirmed by CÆSAR.BDD version 1.8.
\(^{(q)}\) lower and upper bounds given by the number of initial tokens and the number of places.
\(^{(r)}\) computed by ITS-Tools, marcie, neco, and pxndd at MCC’2013; confirmed by CÆSAR.BDD version 1.8.
\(^{(s)}\) computed by marcie, neco, and pxndd at MCC’2013; confirmed by CÆSAR.BDD version 1.8.
\(^{(t)}\) lower bound given by the number of initial tokens.