Description

Management of resources with the declaration of all resources to be used in a critical section. When process p enters a critical section (transition enter) it locks all the resources needed to be used in the critical section (4 max). Then, it can release a subset of these resources, max 2 at a time (and then stay in the critical section) or exit the critical section, thus releasing all the remaining resources it locks.

Class
Proc is 1..3;
Res is 1..6;
Domain
PR is <Proc,Res>;
Var
p in Proc;
r1, r2, r3, r4 in Res;

References

From a book on operating systems by Sacha Krakowiak. The model is presented and explained in the reference below:
Scaling parameter

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Parameter description</th>
<th>Chosen parameter values</th>
</tr>
</thead>
</table>
| (Cardinality of Proc and Res classes) | see description | \((n, 2 \times n) \) with \( n \in \{3, 5, 6, 7, 9, 10, 11\} \)

Size of the colored net model

- number of places: 5
- number of transitions: 7
- number of arcs: 29

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 = 3 )</td>
<td>33</td>
<td>4791</td>
<td>38652</td>
</tr>
<tr>
<td>( n = 5 )</td>
<td>75</td>
<td>56105</td>
<td>492760</td>
</tr>
<tr>
<td>( n = 6 )</td>
<td>102</td>
<td>136662</td>
<td>1226388</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 transitions(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

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(a) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).
(b) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).
(c) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).
(d) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).
(e) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).
(f) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).
(g) stated by CÆSAR.BDD version 1.7 on all 3 instances (3, 5, and 6).
(h) stated by PNML2NUPN 1.3.0 on all 3 instances (3, 5, and 6).
(i) stated by PNML2NUPN 1.3.0 on all 3 instances (3, 5, and 6).
**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 = 3 )</td>
<td>6,320 (^{(n)})</td>
<td>?</td>
<td>?</td>
<td>( \geq 9 )^{(o)}</td>
</tr>
<tr>
<td>( n = 5 )</td>
<td>( 1.066 \times 10^8 )^{(p)}</td>
<td>?</td>
<td>?</td>
<td>( \geq 15 )</td>
</tr>
<tr>
<td>( n = 6 )</td>
<td>( 2.572 \times 10^{10} )^{(q)}</td>
<td>?</td>
<td>?</td>
<td>( \geq 18 )</td>
</tr>
</tbody>
</table>

\(^{(m)}\) checked by the Crocodile tool in 2012, see reference 1.

\(^{(n)}\) Computed by greatSPN, ITS-Tools, marcie, and pnxdd at MCC’2013.

\(^{(o)}\) lower bound given by the number of initial tokens.

\(^{(p)}\) Computed by ITS-Tools at MCC’2013.

\(^{(q)}\) Computed by ITS-Tools at MCC’2013.