This form is a summary description of the model entitled “Permutation admissibility in multistage interconnection networks” 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

The model describes a 8 × 8 stages shuffle-exchange network. In order to ease readability, the net components are grouped in columns similar to the way the switches are arranged in stages. Thus, whole net is represented as a cascade of columns alternating in type of the components being either place or transition. Transitions occur column-wise from the leftmost to the rightmost and in columns from the topmost to the bottommost. It can be easily seen that no token can visit a place more than once. Direction of the arcs indicates the flow of tokens through the net.

Here, we consider the scaling parameter \( N \) as a multiplier for the initial marking in places \( \text{in}(x) \) and \( \text{c5} \). The figure shows the model when \( N = 1 \).

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>Multiplier for the marking of places ( \text{in}(x) ) and ( \text{c5} )</td>
<td>1, 2, 5, 10, 20, 50</td>
</tr>
</tbody>
</table>

Size of the model

Although the model is parameterized, its size does not depend on parameter values.
number of places: 40
number of transitions: 16
number of arcs: 83

**Structural properties**

free choice — all (different) transitions with a shared input place have no other input place .......................... X \(^{(a)}\)
state machine — every transition has exactly one input place and exactly one output place .......................... X \(^{(b)}\)
marked graph — every place has exactly one input transition and exactly one output transition .......................... X \(^{(c)}\)
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 transition(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 .......................... X \(^{(m)}\)
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 .......................... X
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 = 1 )</td>
<td>52 537 (^{(o)})</td>
<td>?</td>
<td>?</td>
<td>( \geq 9 ) (^{(n)})</td>
</tr>
<tr>
<td>( N = 2 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 18 )</td>
</tr>
<tr>
<td>( N = 5 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 45 )</td>
</tr>
<tr>
<td>( N = 10 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 90 )</td>
</tr>
<tr>
<td>( N = 20 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 180 )</td>
</tr>
<tr>
<td>( N = 50 )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>( \geq 450 )</td>
</tr>
</tbody>
</table>

\(^{(a)}\) 1776 arcs are not free choice, e.g., the arc from place “in4,6” (which has 4 outgoing transitions) to transition “switch3,3,6” (which has 3 input places).
\(^{(b)}\) 592 transitions are not of a state machine, e.g., transition “display4,0,0”.
\(^{(c)}\) 168 places are not of a marked graph, e.g., place “in4,6”.
\(^{(d)}\) stated by CÆSAR.BDD version 1.7 on all 6 instances (1, 2, 5, 10, 20, and 50).
\(^{(e)}\) from place “aux16,0” one cannot reach place “in4,6”.
\(^{(f)}\) there exist 9 source places, e.g., place “in4,6”.
\(^{(g)}\) there exist 64 sink places, e.g., place “out7,1”.
\(^{(h)}\) stated by CÆSAR.BDD version 1.7 on all 6 instances (1, 2, 5, 10, 20, and 50).
\(^{(i)}\) stated by CÆSAR.BDD version 1.7 on all 6 instances (1, 2, 5, 10, 20, and 50).
\(^{(j)}\) stated by CÆSAR.BDD version 1.7 on all 6 instances (1, 2, 5, 10, 20, and 50).
\(^{(k)}\) stated by PNML2NUPN 1.3.0 on all 6 instances (1, 2, 5, 10, 20, and 50).
\(^{(l)}\) stated by PNML2NUPN 1.3.0 on all 6 instances (1, 2, 5, 10, 20, and 50).
\(^{(m)}\) in the initial marking, some places have several tokens (the number of which depends on \( N \)).
\(^{(n)}\) Computed by alpina, and ITS-Tools at MCC’2013.
\(^{(o)}\) lower bound given by the number of initial tokens.