This form is a summary description of the model entitled “Resource Allocation Model” 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

Let us consider a kind of chessboard, whose dimensions are nR (nR ≥ 1) and nC (nC ≥ 2), respectively, in which each position has a given capacity (let say K ≥ 1) for holding ants. Let us also consider ant processes which traverse the board, either North-South or South-North directions, always jumping from one position to the following one. For safety reasons each ant, before jumping to the next position, books the position he is going to jump over and also the adjacent one in the west side of the target position. Of course, because of the position capacity constraint, no more than K ants can stay simultaneously in the same position.

In the set of considered specific models, even columns correspond to North-South ant processes, while odd columns correspond to South-North ant processes. The figure sketches a particular board model for nR=3, nC=5 and K=1.

The system can be parametrized in three ways, varying each one of nR, nC and K (here K=1). When varying nR we will call the model a RAS-R, and when varying nC we will call it a RAS-C.

These models belong the family of Resource Allocation Systems, RAS. A RAS is composed of a finite set of processes that share in a competitive way a finite set of resources. In a system there can be resources of several types, and for each type there can be several available copies. In this case, the model belong to the family of the $S^4PR$ nets, as described in [TrEz2006].

Places $p_{i,j}$ correspond to state places, while places $r_{i,j}$ correspond to resource places. Resource places model the state of the resources shared by the ant processes (in this case the state of a resource is identified as its free capacity). State places model the board position where an ant process is at a given moment.
References


The program used to generate the PNML models can be downloaded from:
https://github.com/fernand0/Petri-Net-tools/blob/master/model_generator.c

There is a script to generate all the models for a selected set of parameters, at:
https://github.com/fernand0/Petri-Net-tools/blob/master/pnml.sh

Scaling parameter

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Parameter description</th>
<th>Chosen parameter values</th>
</tr>
</thead>
<tbody>
<tr>
<td>((nR, nC))</td>
<td>Number of (rows, columns)</td>
<td>((2,2), (3,2), (3,3), (3,5), (3,10), (3,15), (3,20), (3,50), (3,100), (5,2), (10,2), (15,2), (20,2), (50,2), (100,2))</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>((nR, nC))</td>
<td>(2 \cdot nR \cdot nC)</td>
<td>(nC \cdot (nR + 1))</td>
<td>(4 \cdot nR \cdot nC + 2 \cdot nR \cdot (nC - 1))</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
extended free choice — all transitions sharing a common input place have the same input places
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 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
nested units — places are structured into hierarchically nested sequential units

(a) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(b) stated by CÆSAR.BDD version 2.6 on all 15 instances (see all aforementioned parameter values).
(c) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(d) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(e) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(f) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(g) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(h) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(i) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(j) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(k) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(l) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(m) stated by CÆSAR.BDD version 1.7 on all 15 instances (see all aforementioned parameter values).
(n) the definition of Nested-Unit Petri Nets (NUPN) is available from http://mcc.lip6.fr/nupn.php
### Behavioural properties

**safe** — in every reachable marking, there is no more than one token on a place

**reversible** — there exists a reachable marking from which no transition can be fired

**quasi-live** — for every transition, there exists a reachable marking in which it can fire

**live** — for every transition, from every reachable marking, one can reach a marking in which it can fire

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### 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>((nR, nC) = 2, 2)</td>
<td>8 (^{(l)})</td>
<td>12 (^{(l)})</td>
<td>1 (^{(l)})</td>
<td>4 (^{(w)})</td>
</tr>
<tr>
<td>((nR, nC) = 3, 2)</td>
<td>20 (^{(k)})</td>
<td>34 (^{(l)})</td>
<td>1 (^{(k)})</td>
<td>6 (^{(aa)})</td>
</tr>
<tr>
<td>((nR, nC) = 3, 3)</td>
<td>92 (^{(ab)})</td>
<td>257 (^{(ac)})</td>
<td>1 (^{(ad)})</td>
<td>9 (^{(ac)})</td>
</tr>
<tr>
<td>((nR, nC) = 3, 5)</td>
<td>1200 (^{(al)})</td>
<td>4960 (^{(ag)})</td>
<td>1 (^{(ah)})</td>
<td>15 (^{(ai)})</td>
</tr>
<tr>
<td>((nR, nC) = 3, 10)</td>
<td>823552 (^{(ah)})</td>
<td>6.2867E+6 (^{(aj)})</td>
<td>1 (^{(ak)})</td>
<td>30 (^{(am)})</td>
</tr>
<tr>
<td>((nR, nC) = 3, 15)</td>
<td>5.7888E+8 (^{(an)})</td>
<td>6.4857E+9 (^{(ao)})</td>
<td>1 (^{(ao)})</td>
<td>45 (^{(ap)})</td>
</tr>
<tr>
<td>((nR, nC) = 3, 20)</td>
<td>4.0646E+11 (^{(ap)})</td>
<td>6.0029E+12 (^{(aq)})</td>
<td>1 (^{(aq)})</td>
<td>60 (^{(ar)})</td>
</tr>
<tr>
<td>((nR, nC) = 3, 30)</td>
<td>4.8718E+28 (^{(ar)})</td>
<td>1.2698E+6 (^{(as)})</td>
<td>1 (^{(as)})</td>
<td>150 (^{(at)})</td>
</tr>
<tr>
<td>((nR, nC) = 3, 100)</td>
<td>1.1495E+57 (^{(aw)})</td>
<td>1.0194E+59 (^{(ax)})</td>
<td>1 (^{(ax)})</td>
<td>300 (^{(ay)})</td>
</tr>
</tbody>
</table>

\(^{(l)}\) computed at MCC’2013 by Alpina, ITS-Tools, Marcie, Neco, and PNXDD; confirmed by CÆSAR.BDD version 1.8; confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal.

\(^{(w)}\) stated by CÆSAR.BDD version 2.0 to be true on 13 instances out of 15, and unknown on the remaining 3 instance(s).

\(^{(k)}\) stated by CÆSAR.BDD version 2.0 to be true on 13 instances out of 15, and unknown on the remaining 3 instance(s).

\(^{(m)}\) stated by CÆSAR.BDD version 2.0 to be true on 13 instances out of 15, and unknown on the remaining 3 instance(s).

\(^{(l)}\) computed at MCC’2013 by Alpina, ITS-Tools, Marcie, Neco, and PNXDD; confirmed by CÆSAR.BDD version 1.8; confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal.

\(^{(k)}\) computed at MCC’2014 by Marcie.

\(^{(j)}\) confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal.

\(^{(i)}\) confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal.

\(^{(h)}\) confirmed at MCC’2013 by Alpina, ITS-Tools, Marcie, Neco, and PNXDD; confirmed by CÆSAR.BDD version 1.8; confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal.

\(^{(g)}\) computed at MCC’2014 by Marcie.

\(^{(f)}\) confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal.

\(^{(e)}\) computed at MCC’2014 by Marcie, PNMC, and Tapaal.

\(^{(d)}\) computed at MCC’2013 by Alpina, ITS-Tools, Marcie, Neco, and PNXDD; confirmed by CÆSAR.BDD version 1.8; confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal.

\(^{(c)}\) computed at MCC’2014 by Marcie, PNMC, and Tapaal.

\(^{(b)}\) confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal.

\(^{(a)}\) confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, and Tapaal.

\(^{(n)}\) computed at MCC’2013 by Alpina, ITS-Tools, Marcie, Neco, and PNXDD; confirmed by CÆSAR.BDD version 1.8; confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, PNXDD, and Stratagem.
Other properties

- For each resource, \( r_{i,j} \), the set \( \{ r_{i,j}, p_{i,j}, p_{i,(i+1),j} \} \) (for the most eastern process) is the support of a (minimal) 1-valued P-semiflow, stating the conservativeness of the resource capacity. The whole set of that P-semiflow forms a basis of the set of P-semiflows.

- For each ant process \( j \), the set of involved transitions \( \{ t_{j,0}, t_{j,1}, ..., t_{j,nR} \} \) is the support of a (minimal) 1-valued T-semiflow, stating the repetitiveness of the process. The whole set of that T-semiflow forms a basis of the set of T-semiflows.

(a) computed at MCC'2014 by Marcie.
(b) confirmed at MCC'2014 by GreatSPN, Marcie, and PNMC.
(c) computed at MCC'2014 by Marcie and PNMC.
(d) computed at MCC'2013 by ITS-Tools, Marcie, and PNXDD; confirmed by CÆSAR.BDD version 1.8; confirmed at MCC'2014 by Marcie, PNMC, and PNXDD.
(e) computed at MCC'2014 by Marcie.
(f) confirmed at MCC'2014 by Marcie and PNMC.
(g) computed at MCC'2014 by Marcie and PNMC.
(h) computed at MCC'2014 by Marcie and PNMC.
(i) computed at MCC'2013 by ITS-Tools, Marcie, and PNXDD; confirmed at MCC'2014 by Marcie, PNMC, and PNXDD.
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(p) computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapeal.
(q) computed at MCC'2014 by Marcie.
(r) confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapeal.
(s) computed at MCC'2013 by Alpina, ITS-Tools, Marcie, Neco, and PNXDD; confirmed by CÆSAR.BDD version 1.8; confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapeal.
(t) computed at MCC'2014 by Marcie.
(u) confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapeal.
(v) computed at MCC'2014 by Marcie.
(w) computed at MCC'2014 by Marcie.
(x) confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapeal.
(y) computed at MCC'2014 by Marcie.
(z) confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapeal.