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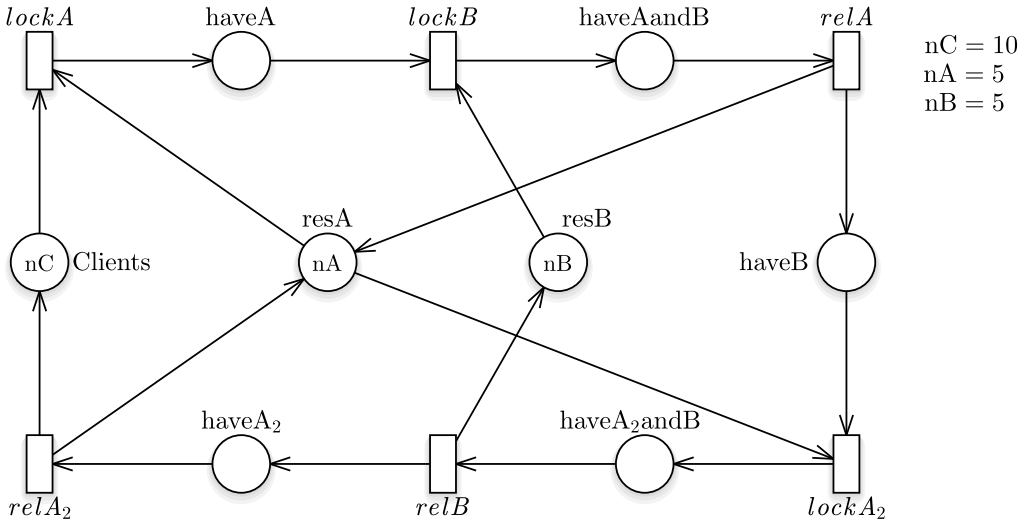
This form is a summary description of the model entitled "TwoPhaseLocking" proposed for the Model Checking Contest @ Petri Nets. Models can be given in several instances parameterized by scaling parameters. Colored nets can be accompanied by one or many equivalent, unfolded P/T nets. Models are given together with property files (possibly, one per model instance) giving a set of properties to be checked on the model.

Description

The model simulates a problematic condition where a badly-designed process violates the *two phase locking* (2PL) protocol rules. A process performing 2PL follows two phases: an *acquisition phase*, where resource can be obtained, and a *release phase*, where all resources must be released. Re-acquiring resources during the release phase is a 2PL protocol violation. 2PL, together with fixed-order resource acquisition, ensures deadlock avoidance.

In the Petri net model, a client process first acquires a resource of type A and one of type B. It then releases A, thus starting the release phase. However, after this first step, the process reacquires a new resource of type A, violating the 2PL rules. The process that releases both B and A. If the number of concurrently running *Clients* nC is equal or less than the sum of the resources $nA + nB$, a deadlock condition may form. The model is parametric in nC, the number of clients. For each value of nC, two model versions are proposed: Version N has $nC = 2 \cdot nA = 2 \cdot (nB - 1)$, resulting in no deadlocks; Version D has $nC = 2 \cdot nA = 2 \cdot nB$, generating deadlock states.



Graphical representation for $nC = 10$ (version D). Version N would have $nB = 6$.

References

Philip A. Bernstein, Vassos Hadzilacos, Nathan Goodman (1987): *Concurrency Control and Recovery in Database Systems*, Addison Wesley Publishing Company, ISBN 0-201-10715-5.

Scaling parameter

Parameter name	Parameter description	Chosen parameter values
N	Number of client processes.	4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000

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Size of the model

Although the model is parameterized, its size does not depend on parameter values.

number of places:	8
number of transitions:	6
number of arcs:	18

Structural properties

ordinary — *all arcs have multiplicity one* ..... ✔
simple free choice — *all transitions sharing a common input place have no other input place* ..... ✗ [a]
extended free choice — *all transitions sharing a common input place have the same input places* ..... ✗ [b]
state machine — *every transition has exactly one input place and exactly one output place* ..... ✗ [c]
marked graph — *every place has exactly one input transition and exactly one output transition* ..... ✗ [d]
connected — *there is an undirected path between every two nodes (places or transitions)* ..... ✔ [e]
strongly connected — *there is a directed path between every two nodes (places or transitions)* ..... ✔ [f]
source place(s) — *one or more places have no input transitions* ..... ✗ [g]
sink place(s) — *one or more places have no output transitions* ..... ✗ [h]
source transition(s) — *one or more transitions have no input places* ..... ✗ [i]
sink transitions(s) — *one or more transitions have no output places* ..... ✗ [j]
loop-free — *no transition has an input place that is also an output place* ..... ✔ [k]
conservative — *for each transition, the number of input arcs equals the number of output arcs* ..... ✗ [l]
subconservative — *for each transition, the number of input arcs equals or exceeds the number of output arcs* ..... ✗ [m]
nested units — *places are structured into hierarchically nested sequential units* [n] ..... ✗

Behavioural properties

safe — *in every reachable marking, there is no more than one token on a place* ..... ✗ [o]
dead place(s) — *one or more places have no token in any reachable marking* ..... ✗ [p]
dead transition(s) — *one or more transitions cannot fire from any reachable marking* ..... ✗ [q]
deadlock — *there exists a reachable marking from which no transition can be fired* ..... ? [r]
reversible — *from every reachable marking, there is a transition path going back to the initial marking* ..... ? [s]
live — *for every transition t, from every reachable marking, one can reach a marking in which t can fire* ..... ? [t]

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[a] 2 arcs are not simple free choice, e.g., the arc from place "resA" (which has 2 outgoing transitions) to transition "lockA" (which has 2 input places).
[b] transitions "lockA2" and "lockA" share a common input place "resA", but only the former transition has input place "haveB".
[c] 6 transitions are not of a state machine, e.g., transition "relB".
[d] place "resA" is not of a marked graph.
[e] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[f] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[g] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[h] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[i] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[j] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[k] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[l] 6 transitions are not conservative, e.g., transition "relB".
[m] 3 transitions are not subconservative, e.g., transition "relB".
[n] the definition of Nested-Unit Petri Nets (NUPN) is available from http://mcc.lip6.fr/nupn.php
[o] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[p] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[q] stated by CÆSAR.BDD version 3.5 on all 22 instances ($nC \in \{4, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000\}$, version D or N).
[r] ✔ for the D version, ✗ for the N version.
[s] ✔ for the D version, ✗ for the N version.
[t] ✔ for the D version, ✗ for the N version.

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Size of the marking graphs

Parameter	Number of reachable markings	Number of transition firings	Max. number of tokens per place	Max. number of tokens per marking
$nC = 4$ version D	32	57	4	8
$nC = 4$ version N	45	84	4	9
$nC = 10$ version D	?	?	?	≥ 20 [u]
$nC = 10$ version N	?	?	?	≥ 21 [v]
$nC = 20$ version D	?	?	?	≥ 40 [w]
$nC = 20$ version N	?	?	?	≥ 41 [x]
$nC = 50$ version D	?	?	?	≥ 100 [y]
$nC = 50$ version N	?	?	?	≥ 101 [z]
$nC = 100$ version D	?	?	?	≥ 200 [aa]
$nC = 100$ version N	?	?	?	≥ 201 [ab]
$nC = 200$ version D	?	?	?	≥ 400 [ac]
$nC = 200$ version N	?	?	?	≥ 401 [ad]
$nC = 500$ version D	?	?	?	≥ 1000 [ae]
$nC = 500$ version N	?	?	?	≥ 1001 [af]
$nC = 1000$ version D	?	?	?	≥ 2000 [ag]
$nC = 1000$ version N	?	?	?	≥ 2001 [ah]
$nC = 2000$ version D	?	?	?	≥ 4000 [ai]
$nC = 2000$ version N	?	?	?	≥ 4001 [aj]
$nC = 5000$ version D	?	?	?	≥ 10000 [ak]
$nC = 5000$ version N	?	?	?	≥ 10001 [al]
$nC = 10000$ version D	?	?	?	≥ 20000 [am]
$nC = 10000$ version N	?	?	?	≥ 20001 [an]

[u] lower bound given by the number of initial tokens.
[v] lower bound given by the number of initial tokens.
[w] lower bound given by the number of initial tokens.
[x] lower bound given by the number of initial tokens.
[y] lower bound given by the number of initial tokens.
[z] lower bound given by the number of initial tokens.
[aa] lower bound given by the number of initial tokens.
[ab] lower bound given by the number of initial tokens.
[ac] lower bound given by the number of initial tokens.
[ad] lower bound given by the number of initial tokens.
[ae] lower bound given by the number of initial tokens.
[af] lower bound given by the number of initial tokens.
[ag] lower bound given by the number of initial tokens.
[ah] lower bound given by the number of initial tokens.
[ai] lower bound given by the number of initial tokens.
[aj] lower bound given by the number of initial tokens.
[ak] lower bound given by the number of initial tokens.
[al] lower bound given by the number of initial tokens.
[am] lower bound given by the number of initial tokens.
[an] lower bound given by the number of initial tokens.

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