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This form is a summary description of the model entitled "Lamport's fast mutual exclusion algorithm" 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

This net models Lamport's fast mutual exclusion algorithm designed for multi-processor architectures with a shared memory.

The pseudo code of this algorithm is given in file `code.pdf`. Each transition of the net has a name of the form XXX_N where XXX is a description of the statement executed and N is the corresponding line number of the statement in the pseudo-code of the algorithm.

In March 2020, Pierre Bouvier and Hubert Garavel provided a decomposition of four instances of this model into networks of communicating automata. Each network is expressed as a Nested-Unit Petri Net (NUPN) that can be found, for each instance, in the "toolspecific" section of the corresponding PNML file. In April 2021, Pierre Bouvier decomposed all the remaining instances of this model.

References

J.B. Jorgensen and L.M Kristensen. *Computer aided verification of Lamport's fast mutual exclusion algorithm using colored Petri nets and occurrence graphs with symmetries.* In *IEEE Transactions on Parallel and Distributed Systems*, Volume 10, Issue 7. IEEE Computer Society, 1999.

Scaling parameter

Parameter name	Parameter description	Chosen parameter values
N	Number of processes competing to access the critical section.	2,3,4,5,6,7,8

Size of the colored net model

number of places:	18
number of transitions:	17
number of arcs:	68

Size of the derived P/T model instances

Parameter	Number of places	Number of transitions	Number of arcs	Number of units	HWB code
$N = 2$	69	96	402	9	1–8–23
$N = 3$	100	156	664	17	1–16–36
$N = 4$	135	230	990	27	1–26–56
$N = 5$	174	318	1380	38	1–37–77
$N = 6$	217	420	1834	51	1–50–103
$N = 7$	264	536	2352	66	1–65–134
$N = 8$	315	666	2934	83	1–82–168

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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* ✗
live — *for every transition t, from every reachable marking, one can reach a marking in which t can fire* ✗ [s]

[a] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[b] transitions "T-setbi_2_1" and "T-setbi_2_2" share a common input place "P-start_1_0", but only the former transition has input place "P-b_0_false".
[c] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[d] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[e] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[f] stated by CÆSAR.BDD version 3.3 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[g] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[h] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[i] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[j] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[k] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[l] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[m] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[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 7 instances (2, 3, 4, 5, 6, 7, and 8).
[p] stated by CÆSAR.BDD version 3.3 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[q] stated by CÆSAR.BDD version 2.0 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[r] stated by CÆSAR.BDD version 2.0 to be false on 3 instance(s) out of 7, and unknown on the remaining 4 instance(s); confirmed at MCC'2014 by Helena on 3 colored instances ($N = 2$, $N = 3$, and $N = 4$) and by GreatSPN and Lola on the 3 corresponding P/T instances.
[s] the net has dead transitions.

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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
$N = 2$	380 [t]	716 [u]	1 [v]	8 [w]
$N = 3$	19 742 [x]	58 272 [y]	1 [z]	14 [aa]
$N = 4$	1.9148E+6 [ab]	9.0461E+6 [ac]	1 [ad]	22 [ae]
$N = 5$	5.3068E+8 [af]	?	1 [ag]	32 [ah]
$N = 6$	$\geq$ 3.01209e+11 [ai]	?	1 [aj]	$\in$ [44, 50] [ak]
$N = 7$	$\geq$ 4.24219e+14 [al]	?	1 [am]	$\in$ [58, 65] [an]
$N = 8$	$\geq$ 3.81235e+15 [ao]	?	1 [ap]	$\in$ [74, 82] [aq]

[t] computed by Alpina, ITS-Tools, Marcie, Neco, and PNXDD at MCC'2013; confirmed by CÆSAR.BDD 1.8; confirmed at MCC'2014 by GreatSPN and Helena on the colored net instance, and by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal on the P/T net instance.
[u] confirmed at MCC'2014 by Helena on the colored net instance, and by Marcie on the P/T net instance.
[v] computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal on the P/T net instance.
[w] computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal on the P/T net instance.
[x] computed at MCC'2013 by Alpina, ITS-Tools, Marcie, Neco, and PNXDD; confirmed by CÆSAR.BDD 1.8; confirmed at MCC'2014 by GreatSPN and Helena on the colored net instance, and by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal on the P/T net instance.
[y] confirmed at MCC'2014 by Helena on the colored net instance, and by Marcie on the P/T net instance.
[z] computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.
[aa] computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.
[ab] computed at MCC'2013 by ITS-Tools, and PNXDD; confirmed by CÆSAR.BDD 1.8; confirmed at MCC'2014 by GreatSPN and Helena on the colored net instance, and by GreatSPN, Marcie, PNMC, and PNXDD on the P/T net instance.
[ac] confirmed at MCC'2014 by Helena on the colored net instance, and by Marcie on the P/T net instance.
[ad] computed at MCC'2014 by GreatSPN, Marcie, and PNMC.
[ae] computed at MCC'2014 by GreatSPN, Marcie, and PNMC.
[af] computed at MCC'2013 by ITS-Tools, and PNXDD; confirmed at MCC'2014 by PNMC and PNXDD.
[ag] computed at MCC'2014 by PNMC.
[ah] computed at MCC'2014 by PNMC.
[ai] stated by CÆSAR.BDD version 3.5.
[aj] the P/T instance is safe.
[ak] upper bound given by the number of leaf units.
[al] stated by CÆSAR.BDD version 3.5.
[am] the P/T instance is safe.
[an] upper bound given by the number of leaf units.
[ao] stated by CÆSAR.BDD version 3.5.
[ap] the P/T instance is safe.
[aq] upper bound given by the number of leaf units.