

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.

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
$N = 2$	69	96	402
$N = 3$	100	156	664
$N = 4$	135	230	990
$N = 5$	174	318	1380
$N = 6$	217	420	1834
$N = 7$	264	536	2352
$N = 8$	315	666	2934

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)

(a) stated by [CÆSAR.BDD](#) version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
 (b) transitions "T-setbi_2.3" and "T-setbi_2.4" share a common input place "P-start_1.1", but only the former transition has input place "P-b_1.false".

- 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)
- deadlock — there exists a reachable marking from which no transition can be fired ✗ (p)
- 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 ✗ (q)
- live — for every transition t , from every reachable marking, one can reach a marking in which t can fire ✗ (r)

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 ^(s)	716 ^(t)	1 ^(u)	8 ^(v)
$N = 3$	19 742 ^(w)	58 272 ^(x)	1 ^(y)	14 ^(z)
$N = 4$	1.9148E+6 ^(aa)	9.0461E+6 ^(ab)	1 ^(ac)	22 ^(ad)
$N = 5$	5.3068E+8 ^(ae)	?	1 ^(af)	32 ^(ag)
$N = 6$	$\geq 3.0E+8$ ^(ah)	?	?	≥ 14
$N = 7$	$\geq 5.1E+11$ ^(ai)	?	?	≥ 16
$N = 8$?	?	?	≥ 18

(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) from place “P-start.1.1” one cannot reach place “P-wait.0.0”.
 (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 2.0 to be true on 3 instance(s) out of 7, and unknown on the remaining 4 instance(s).
 (p) 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.
 (q) stated by CÆSAR.BDD version 2.0 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
 (r) the net is not quasi-live and, thus, not live.
 (s) 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.
 (t) confirmed at MCC'2014 by Helena on the colored net instance, and by Marcie on the P/T net instance.
 (u) computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal 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'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.

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- (x) confirmed at MCC'2014 by Helena on the colored net instance, and by Marcie on the P/T net instance.
(y) computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.
(z) computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.
(aa) 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.
(ab) confirmed at MCC'2014 by Helena on the colored net instance, and by Marcie on the P/T net instance.
(ac) computed at MCC'2014 by GreatSPN, Marcie, and PNMC.
(ad) computed at MCC'2014 by GreatSPN, Marcie, and PNMC.
(ae) computed at MCC'2013 by ITS-Tools, and PNXDD; confirmed at MCC'2014 by PNMC and PNXDD.
(af) computed at MCC'2014 by PNMC.
(ag) computed at MCC'2014 by PNMC.
(ah) stated by [CÆSAR.BDD](#) version 2.0.
(ai) stated by [CÆSAR.BDD](#) version 2.0.