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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.

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

free choice — *all (different) transitions with a shared input place have no other input place* ..... ✗ [a]
state machine — *every transition has exactly one input place and exactly one output place* ..... ✗ [b]
marked graph — *every place has exactly one input transition and exactly one output transition* ..... ✗ [c]

[a] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[b] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
[c] stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).

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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 transitions(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* ✔ (m)
deadlock — *there exists a reachable marking from which no transition can be fired* ✗ (n)
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* ✗ (o)
live — *for every transition t, from every reachable marking, one can reach a marking in which t can fire* ✗ (p)

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 (q)	?	1	$\in [6, 69]$ (r)
$N = 3$	19 742 (s)	?	1	$\in [8, 100]$
$N = 4$	1.915×10^6 (t)	?	1	$\in [10, 135]$
$N = 5$	5.307×10^8 (u)	?	?	≥ 12 (v)
$N = 6$	$\geq$ 3.0E+8 (w)	?	?	≥ 14
$N = 7$	$\geq$ 5.1E+11 (x)	?	?	≥ 16
$N = 8$	?	?	?	≥ 18

(d) stated by CÆSAR.BDD version 1.7 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(e) from place "P-start_1_1" one cannot reach place "P-wait_0_0".
(f) stated by CÆSAR.BDD version 1.7 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 2.0 to be true on 3 instance(s) out of 7, and unknown on the remaining 4 instance(s).
(n) 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).
(o) stated by CÆSAR.BDD version 2.0 on all 7 instances (2, 3, 4, 5, 6, 7, and 8).
(p) the net is not quasi-live and, thus, not live.
(q) computed by alpina, ITS-Tools, marcie, neco, and pnxdd at MCC'2013; confirmed by CÆSAR.BDD 1.8.
(r) lower and upper bounds given by the number of initial tokens and the number of places.
(s) computed by alpina, ITS-Tools, marcie, neco, and pnxdd at MCC'2013; confirmed by CÆSAR.BDD 1.8.
(t) computed by ITS-Tools, and pnxdd at MCC'2013; confirmed by CÆSAR.BDD 1.8.
(u) computed by ITS-Tools, and pnxdd at MCC'2013.
(v) lower bound given by the number of initial tokens.
(w) stated by CÆSAR.BDD version 2.0.
(x) stated by CÆSAR.BDD version 2.0.