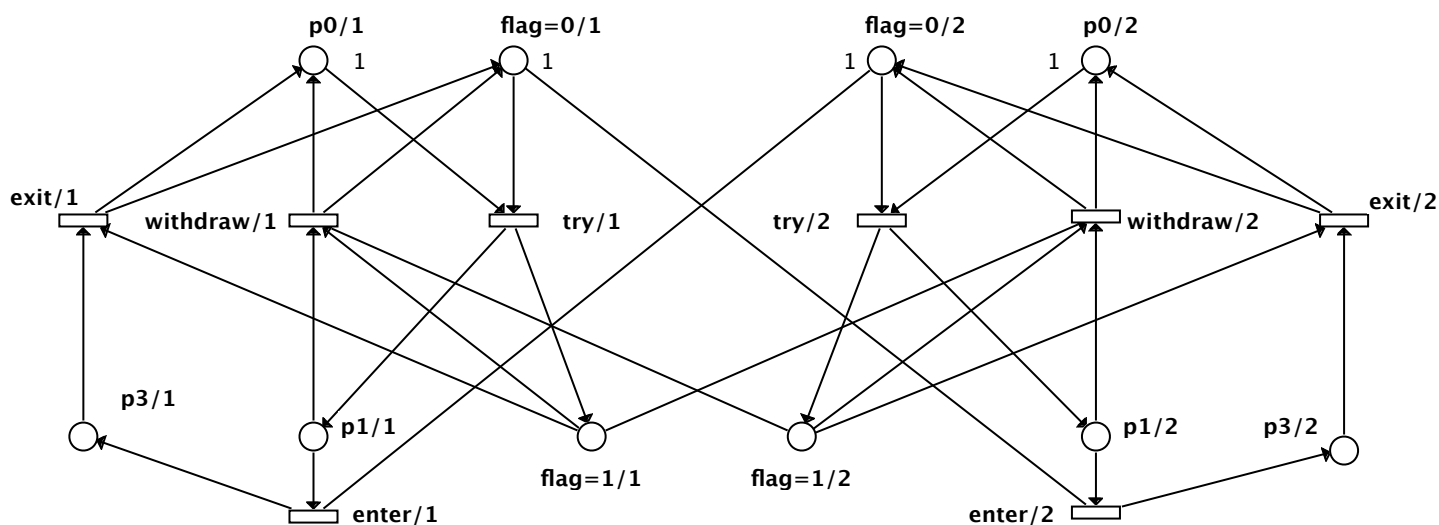


This form is a summary description of the model entitled "A variant of Dekker's algorithm for mutual exclusion" proposed for the Model Checking Contest @ Petri Nets. Models can be given in several instances parameterized by scaling parameters. Colored nets can be accompanied by one or many equivalent, 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

A Place-Transition net representing a variant of the Dekker's mutual exclusion algorithm for $N > 2$ processes. Each process has three states, **p0**, **p1**, and **p3**. **p0** is initial. From there, the process executes **try** and raises its **flag**, reaching **p1**. In **p1**, if at least one of the other process has a high **flag**, it **withdraws** its intent and goes back to **p0**. In **p1**, it **enters** the critical section if all other process' **flag** is zero. From **p3**, the process can only **exit** the critical section.

In March 2020, Pierre Bowier and Hubert Garavel provided a decomposition of all 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.



Graphical representation for $N = 2$

References

<https://code.google.com/p/cunf/source/browse/tools/mkdekker.py>

Scaling parameter

Parameter name	Parameter description	Chosen parameter values
N	Number of processes	10, 15, 20, 50, 100, 200

Size of the model

Parameter	Number of places	Number of transitions	Number of arcs	Number of units	HWB code
N	$5N$	$N^2 + 2N$	$O(N^2)$?	1-?-?
$N = 10$	50	120	820	23	1-22-35
$N = 15$	75	255	1830	32	1-31-49
$N = 20$	100	440	3240	42	1-41-65
$N = 50$	250	2600	20100	102	1-101-156
$N = 100$	500	10200	80200	203	1-202-308
$N = 200$	1000	40400	320400	402	1-401-608

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 ✓

(a) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (b) transitions “enter_2” and “try_0” share a common input place “flag_0.0”, but only the former transition has input place “flag_0.1”.
 (c) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (d) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (e) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (f) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (g) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (h) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (i) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (j) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (k) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (l) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (m) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (n) the definition of Nested-Unit Petri Nets (NUPN) is available from <http://mcc.lip6.fr/nupn.php>
 (o) stated by [CÆSAR.BDD](#) version 3.3 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (p) stated by [CÆSAR.BDD](#) version 3.3 on all 6 instances (10, 15, 20, 50, 100, and 200).
 (q) stated by [CÆSAR.BDD](#) version 3.3 to be false on 4 instance(s) out of 6, and unknown on the remaining 2 instance(s).
 (r) stated by [CÆSAR.BDD](#) version 2.0 to be false on 4 instance(s) out of 6, and unknown on the remaining 4 instance(s); confirmed at MCC'2014 by Tapaal, GreatSPN, and Lola on the 2, 3, and 4 smallest instances, respectively.

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

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
$N = 10$	6144 ^(s)	171 530 ^(t)	1 ^(u)	20 ^(v)
$N = 15$	278 528 ^(w)	1.6835E+7 ^(x)	1 ^(y)	30 ^(z)
$N = 20$	1.1534E+7 ^(aa)	1.2164E+9 ^(ab)	1 ^(ac)	40 ^(ad)
$N = 50$	2.9273E+16 ^(ae)	?	1 ^(af)	100 ^(ag)
$N = 100$	6.4650E+31 ^(ah)	?	1 ^(ai)	200 ^(aj)
$N = 200$	1.6230E+62 ^(ak)	?	1 ^(al)	400 ^(am)

Other properties

Mutual exclusion is guaranteed: no reachable marking covers any two places $p3/i$, $p3/j$ with $i \neq j$ and $i, j \in \{1, \dots, N\}$.
 Unfair runs are however possible.

^(s) computed at MCC'2013 by 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.

^(t) computed at MCC'2014 by Marcie.

^(u) confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.

^(v) number of initial tokens, because the net is conservative.

^(w) computed at MCC'2013 by 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.

^(x) computed at MCC'2014 by Marcie.

^(y) confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.

^(z) number of initial tokens, because the net is conservative.

^(aa) computed at MCC'2013 by Marcie, Neco, and PNXDD; confirmed by [CÆSAR.BDD](#) version 1.8; confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and PNXDD.

^(ab) computed at MCC'2014 by Marcie.

^(ac) confirmed at MCC'2014 by GreatSPN, Marcie, and PNMC.

^(ad) number of initial tokens, because the net is conservative.

^(ae) computed at MCC'2014 by PNMC; confirmed by [CÆSAR.BDD](#) version 3.3.

^(af) computed at MCC'2014 by PNMC.

^(ag) number of initial tokens, because the net is conservative.

^(ah) computed at MCC'2014 by PNMC.

^(ai) computed at MCC'2014 by PNMC.

^(aj) number of initial tokens, because the net is conservative.

^(ak) computed at MCC'2014 by PNMC.

^(al) computed at MCC'2014 by PNMC.

^(am) number of initial tokens, because the net is conservative.