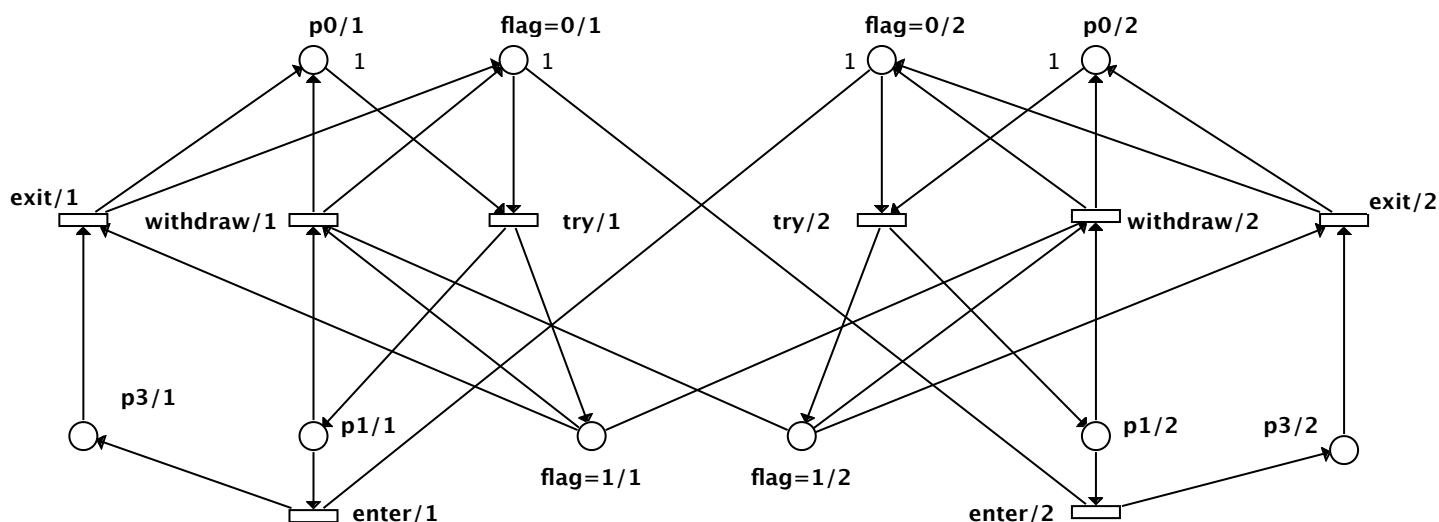


*This form is a summary description of the model entitled "A variant of Dekker's algorithm for mutual exclusion" proposed for the Model Checking Contest @ Petri Nets. Models can be given in several instances parameterized by scaling parameters. Colored nets can be accompanied by one or many equivalent,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



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
$N$	$5N$	$N^2 + 2N$	$O(N^2)$
$N = 10$	50	120	820
$N = 15$	75	255	1830
$N = 20$	100	440	3240
$N = 50$	250	2600	20100
$N = 100$	500	10200	80200
$N = 200$	1000	40400	320400

## Structural properties

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

## Behavioural properties

<b>safe</b> — in every reachable marking, there is no more than one token on a place .....	✓ (n)
<b>deadlock</b> — there exists a reachable marking from which no transition can be fired .....	✗ (o)
<b>reversible</b> — from every reachable marking, there is a transition path going back to the initial marking .....	✓
<b>quasi-live</b> — for every transition $t$ , there exists a reachable marking in which $t$ can fire .....	? (p)
<b>live</b> — for every transition $t$ , from every reachable marking, one can reach a marking in which $t$ can fire .....	?

(a) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).

(b) stated by [CÆSAR.BDD](#) version 1.7 on all 6 instances (10, 15, 20, 50, 100, and 200).

(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) the definition of Nested-Unit Petri Nets (NUPN) is available from <http://mcc.lip6.fr/nupn.php>

(n) stated by [CÆSAR.BDD](#) version 2.0 to be true on 3 instance(s) out of 6, and unknown on the remaining 3 instance(s).

(o) stated by [CÆSAR.BDD](#) version 2.0 to be false on 3 instance(s) out of 6, and unknown on the remaining 3 instance(s); confirmed at MCC'2014 by Tapaal, GreatSPN, and Lola on the 2, 3, and 4 smallest instances, respectively.

(p) stated by [CÆSAR.BDD](#) version 2.0 to be true on 3 instance(s) out of 6, and unknown on the remaining 3 instance(s).

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

## 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.

<sup>(q)</sup> 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.

<sup>(r)</sup> computed at MCC'2014 by Marcie.

<sup>(s)</sup> confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.

<sup>(t)</sup> computed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.

<sup>(u)</sup> 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.

<sup>(v)</sup> computed at MCC'2014 by Marcie.

<sup>(w)</sup> confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.

<sup>(x)</sup> confirmed at MCC'2014 by GreatSPN, Marcie, PNMC, and Tapaal.

<sup>(y)</sup> 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.

<sup>(z)</sup> computed at MCC'2014 by Marcie.

<sup>(aa)</sup> confirmed at MCC'2014 by GreatSPN, Marcie, and PNMC.

<sup>(ab)</sup> computed at MCC'2014 by GreatSPN, Marcie, and PNMC.

<sup>(ac)</sup> computed at MCC'2014 by PNMC.

<sup>(ad)</sup> computed at MCC'2014 by PNMC.

<sup>(ae)</sup> computed at MCC'2014 by PNMC.

<sup>(af)</sup> computed at MCC'2014 by PNMC.

<sup>(ag)</sup> computed at MCC'2014 by PNMC.

<sup>(ah)</sup> computed at MCC'2014 by PNMC.

<sup>(ai)</sup> computed at MCC'2014 by PNMC.

<sup>(aj)</sup> computed at MCC'2014 by PNMC.

<sup>(ak)</sup> computed at MCC'2014 by PNMC.