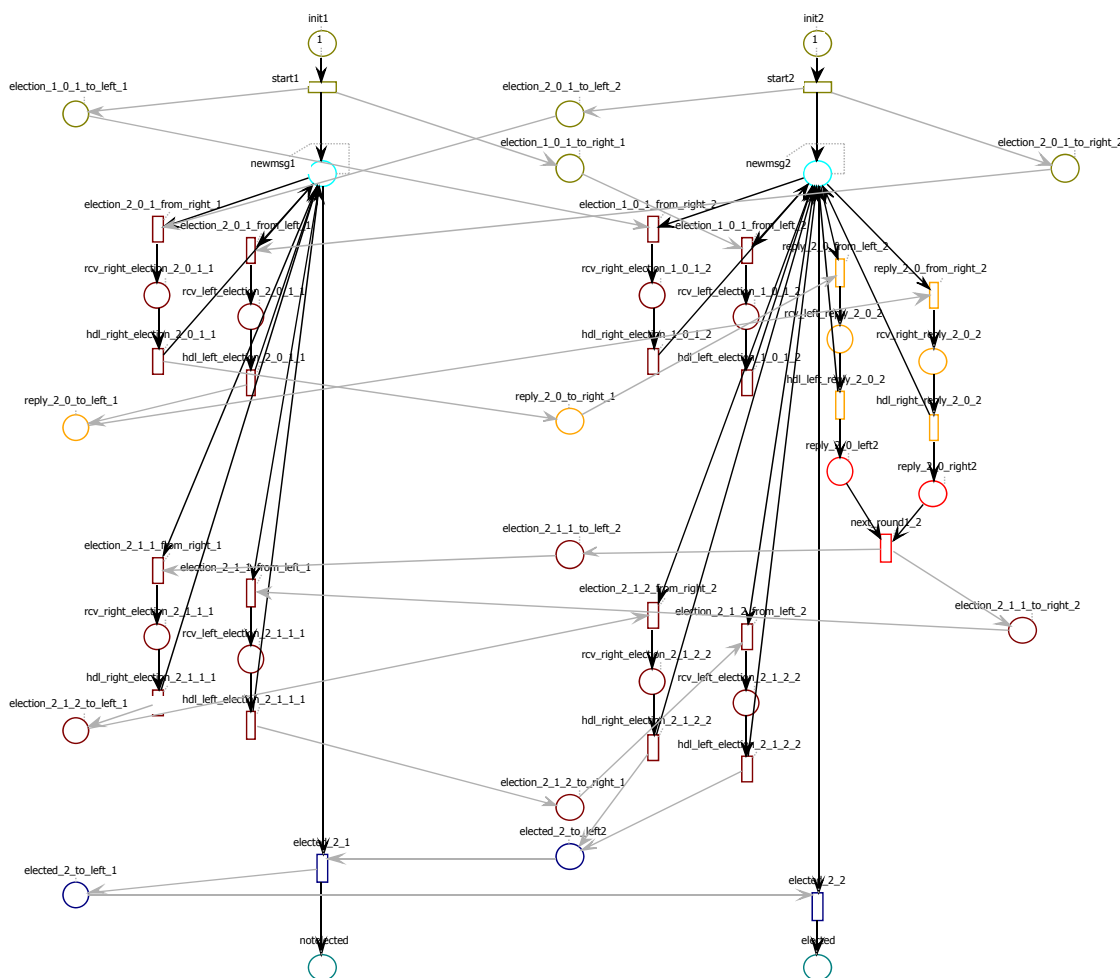


*This form is a summary description of the model entitled “HirschbergSinclair” proposed for the Model Checking Contest @ Petri Nets. Models can be given in several instances parameterized by scaling parameters. Colored nets can be accompanied by one or many equivalent, unfolded P/T nets. Models are given together with property files (possibly, one per model instance) giving a set of properties to be checked on the model.*

## Description

This Petri net models a simplified version of the Hirschberg and Sinclair algorithm (leader election in a synchronous ring network). This was one of the Tra My Nguyen’s exercices during her bachelor.



Graphical representation for  $n = 2$

## References

Daniel S. Hirschberg, James B. Sinclair: Decentralized Extrema-Finding in Circular Configurations of Processors. Communications of the ACM 23(11): 627-628 (1980)

## Scaling parameter

Parameter name	Parameter description	Chosen parameter values
$n$	$n$ is the number of processes in the ring	5, 10, 15, 20, 25, 30, 35, 40, 45, 50

## Size of the model

Parameter	Number of places	Number of transitions	Number of arcs
5	124	111	340
10	260	236	721
15	330	296	906
20	530	485	1 479
25	600	545	1 664
30	670	605	1 849
35	998	922	2 806
40	1 068	982	2 991
45	1 138	1 042	3 176
50	1 208	1 102	3 361

## Structural properties

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

## Behavioural properties

<b>safe</b> — in every reachable marking, there is no more than one token on a place .....	? (o)
<b>dead place(s)</b> — one or more places have no token in any reachable marking .....	✗
<b>dead transition(s)</b> — one or more transitions cannot fire from any reachable marking .....	✗
<b>deadlock</b> — there exists a reachable marking from which no transition can be fired .....	✓ (p)
<b>reversible</b> — from every reachable marking, there is a transition path going back to the initial marking .....	✗ (q)

(a) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(b) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(c) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(d) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(e) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(f) from place “init1” one cannot reach place “init2”.

(g) at least place “init1”; confirmed by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(h) at least place “notelected”; confirmed by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(i) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(j) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(k) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(l) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(m) stated by [CÆSAR.BDD](#) version 3.5 on all 10 instances (5, 10, 15, 20, 25, 30, 35, 40, 45, 50).

(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 to be false on 4 instance(s) out of 10, and unknown on the remaining 6 instance(s).

(p) Stated by PROD on March 2021.

(q) By construction, since the model ends.

live — for every transition  $t$ , from every reachable marking, one can reach a marking in which  $t$  can fire .....  $\times$  <sup>(r)</sup>

### Size of the marking graphs

Parameter	Number of reach-able markings	Number of tran-sition firings	Max. number of tokens per place	Max. number of tokens per marking
5	$\geq 6.17794e+06$ <sup>(s)</sup>	?	?	$\geq 15$
10	$\geq 6.96577e+12$ <sup>(t)</sup>	?	?	$\geq 30$
15	$\geq 2.93539e+18$ <sup>(u)</sup>	?	?	$\geq 45$
20	$\geq 1.20319e+20$ <sup>(v)</sup>	?	?	$\geq 60$
25	?	?	?	$\geq 75$
30	?	?	?	$\geq 90$
35	?	?	?	$\geq 105$
40	?	?	?	$\geq 120$
45	?	?	?	$\geq 135$
50	?	?	?	$\geq 150$

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<sup>(r)</sup> Stated by PROD on March 2021.

<sup>(s)</sup> stated by [CÆSAR.BDD](#) version 3.5.

<sup>(t)</sup> stated by [CÆSAR.BDD](#) version 3.5.

<sup>(u)</sup> stated by [CÆSAR.BDD](#) version 3.5.

<sup>(v)</sup> stated by [CÆSAR.BDD](#) version 3.5.