Thomas Chatain and Loïc Paulevé
chatain@lsv.fr and loic.pauleve@lri.fr

This form is a summary description of the model entitled "MAPKbis" 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 model is extracted from a set presented in [1] and modeling biological systems, obtained from influence graphs provided by biologists. This particular Petri net describes a Boolean model of Mitogen-Activated Protein Kinase network [2] (MAPK). It is a different model from the variant proposed in this contest in 2011.

In March 2020, Pierre Bouvier 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.

References

1. Loïc Paulevé, "Reduction of Qualitative Models of Biological Networks for Transient Dynamics Analysis", https://hal.archives-ouvertes.fr/hal-01580765.
2. L. Grieco, L. Calzone, I. Bernard-Pierrot, F. Radvanyi, B. Kahn-Perlès, and D. Thieffry, Integrative modelling of the influence of MAPK network on cancer cell fate decision, *PLoS Comput Biol*, vol. 9, no. 10, p. e1003286, oct 2013.

Scaling parameter

Parameter name	Parameter description	Chosen parameter values
n_1, n_2, n_3	setting parameters	$(53, 1, 0)$ and $(53, 2, 0)$

Size of the model

Parameter	Number of places	Number of transitions	Number of arcs	Number of units	HWB code
$(53, 1, 0)$	106	173	986	54	1–53–60
$(53, 2, 0)$	106	173	986	54	1–53–75

Structural properties

ordinary — *all arcs have multiplicity one* ..... yes
simple free choice — *all transitions sharing a common input place have no other input place* ..... no [a]
extended free choice — *all transitions sharing a common input place have the same input places* ..... no [b]
state machine — *every transition has exactly one input place and exactly one output place* ..... no [c]
marked graph — *every place has exactly one input transition and exactly one output transition* ..... no [d]
connected — *there is an undirected path between every two nodes (places or transitions)* ..... yes [e]
strongly connected — *there is a directed path between every two nodes (places or transitions)* ..... yes [f]
source place(s) — *one or more places have no input transitions* ..... no [g]
sink place(s) — *one or more places have no output transitions* ..... no [h]

[a] stated by CÆSAR.BDD version 3.3 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[b] stated by CÆSAR.BDD version 3.3 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[c] 173 transitions are not of a state machine, e.g., transition "AKT_equals_0_to_AKT_equals_1_when_PDK1_equals_1_and_PTEN_equals_0".
[d] stated by CÆSAR.BDD version 3.3 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[e] stated by CÆSAR.BDD version 2.8 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[f] stated by CÆSAR.BDD version 2.8 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[g] stated by CÆSAR.BDD version 2.8 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[h] stated by CÆSAR.BDD version 2.8 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).

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source transition(s) — *one or more transitions have no input places* ..... no [i]
sink transitions(s) — *one or more transitions have no output places* ..... no [j]
loop-free — *no transition has an input place that is also an output place* ..... no [k]
conservative — *for each transition, the number of input arcs equals the number of output arcs* ..... yes [l]
subconservative — *for each transition, the number of input arcs equals or exceeds the number of output arcs* ..... yes [m]
nested units — *places are structured into hierarchically nested sequential units* [n] ..... yes

Behavioural properties

safe — *in every reachable marking, there is no more than one token on a place* ..... yes [o]
dead place(s) — *one or more places have no token in any reachable marking* ..... yes [p]
dead transition(s) — *one or more transitions cannot fire from any reachable marking* ..... yes [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* ..... ? [s]
live — *for every transition t, from every reachable marking, one can reach a marking in which t can fire* ..... no [t]

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
$(53, 1, 0)$	$\geq$ 2.3263e+11 [u]	?	1	53 [v]
$(53, 2, 0)$	8.12646e+06 [w]	?	1	53 [x]

[i] stated by CÆSAR.BDD version 2.8 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[j] stated by CÆSAR.BDD version 2.8 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[k] 173 transitions are not loop free, e.g., transition "AKT_equals_0_to_AKT_equals_1_when_PDK1_equals_1_and_PTEN_equals_0".
[l] stated by CÆSAR.BDD version 2.8 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[m] stated by CÆSAR.BDD version 2.8 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[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 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[p] stated by CÆSAR.BDD version 3.3 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[q] stated by CÆSAR.BDD version 2.8 on all 2 instances (i.e., $(53, 1, 0)$ and $(53, 2, 0)$).
[r] stated by CÆSAR.BDD version 2.8 to be true on 1 instance(s) out of 2, and unknown on the remaining 1 instance(s).
[s] stated by CÆSAR.BDD version 2.8 to be false on 1 instance(s) out of 2, and unknown on the remaining 1 instance(s).
[t] the net has dead transitions.
[u] stated by CÆSAR.BDD version 2.8.
[v] number of initial tokens, because the net is conservative.
[w] stated by CÆSAR.BDD version 2.8.
[x] number of initial tokens, because the net is conservative.