This form is a summary description of the model entitled “MAPK” 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 is extracted from the examples of the data structures and software dependability group of the Brandenburg University of Technology Cottbus and models a biochemical reaction: Mitogen-activated protein kinase kaskade.

Graphical representation for $N = 8$

References

http://www-dssz.informatik.tu-cottbus.de/DSSZ/Examples/Map

Scaling parameter

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Parameter description</th>
<th>Chosen parameter values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N = N_1 + N_2$</td>
<td>$M_0$(MEK) = $M_0$(Phase2) = $N/2$, $M_0$(Raf) = $N$, $M_0$(RasGTP) = $N_1$, $M_0$(Phase1) = $M_0$(ERK) = $N_2$</td>
<td>8, 20, 40, 80, 160, 320</td>
</tr>
</tbody>
</table>

Size of the model

Although the model is parameterized, its size does not depend on parameter values.

- number of places: 22
- number of transitions: 30
- number of arcs: 90

Structural properties

- **ordinary** — all arcs have multiplicity one
- **simple free choice** — all transitions sharing a common input place have no other input place

(a) 14 arcs are not simple free choice, e.g., the arc from place “Phase2” (which has 2 outgoing transitions) to transition “k13” (which has 2 input places).
Behavioural properties

- safe — in every reachable marking, there is no more than one token on a place
- deadlock — there exists a reachable marking from which no transition can be fired
- 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
- live — for every transition $t$, from every reachable marking, one can reach a marking in which $t$ can fire

Size of the marking graphs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number of reachable markings</th>
<th>Number of transition firings</th>
<th>Max. number of tokens per place</th>
<th>Max. number of tokens per marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N = 8$</td>
<td>$6.1106E+6$</td>
<td>$7.8949E+7$</td>
<td>$8$</td>
<td>$36$</td>
</tr>
<tr>
<td>$N = 20$</td>
<td>$8.8126E+10$</td>
<td>$1.6890E+12$</td>
<td>$20$</td>
<td>$90$</td>
</tr>
<tr>
<td>$N = 40$</td>
<td>$4.7829E+14$</td>
<td>$1.1099E+16$</td>
<td>$40$</td>
<td>$180$</td>
</tr>
<tr>
<td>$N = 80$</td>
<td>$3.5349E+18$</td>
<td>$1.4704E+20$</td>
<td>$80$</td>
<td>$360$</td>
</tr>
<tr>
<td>$N = 100$</td>
<td>$1.0640E+23$</td>
<td>?</td>
<td>$160$</td>
<td>$720$</td>
</tr>
<tr>
<td>$N = 320$</td>
<td>$2.6163E+27$</td>
<td>?</td>
<td>$320$</td>
<td>$1440$</td>
</tr>
</tbody>
</table>

(b) transitions “k13” and “k16” share a common input place “Phase2”, but only the former transition has input place “MEKPP”.
(c) 30 transitions are not of a state machine, e.g., transition “k2”.
(d) 22 places are not of a marked graph, e.g., place “Phase1”.
(e) stated by CÆSAR.BDD version 1.7 on all 6 instances (8, 20, 40, 80, 160, and 320).
(f) stated by CÆSAR.BDD version 1.7 on all 6 instances (8, 20, 40, 80, 160, and 320).
(g) stated by CÆSAR.BDD version 1.7 on all 6 instances (8, 20, 40, 80, 160, and 320).
(h) stated by CÆSAR.BDD version 1.7 on all 6 instances (8, 20, 40, 80, 160, and 320).
(i) stated by CÆSAR.BDD version 1.7 on all 6 instances (8, 20, 40, 80, 160, and 320).
(j) stated by CÆSAR.BDD version 1.7 on all 6 instances (8, 20, 40, 80, 160, and 320).
(k) 30 transitions are not conservative, e.g., transition “k2”.
(l) 20 transitions are not subconservative, e.g., transition “k2”.
(m) the definition of Nested-Unit Petri Nets (NUPN) is available from http://mcc.lip6.fr/nupn.php
(n) in the initial marking, some places have several tokens (the number of which depends on $N$).
(o) stated to be false at MCC’2014 by GreatSPN, Lola, and Tappal on one instance ($N = 8$).
(p) stated to be false at MCC’2014 by GreatSPN, Lola, and Tappal on one instance ($N = 8$).
(q) computed at MCC’2013 by GreatSPN, ITS-Tools, Marcie, Neco, and PNXDD; confirmed at MCC’2014 by GreatSPN, Marcie, PNMC, PNXDD, Stratagem, and Tapaal.
(r) computed at MCC’2014 by Marcie.
(s) computed at MCC’2014 by Marcie.
(t) computed at MCC’2014 by Marcie.
(u) computed at MCC’2013 by GreatSPN, ITS-Tools, Marcie, and PNXDD; confirmed at MCC’2014 by Marcie, PNMC, and PNXDD.
(v) computed at MCC’2014 by Marcie, PNMC, and PNXDD.
(w) computed at MCC’2014 by Marcie.
(x) computed at MCC’2014 by Marcie and PNMC.
(v) computed at MCC’2014 by Marcie and PNMC.
(x) computed at MCC’2013 by GreatSPN, ITS-Tools, Marcie, and PNXDD; confirmed at MCC’2014 by Marcie, PNMC, and PNXDD.
(aa) computed at MCC’2014 by Marcie.
(ab) computed at MCC’2014 by Marcie and PNMC.
(ac) computed at MCC’2014 by ITS-Tools, and PNXDD; confirmed at MCC’2014 by Marcie and PNMC.
(ad) computed at MCC’2014 by ITS-Tools, and PNXDD; confirmed at MCC’2014 by Marcie and PNMC.
(ae) computed at MCC’2014 by Marcie.
(af) computed at MCC’2014 by Marcie and PNMC.
(ag) computed at MCC’2014 by Marcie and PNMC.
(ah) computed at MCC’2014 by PNMC.
(ai) computed at MCC’2014 by PNMC.
(aj) computed at MCC’2014 by PNMC.
(ak) computed at MCC’2014 by PNMC.
(al) computed at MCC’2014 by PNMC.
(am) computed at MCC’2014 by PNMC.