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/Mapk

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(\text{MEK}) = M_0(\text{Phase2}) = N/2, ) ( M_0(\text{Raf}) = N, ) ( M_0(\text{RasGTP}) = N_1, ) ( M_0(\text{Phase1}) ) ( = M_0(\text{ERK}) ) ( = M_0(\text{Phase3}) = 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

- free choice — all (different) transitions with a shared input place have no other input place.
- state machine — every transition has exactly one input place and exactly one output place.

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

\( ^{(b)} \) 30 transitions are not of a state machine, e.g., transition “k2”.

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marked graph — every place has exactly one input transition and exactly one output transition
[ (c) ]
connected — there is a undirected path between every two nodes (places or transitions)
[ (d) ]
strongly connected — there is a directed path between every two nodes (places or transitions)
[ (e) ]
source place(s) — one or more places have no input transitions
[ (f) ]
sink place(s) — one or more places have no output transitions
[ (g) ]
source transition(s) — one or more transitions have no input places
[ (h) ]
sink transition(s) — one or more transitions have no output places
[ (i) ]
loop-free — no transition has an input place that is also an output place
[ (j) ]
conservative — for each transition, the number of input arcs equals the number of output arcs
[ (k) ]
subconservative — for each transition, the number of input arcs equals or exceeds the number of output arcs
[ (l) ]

Behavioural properties

safe — in every reachable marking, there is no more than one token on a place
[ (m) ]
deadlock — there exists a reachable marking from which no transition can be fired
quasi-live — for every transition \(t\), there exists a reachable marking in which \(t\) can fire
[ (n) ]
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>(6.111 \times 10^6) [ (o) ]</td>
<td>?</td>
<td>?</td>
<td>(\geq 36) [ (p) ]</td>
</tr>
<tr>
<td>(N = 20)</td>
<td>(8.813 \times 10^{10} [ (o) ]</td>
<td>?</td>
<td>?</td>
<td>(\geq 90)</td>
</tr>
<tr>
<td>(N = 40)</td>
<td>(4.783 \times 10^{14} [ (o) ]</td>
<td>?</td>
<td>?</td>
<td>(\geq 180)</td>
</tr>
<tr>
<td>(N = 80)</td>
<td>(5.635 \times 10^{18} [ (o) ]</td>
<td>?</td>
<td>?</td>
<td>(\geq 360)</td>
</tr>
<tr>
<td>(N = 160)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>(\geq 720)</td>
</tr>
<tr>
<td>(N = 320)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>(\geq 1440)</td>
</tr>
</tbody>
</table>

(c) 22 places are not of a marked graph, e.g., place “Phase1”.
(d) stated by CÆSAR.BDD version 1.7 on all 6 instances (8, 20, 40, 80, 160, and 320).
(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) in the initial marking, some places have several tokens (the number of which depends on \(N\)).
(n) stated by CÆSAR.BDD version 2.0 on all 6 instances (8, 20, 40, 80, 160, and 320).
(o) Computed by greatSPN, ITS-Tools, marcie, neco, and pxndd at MCC’2013.
(p) lower bound given by the number of initial tokens.
(q) Computed by greatSPN, ITS-Tools, marcie, and pxndd at MCC’2013.
(r) Computed by greatSPN, ITS-Tools, marcie, and pxndd at MCC’2013.
(s) Computed by ITS-Tools, and pxndd at MCC’2013.