Petri Net Based System Analysis

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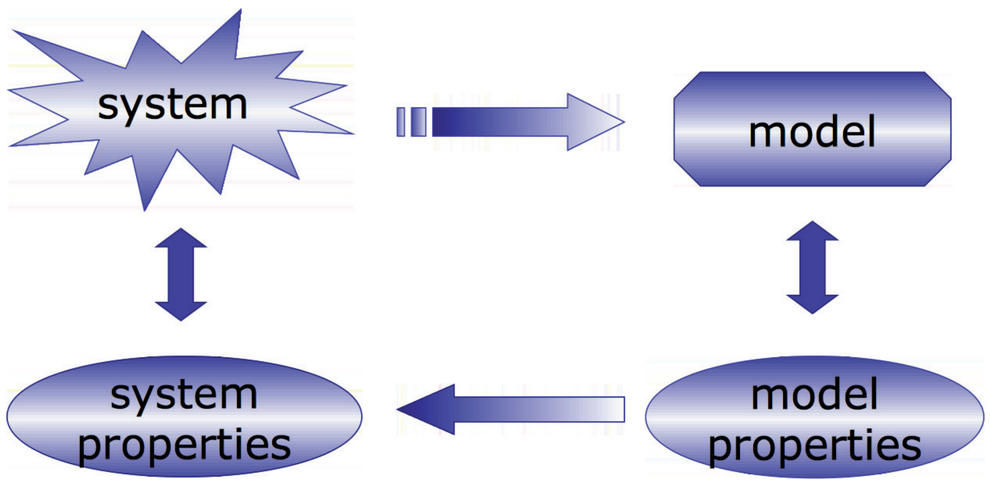
Model-based System Analysis

Verification of Technical Systems

- requirements certification
- quality improvement
- proof engineering

Typical Net Properties

- ordinary
- 1-bounded
- live, reversible
- communicating state machines
- exponential, state space growth



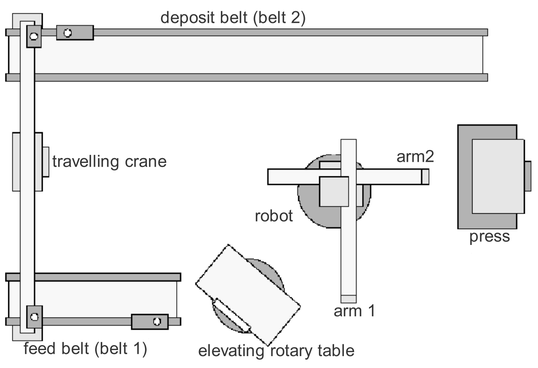
Validation of Natural Systems

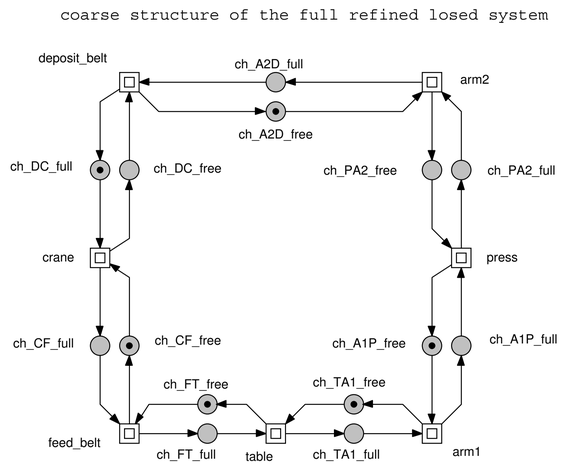
- understanding
- experiment design
- behaviour prediction

Typical Net Properties

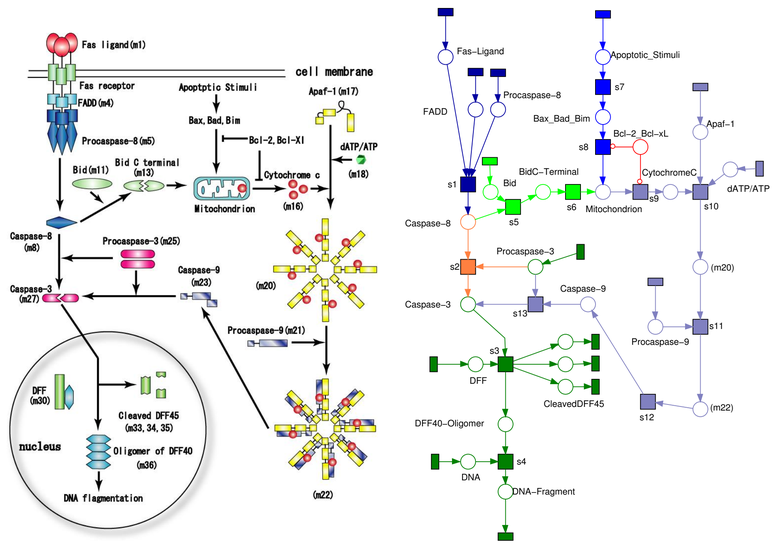
- non-ordinary
- k-bounded / unbounded
- live, reversible, BUT: how to prove?
- apparently unstructured
- over-exponential state space growth

Production Cell [16]

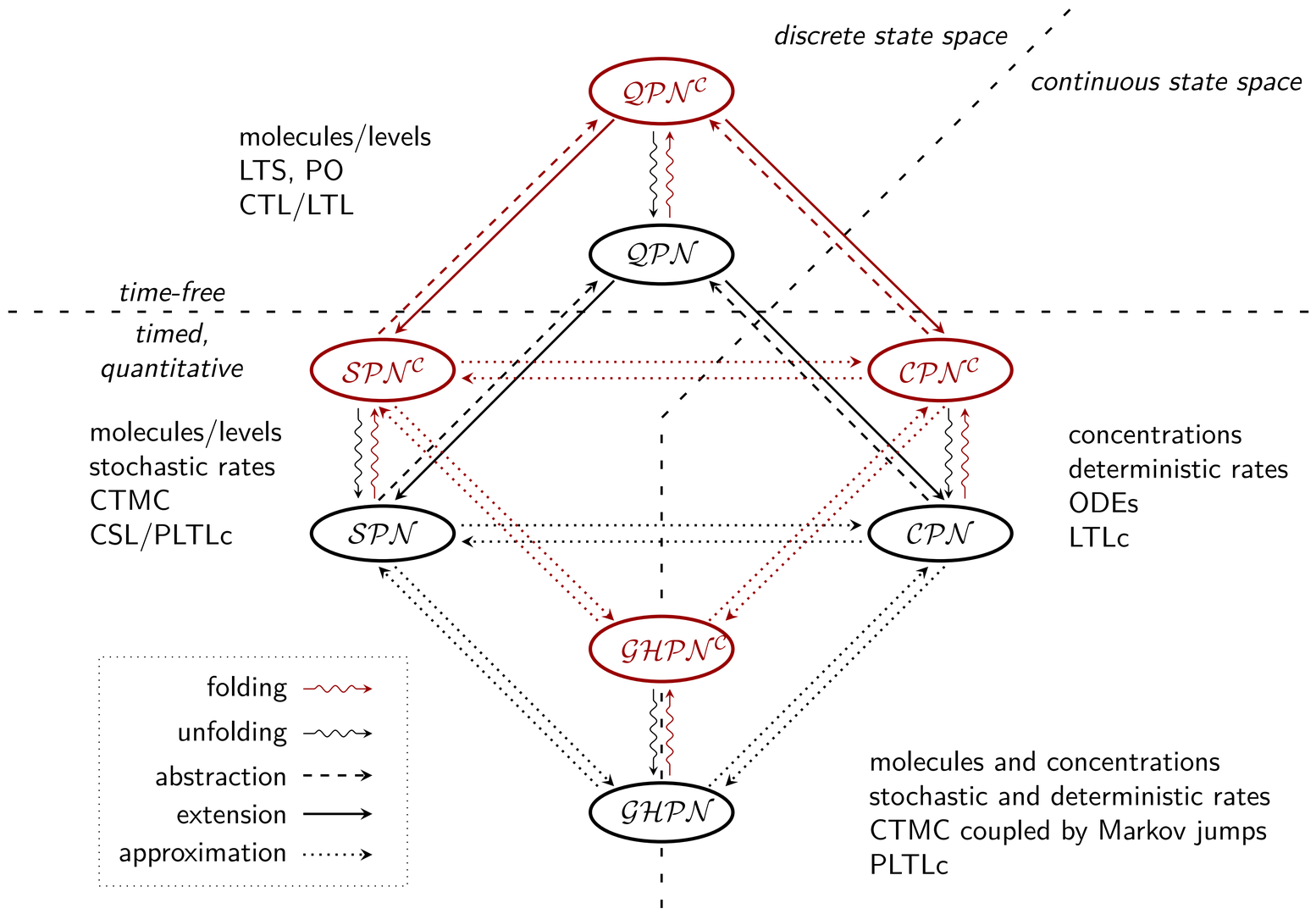




Apoptosis in Mammalian Cells [15]



Conceptional Framework



Tool Kit

CHARLIE [20]

Static – Net Structure

- Net classes
- Deadlock Trap Property
- Place/Transition invariants
- Dependent Sets

Dynamic – Reachability graph

- Liveness, reversibilty, dead states
- Explicit CTL/LTL model checker
- Path search
- Visualization
- Analysis of TPN
- Shortest/Longest paths

SNOOPY [1]

Modelling/Animation

- Different Petri net formalism e.g., QPN, (X)SPN, CPN, GHPN, TPN
- Colored nets: QPN, (X)SPN, CPN, GHPN
- Hierarchies, Coloring

Analysis

- Stochastic Simulation Algorithm (SSA)
- Stiff/unstiff ODE solvers
- Fast adaptive uniformization (FAU)

Import/Export

- SBML, (C)ANDL, CSV

MARCIE [4]

Qualitative Analysis of bounded nets

- Symbolic State Space representation with Interval Decision Diagrams (IDDs)
- Reversibility, liveness, dead states, SCCs
- CTL model checking

Numerical Analysis of bounded (G)SPNs

- IDD-based “on-the-fly" CTMC representation
- Transient/steady-state analysis (multi-threaded)
- CSRL model checking (multi-threaded)

Simulative Analysis of unbounded (X)SPN

- Stochastic Simulation Algorithm (SSA)
- PLTLc model checking

Cooperations

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- K. Sriram, IIIT Delhi, India
- Soliman Sylvain, INRIA Paris

References

Analysis Methods / Tools

1. Heiner M, Herajy M, Liu F, Rohr C, Schwarick M: PETRI NETS 2012
2. Marwan W, Rohr C, Heiner M: Bacterial Molecular Networks 2012
3. Herajy M, Heiner M: J. Nonlinear Analysis: Hybrid Systems 2012
4. Schwarick M, Rohr C, Heiner M: QEST 2011
5. Rohr C, Marvan W, Heiner M: Bioinformatics 2010
6. Schwarick M, Heiner M: CMSB 2009
7. Heiner M, Schwarick M, Tovchigrechko A: PETRI NETS 2009
8. Heiner M, Gilbert D, Donaldson R: SFM 2008

Applications

9. Gao Q, Liu F, Gilbert D, Heiner M, Tree D: CMSB 2011
10. Soliman S, Heiner M: PLoS ONE, 2010
11. Heiner M,Rohr C, Schwarick M, Streif S: CMSB 2010
12. Heiner M, Lehrack S, Gilbert G, Marwan W: LNCS/LNBI 2009
13. Breitling R, Gilbert D, Heiner M, Orton R: Brief. Bioinformatics, 2008
14. Popova-Zeugmann L, Heiner M, Koch I: FI 67: 149-162, 2005
15. Heiner M, Koch I, Will J: J. BioSystems 75/1-3: 15-28, 2004
16. Heiner M, Deussen P, Spranger S: J. of AMT 15: 139-152, 1999

Theses

17. Liu F: Ph.D. Thesis, BTU Cottbus, CS Dept. 2012
18. Tovchigrechko A: Ph.D. Thesis, BTU Cottbus, CS Dept. 2008
19. Spranger A: Ph.D. Thesis, BTU Cottbus, CS Dept. 2001
20. Franzke A: Diploma Thesis, Charlie 2.0, 12/2009
21. Lehrack S: Diploma Thesis, SPN - Snoopy, 11/2007
22. Scheibler D: Diploma Thesis, Continuous Snoopy, 01/2006
23. Fieber M: Diploma Thesis, Snoopy, 07/2004
24. Noack A: Study Project, BDD CTL Model checking, 06/1999