Generalized Hybrid Petri Nets

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Motivations

- Some biological models require to be represented in hybrid way (Cells/Molecular interactions in one model).
- Continuous deterministic simulation does not consider the fluctuation of molecules, specially when there is a low number of them.
- Stochastic Simulation is computational expensive(fast reactions, large number of molecules).

CPN and GSPN

- Continuous Petri Nets:
  - Continuous places
  - Continuous transitions
- Generalized Stochastic Petri Nets
  - Discrete places
  - Stochastic transitions
  - Immediate transitions
  - Deterministic transitions
  - Scheduled transitions

Features of GHPN

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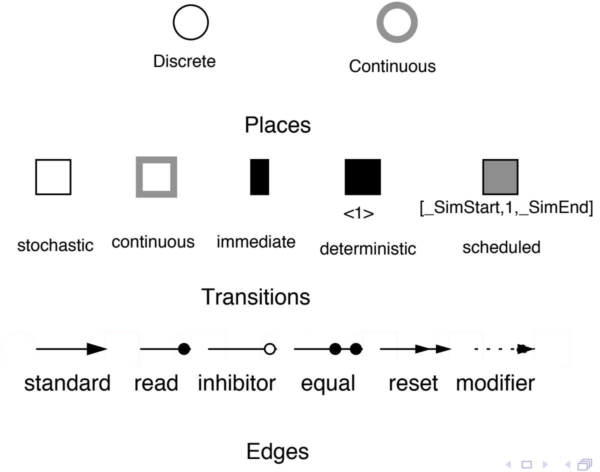
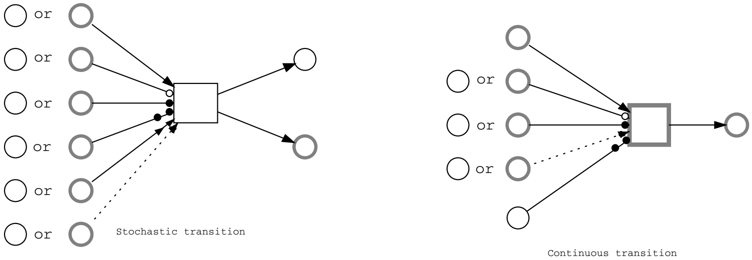
Elements


Discrete
Continuous
Places
<1>
[_SimStart,1,_SimEnd]
stochastic
continuous
immediate
deterministic
scheduled
Transitions
standard
read
inhibitor
equal
reset
modifier
Edges

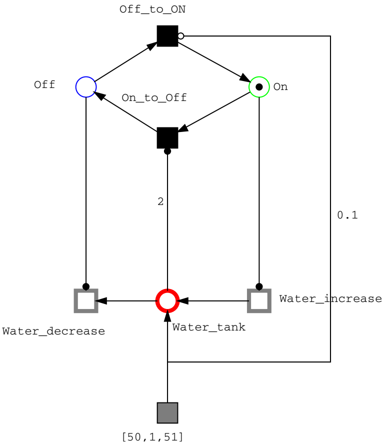
Connectivity



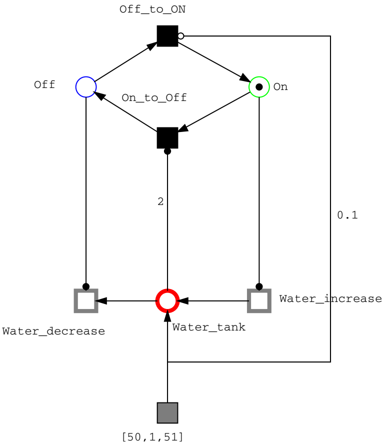
Examples

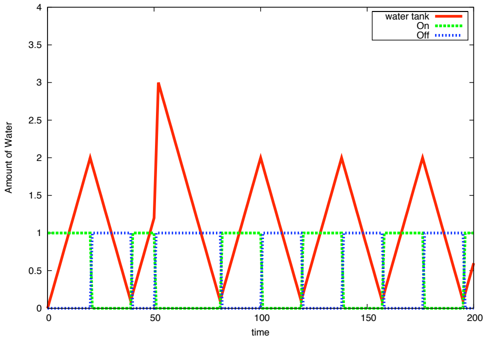
- Water Tank
- T7 Phage
- Goutsias Model

The Water Tank Model



The Water Tank Model





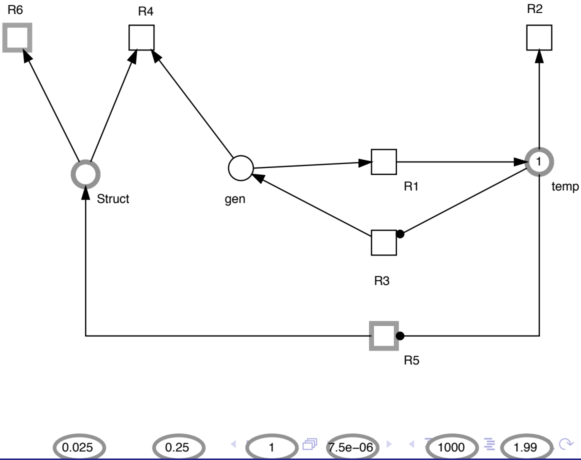
T7 Phage

No.	Reaction	Propensity	Rate
R1	$gen \rightarrow temp$	$c_1 \cdot gen$	$c_1 = 0.0025$
R2	$temp \rightarrow \phi$	$c_2 \cdot temp$	$c_2 = 0.25$
R3	$temp \rightarrow temp + gen$	$c_3 \cdot temp$	$c_3 = 1.0$
R4	$gen + struct \rightarrow "virus"$	$c_4 \cdot gen \cdot struct$	$c_4 = 7.5 \times 10E - 6$
R5	$temp \rightarrow temp + struct$	$c_5 \cdot temp$	$c_5 = 1000$
R6	$struct \rightarrow \phi$	$c_6 \cdot struct$	$c_6 = 1.99$

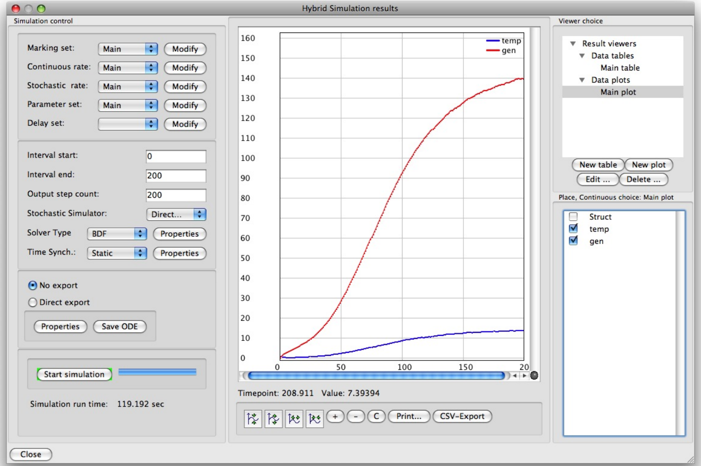
Srivastava et al 2002

T7 Phage (GHPN)

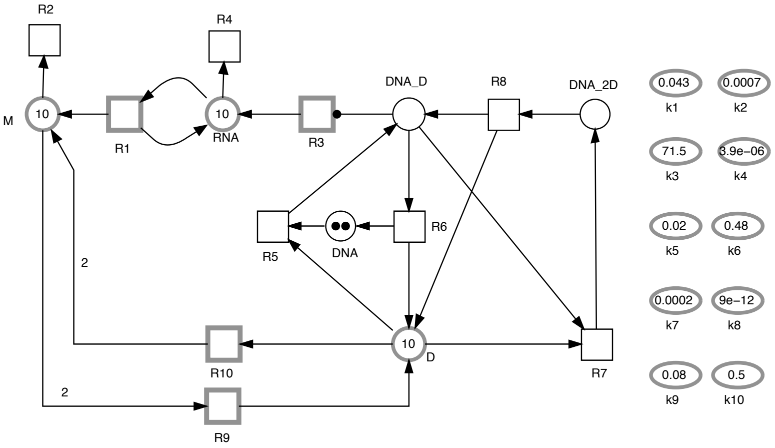
- R_5 and R_6 are represented as continuous reactions
- R_1, R_2,R_3, and R_4 are represented as continuous reactions



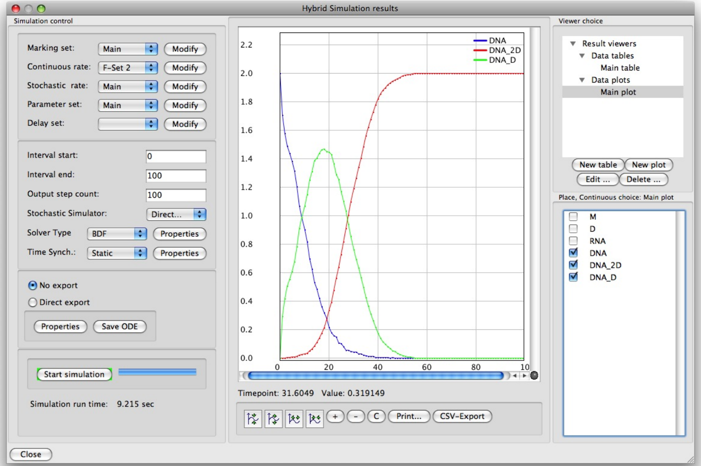
T7 Phage Simulation Results



Goutsias Model (GHPN)



Goutsias Model (Simulation Results)



Simulation Time

	Continuous	Stochastic	hybrid (static)	hybrid (dynamic)
Goutsias	0.01	0.972	0.014	0.138
T7 Phage	0.007	12.36	0.210	0.107

Try It Now

- Get your copy at: http://www-dssz.informatik.tu-cottbus.de/DSSZ/Software/Snoopy
- The implementation is freely available as part of Snoopy
- GHPN enjoys all of Snoopy features

Thank You