

SBML L3 Qualitative model package

- Standard format for qualitative models
- Future extensions
- Simulation parameters **SED-ML**

Chaouiya et al. *BMC Systems Biology* 2013, 7:135
<http://www.biomedcentral.com/1752-0509/7/135>



METHODOLOGY ARTICLE

Open Access



SBML qualitative models: a model representation format and infrastructure to foster interactions between qualitative modelling formalisms and tools

Meeting report for
Biology Network

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<http://identifiers.org/combine.specifications/sbml.level-3.version-1.qual.version-1.release-1>

SBML Level 3 Package Specification

Qualitative Models

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Version 1 Release 1

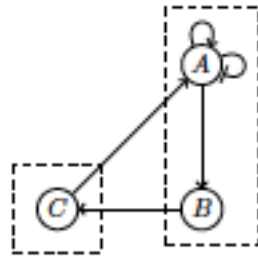


Figure 4: A simple Logical Regulatory Network.

Logical (Boolean / multi-level) models

The logical functions are the following:

$$A_{t+1} := \begin{cases} 2 & \text{if } (1 \leq A_t < 2) \text{ or } ((C_t \geq 1) \text{ and } (A_t \geq 1)) \\ 1 & \text{if } (A_t < 1) \text{ and } (C_t \geq 1) \\ 0 & \text{otherwise} \end{cases}$$

$$B_{t+1} := \begin{cases} 1 & \text{if } A_t \geq 1 \\ 0 & \text{otherwise} \end{cases} \quad C_{t+1} := \begin{cases} 1 & \text{if } B_t \geq 1 \\ 0 & \text{otherwise} \end{cases}$$

Standard Petri nets

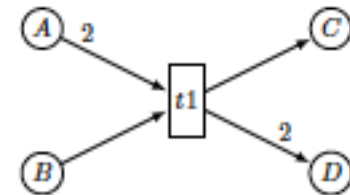
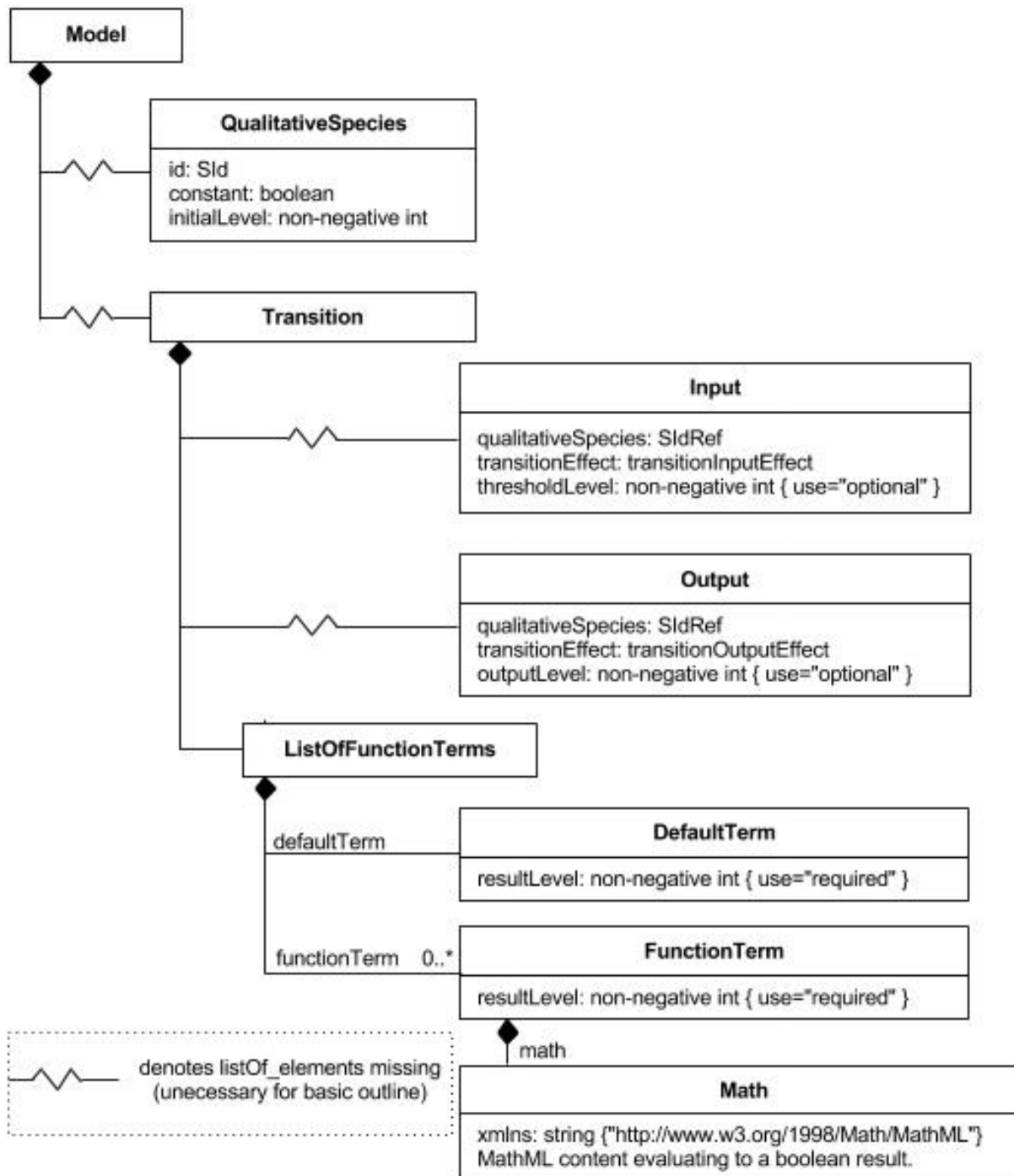


Figure 5: A Petri net model

→ Discrete events dynamical systems

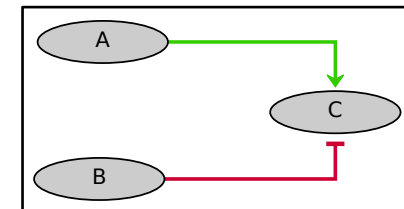


SBML Level 3 Qualitative Model Package Version 1 Release 1

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```



3 qualitative species (A, B, C)

Transition tr_C
with two inputs (A, B)

and one output (C),
which is assigned a
value upon tr_C effect

C is set to 0 by default
C is set to 1 if the following
condition is fulfilled

A=1 AND B=0

The default and function
terms defining the value
assigned to C

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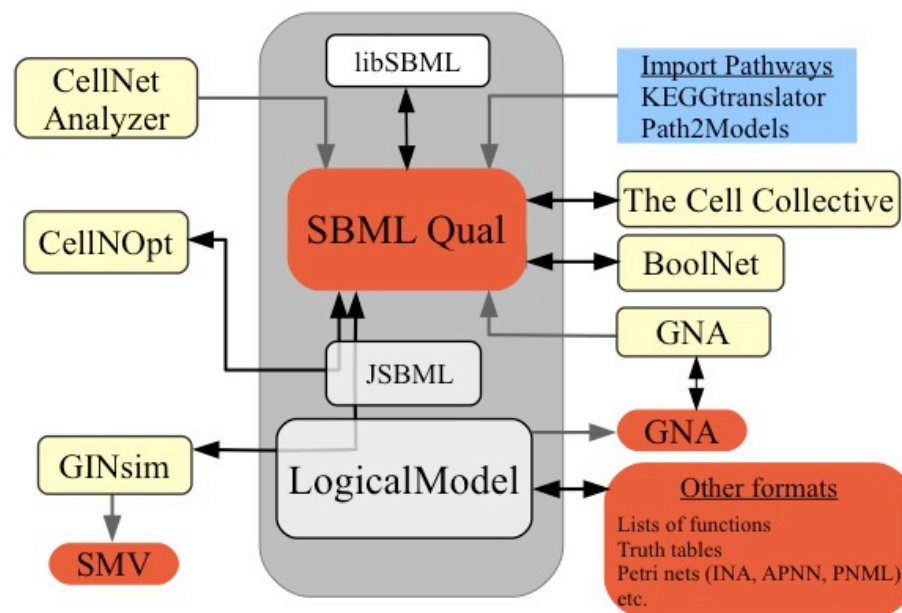
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SBML qualitative package inter-operability between tools demonstrated



Future extensions?

Symbols

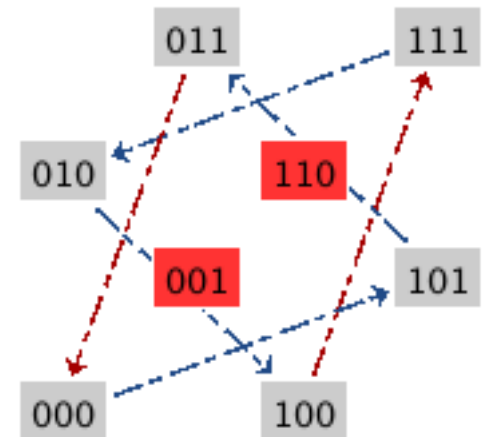
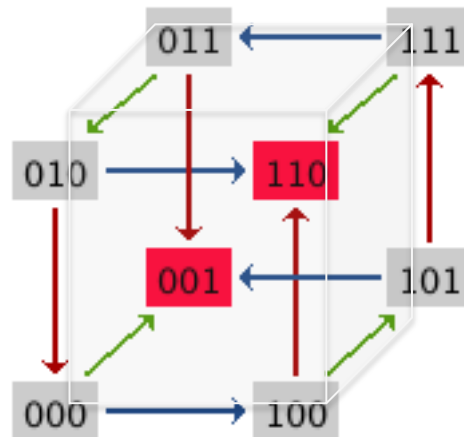
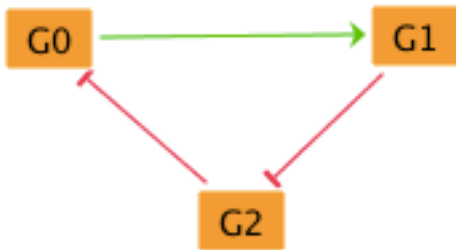
Temporisations

Classes (sets) of models, random models

Interaction with SBML Core concepts

WHAT ABOUT SIMULATION PARAMETERS?

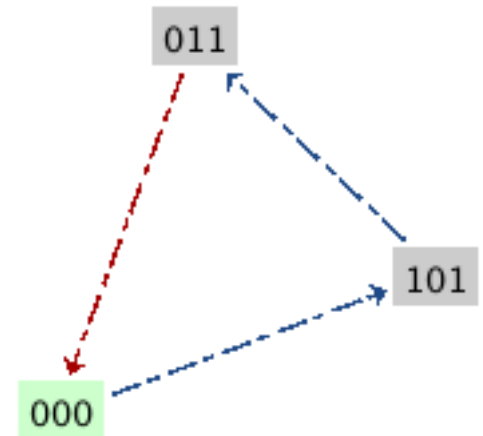
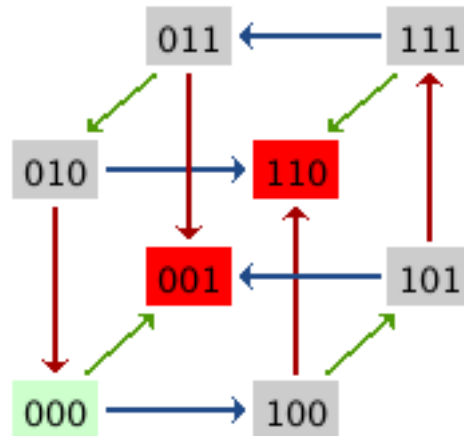
Dynamics over the whole state space



ASYNCHRONOUS

SYNCHRONOUS

From an initial condition



Simulation parameters in GINsim

Perturbations

Updating scheme

Representation of the dynamics

Initial conditions
0 (all) or 1,...

Strategy + limitation of the exploration
Reduction of (pseudo)-outputs

Construction of the Dynamics

Select a perturbation:

Strip outputs

Simulation Settings

filter:

parameter_1
parameter_2
parameter_3
parameter_4

Construction Strategy

Breadth First Depth First

Size limits

Depth:
Number of States:

Priority Class Selection

Initial States

name	use	G0	G1	G2
initState_1	<input checked="" type="checkbox"/>	M1	0	0
initState_2	<input type="checkbox"/>	0	0	0

Perturbations menu:

- ✓ --
- G0 KO
- G1 E1
- G0 KO G1 E1

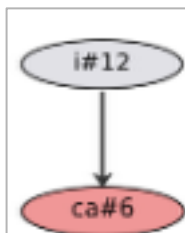
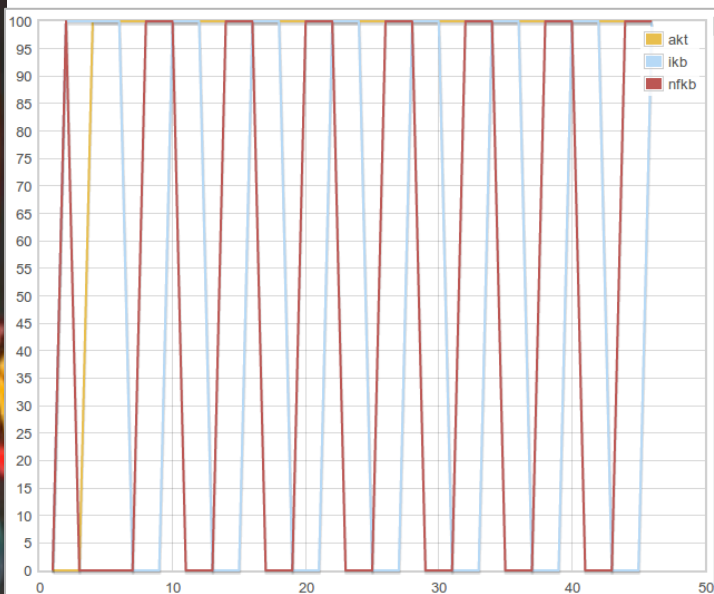
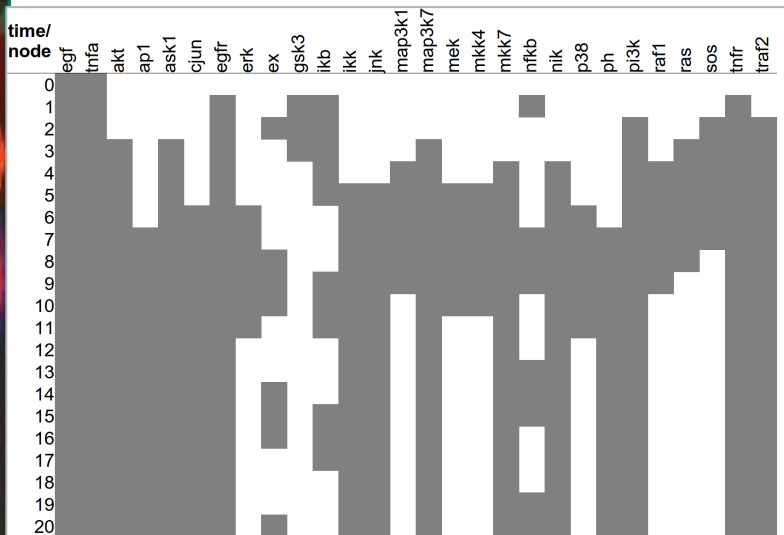
Updating scheme menu:

- ✓ asynchronous
- synchronous
- priorities_1

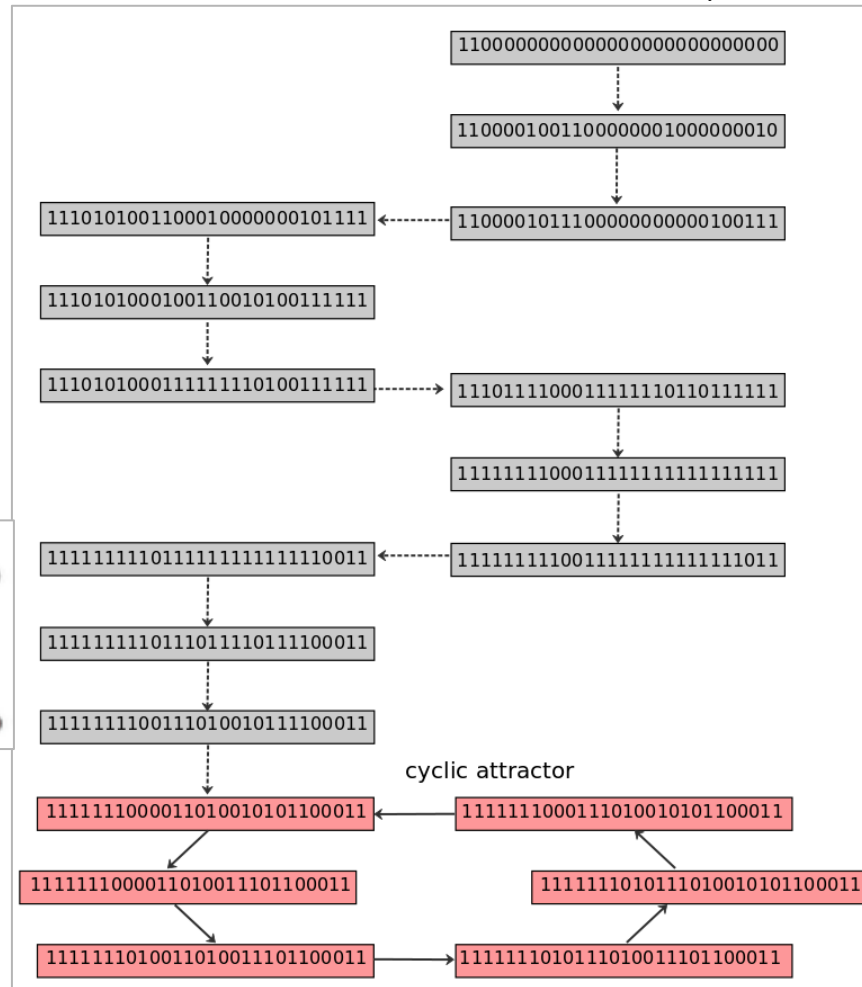
Representation of the dynamics menu:

- ✓ State Transition Graph
- Strongly Connected Components Graph
- Hierarchical Transition Graph

Representations of the dynamics



A Boolean model, synchronous update





A variety of updating schemes

Block-sequential

Stochastic simulations BoolNet, MaBoss

A variety of strategies to limit the construction of the dynamics

Exploration strategy (breadth/depth first)

Number of states / depth limitation

Specification of the behaviour of input nodes

Cell Collective vs GINSim

Perturbations: modification of the logical functions

Representation of the dynamics

SED-ML is an XML-based format for encoding simulation setups, to ensure exchangeability and reproducibility of simulation experiments. It follows the requirements defined in the MIASE guidelines.

Conclusions from last COMBINE meeting

Add terms in KISAO Kinetic Simulation Algorithm Ontology (KiSAO, [Courtot et al., 2011])

- modeling and simulation algorithm
 - + CVODE-like method
 - ... hard-particle molecular dynamics
 - + hybrid method
 - + iterative method for linear system
 - ... Lagrangian sliding fluid element algorithm
 - + Livermore solver
 - logical model simulation method ←
 - ... asynchronous logical model simulation
 - ... synchronous logical model simulation
 - + metamodelling method
 - Monte Carlo method ←
 - ... first-passage Monte Carlo algorithm
 - + Gillespie-like method
 - ... Metropolis Monte Carlo algorithm
 - + multistep method
 - + Newton-type method
 - + one-step method
 - + partial differential equation discretization
 - ... preconditioning technique
 - + rule-based simulation method
 - ... S-System power-law canonical differential equations solver
 - + Smoluchowski equation based method
 - + steady state method

- + modeling and simulation algorithm
- modeling and simulation algorithm characteristic
 - ... hybridity
 - ... spatial description
 - ... symplecticness
 - + type of domain geometry handling
 - + type of method
 - + type of problem
 - + type of progression time step
 - + type of solution
 - type of system behaviour ←
 - ... deterministic system behaviour
 - ... stochastic system behaviour
 - type of updating policy ←
 - + ordered updating policy
 - ... constant updating policy
 - ... prioritized updating policy
 - ... random updating policy
 - + type of variable

SBML Test Suite

Version 3.1.0, released 11 December 2013 (see box at right →)

Latest test case archive released 26 January 2014



The SBML Test Suite is a conformance testing system. It allows developers and users to test the degree and correctness of the SBML support provided in a software package. The test files are platform-independent and can be used on any OS.

The main authors are **Sarah M. Keating**, **Frank Bergmann**, **Lucian Smith**, **Michael Hucka**, and Kimberly Begley.

Components and facilities

The current SBML Test Suite consists of the following components:

- A collection of SBML models, together with expected simulation outputs, that can be used to test interpretation of SBML model semantics. The set of test cases can be downloaded as a **complete archive** [↗](#), or a subset of selected tests can be obtained using the online portion of the Test Suite.
- The **SBML Test Runner** [↗](#), a standalone application that can be used to run an application against the collection of simulation test cases and report successes and failures.
- An **online facility** for evaluating the results of running the simulation test cases (as an alternative to the standalone Test Runner)
- An **online database** [↗](#) of test results provided by software authors for their SBML-compatible software packages.