Representing qualitative models of regulatory networks in SBML

Aurélien Naldi

Developemental Biology Institute of Marseilles-Luminy
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Qualitative models of regulatory networks

several formalisms and tools

- Logical formalisms (GINsim, FluxAnalyzer)
- Piecewise Linear Differential Equations (GNA)
- Petri nets

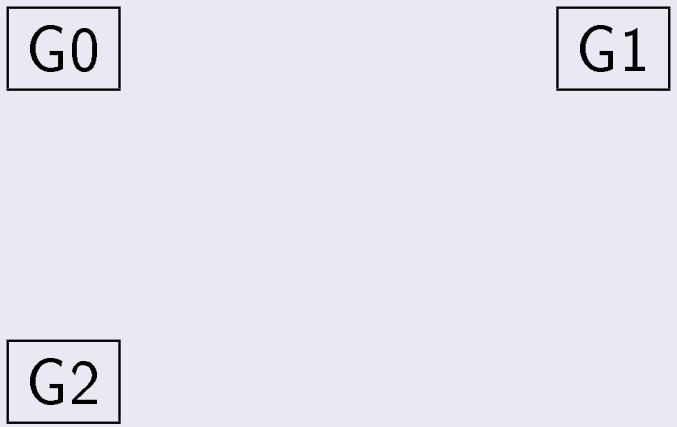
common properties

- Actors of the system: expression level (activity)
- Regulatory mechanisms: regulators not consumed
- Rules controlling the dynamics: next expression level

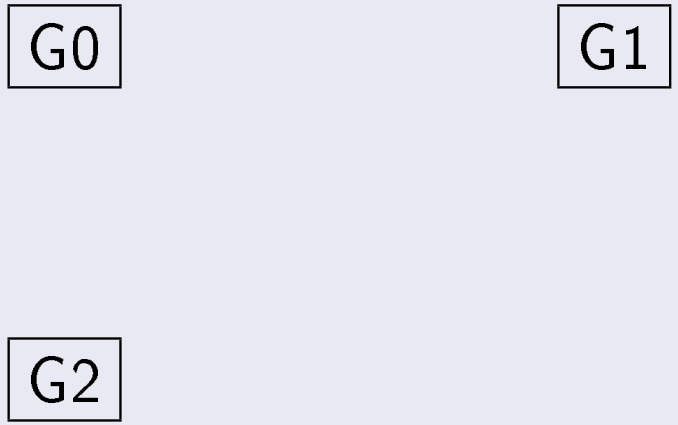
$\Rightarrow$ SBML as exchange format

SBML level2 representation

Regulatory graph



SBML representation



node

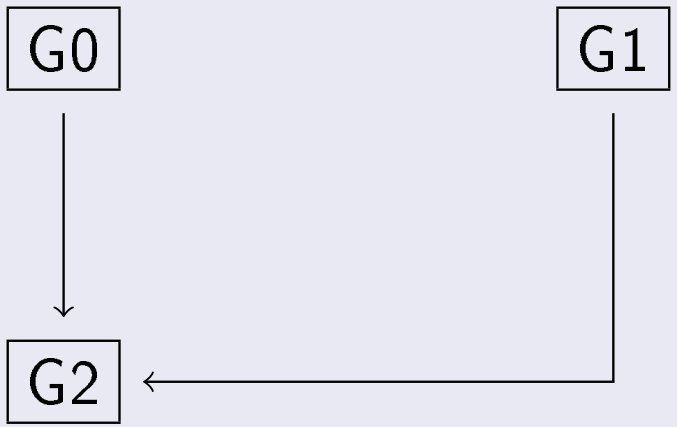
- level of activity

species

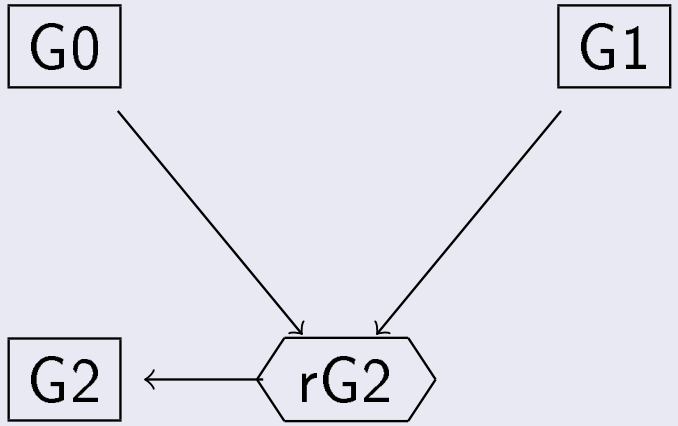
- concentration

SBML level2 representation

Regulatory graph



SBML representation

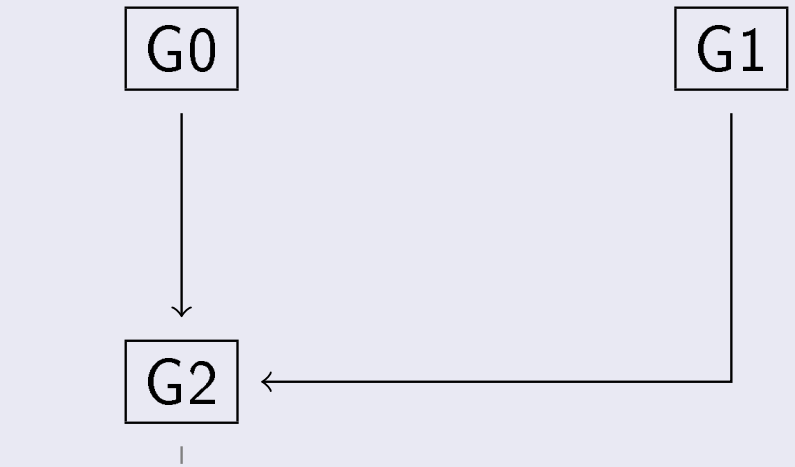


interaction between nodes

reaction

SBML level2 representation

Regulatory graph



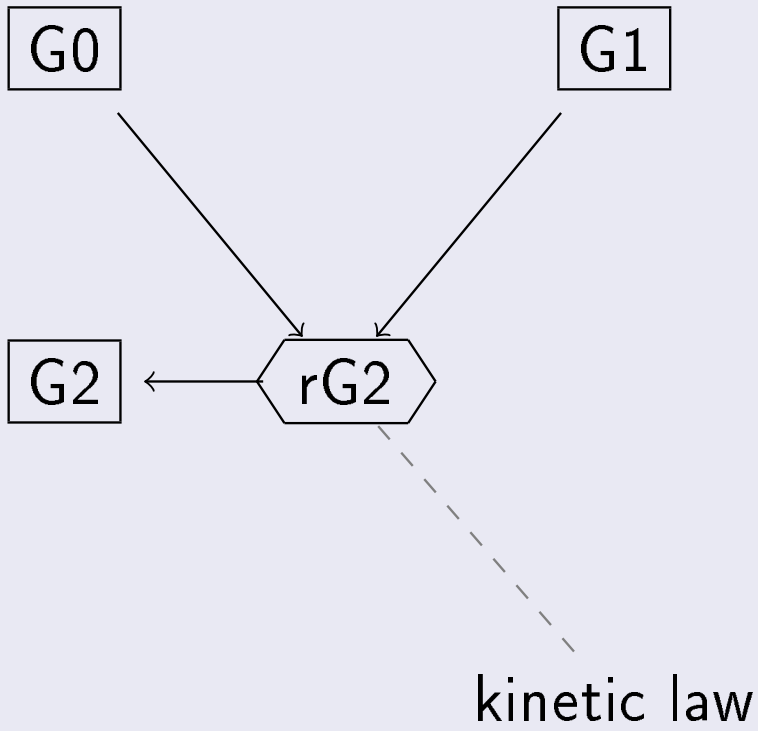
$K_{G2}(\emptyset) = 0$

$K_{G2}(G0) = 1$

...

logical rule

SBML representation



kinetic law

Encoding logical parameters

if $(G1 \vee G0)$then $G2 = 1$
else $G2 = 0$

MathML representation (extract)

```
<piece>
 <piecewise>
  <piece>
   <apply><minus/><cn>1</cn></apply>
   <apply><gt/><ci>s_G2</ci><cn>0</cn></apply>
  </piece>
  <otherwise><cn>0</cn></otherwise>
 </piecewise>
 <apply><eq/><ci>s_G0</ci><cn>0</cn></apply>
</piece>
```

Abusive use of tags and proposal

Several SBML tags have been semantically overloaded:

- Expression level / concentration: not equivalent

$\Rightarrow$ Addition of an *initialActivity* attribute to *species*

- Regulatory mechanisms
  - Not a (single) reaction
  - "target expression level"
  - *event* are not adapted either

$\Rightarrow$ Addition of a *regulation* element

+ *regulatoryTarget*: speciesReference
+ *listOfRegulators*: list of speciesReference
+ *focalPoint*: function giving the target value

Contributors

IBDML

Claudine Chaouiya
Denis Thieffry
Adrien Fauré

MPI Magdeburg

Steffen Klamt
Martin Ginkel