Using and contributing to BioModels

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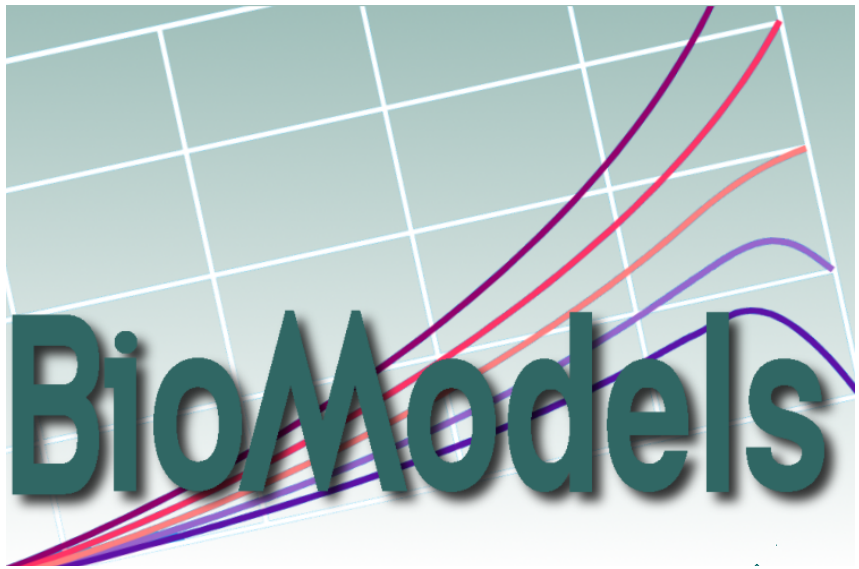


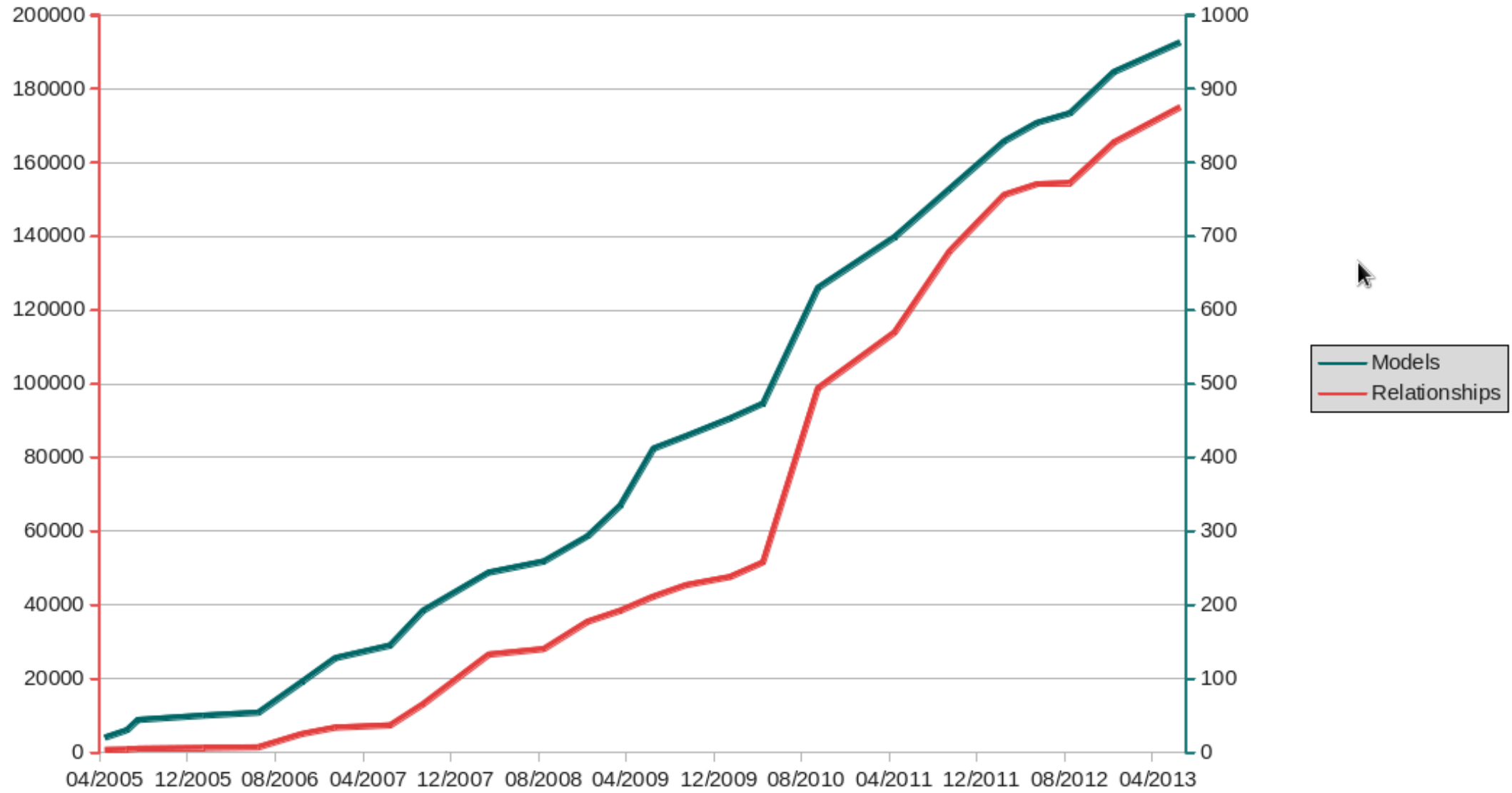
Reusing models

- Availability
- Reliability
- Searchability

Availability

- Models hosted at http://biomodels.net
- Stored in Systems Biology Markup Language (SBML)
  - Other formats coming soon
- Models can be added by authors prior to publication
- Internal or external curators can also submit models that they implemented from the literature
  - This means you!

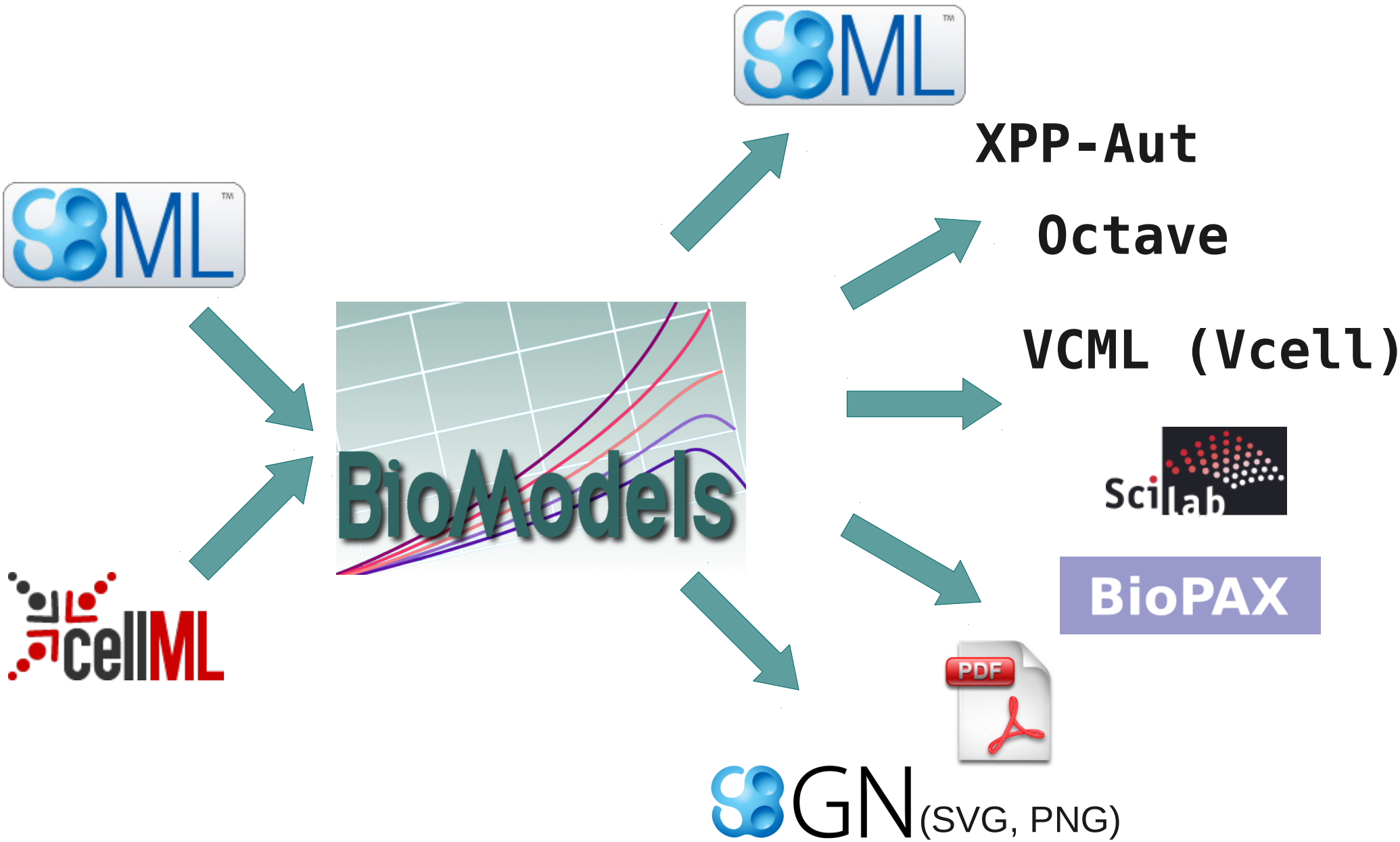
Availability



Systems Biology Markup Language

- Abstracts the biology from the mathematics, so same model can be ODE or stochastic simulation
- Entities in the model are molecular species that exist in compartments
- Species amounts change due to reactions
- Can also specify events, assignment rules, and rate rules
- Parameters can be local or global
- Representation is XML, so optimized for computer processing and extension

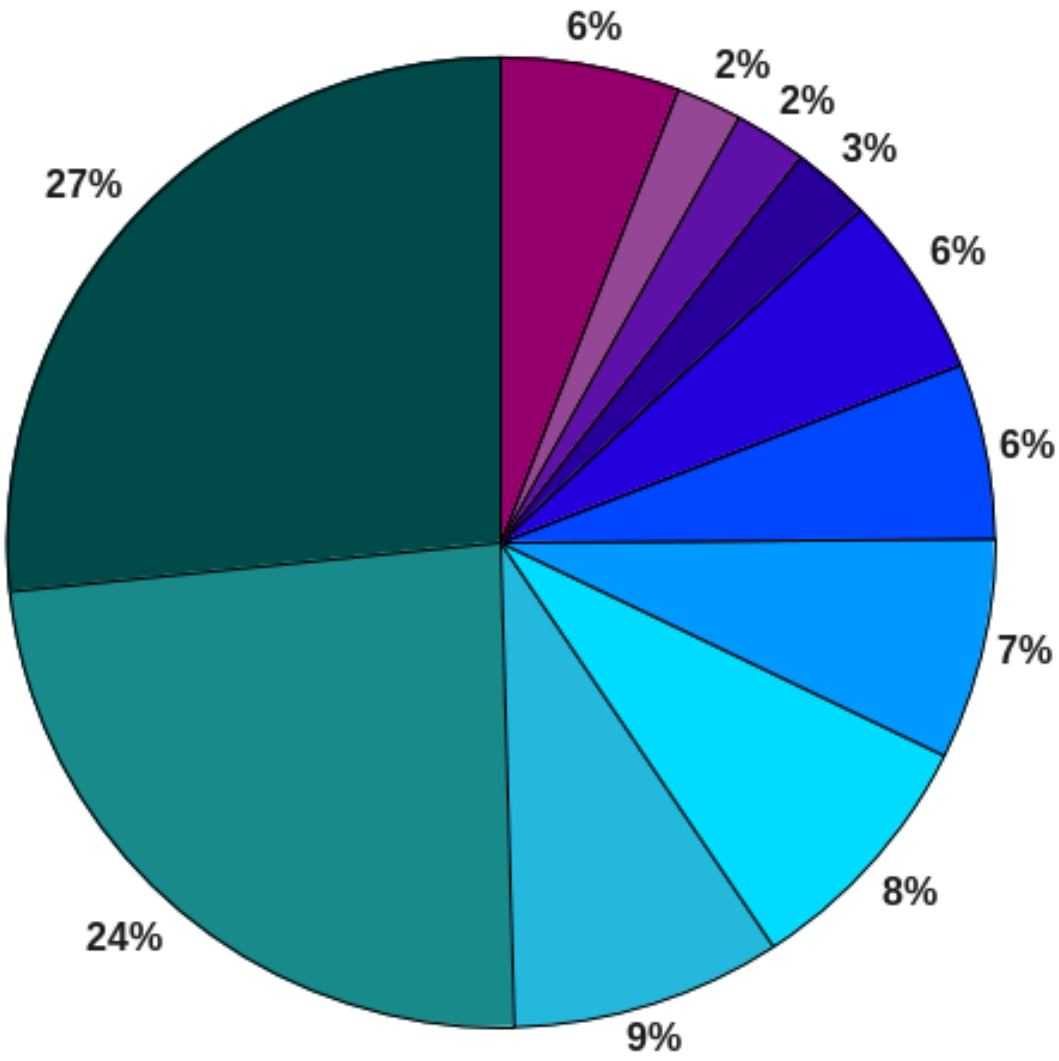
Model formats



Types of BioModels

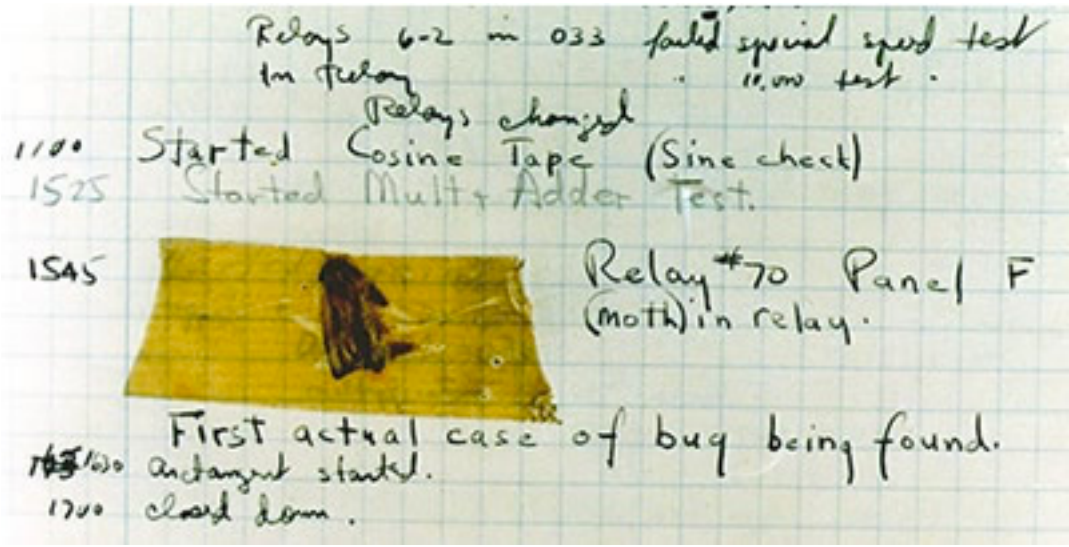
- Biochemical models
  - interactions between molecules in multiple cellular compartments
- Pharmacometrics models
  - tumor growth and treatment response
- Electrophysiology models
  - membrane voltage, current flow, concentration of various ions intra- and extracellularly, …
- Disease models
  - neurodegenerative, diabetes, blood coagulation, infectious diseases (outbreak of zombie infection), ...
- Ecosystem models
  - interaction of living organisms in a given environment

Types of BioModels

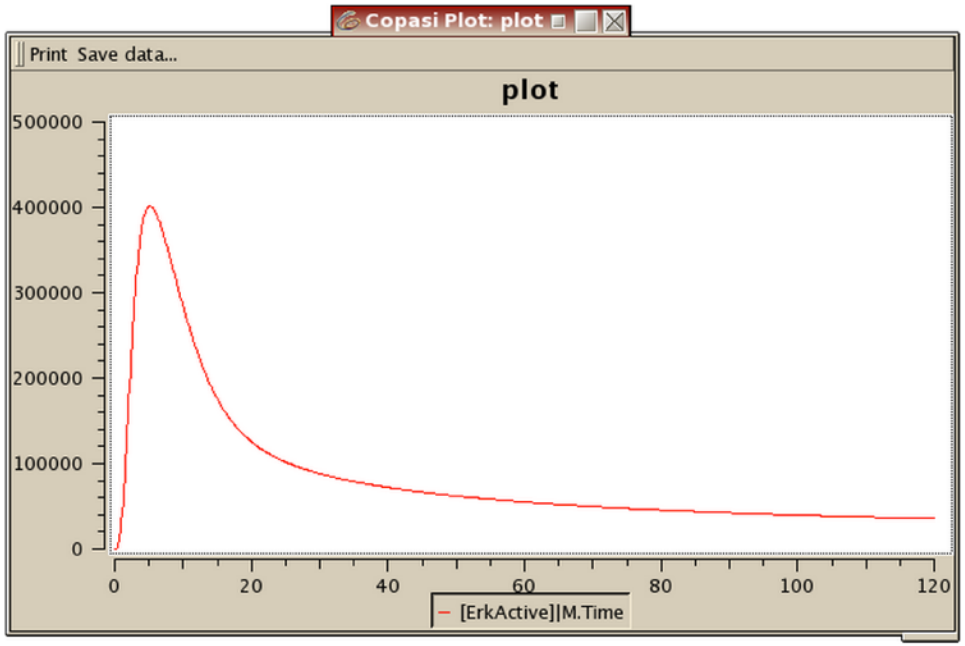


Reliability

- Nontrivial!
  Equations in papers very often have typos or are incomplete.



- Curators ensure that the encoded model can reproduce at least one figure from the paper.



Searchability

- Models in BioModels are extensively annotated with links to other standard biological databases to unambiguously identify them
- Examples:
  - Biological processes: Gene Ontology (GO)
  - Proteins: UniProt
  - Small molecules: CheBI
  - Pathways and reactions: KEGG, Reactome, etc.

Nomenclature is a problem

Kim et al. (2007) *Oncogene*

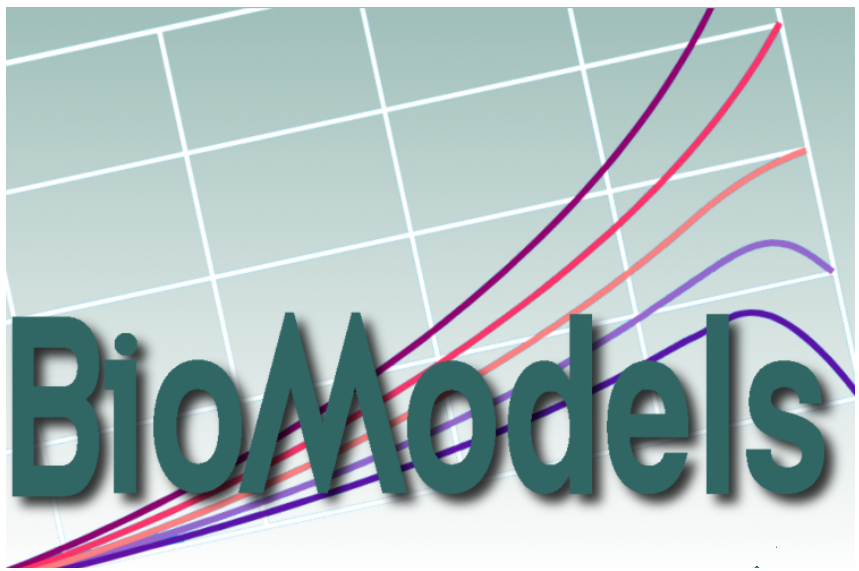
$$\frac{dX1}{dt} = -V1 + V2$$
$$\frac{dX2}{dt} = V1 - V2$$
$$\frac{dX3}{dt} = V4 - V5 - V8 + V10$$
$$\frac{dX4}{dt} = -V3 - V4 + V5 + V6$$
$$\frac{dX5}{dt} = V3 - V6 - V32 + V33$$
$$\frac{dX6}{dt} = V3 - V6 + V7$$
$$\frac{dX7}{dt} = -V7 - V17$$
$$\frac{dX8}{dt} = V8 - V9$$
$$\frac{dX9}{dt} = V9 - V10$$
$$\frac{dX10}{dt} = V10 - V11$$

$$V1 = k_1 * X1 * W$$
$$V2 = k_2 * X2$$
$$V3 = k_3 * X2 * X4$$
$$V4 = k_4 * X4$$
$$V5 = k_5 * X3$$
$$V6 = k_{+6} * X5 * X6 - k_{-6} * X4$$
$$V7 = k_{+7} * X7 * X12 - k_{-7} * X6$$
$$V8 = k_{+8} * X3 * X11 - k_{-8} * X8$$
$$V9 = k_9 * X8$$
$$V10 = k_{10} * X9$$

Can you tell what X1 is?

Uses of BioModels

- Benchmarking modeling and simulation tools
- Building blocks to generate more elaborate models
- Automated clustering and merging of models using annotations



Let's explore!