Dynamic Package

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Dynamic Package Overview

- Multicellular modeling is not well supported within SBML.
- Goal of dynamic package is to provide support for dynamic cellular processes in order to enable multicellular modeling.
- What cellular processes must a dynamic package provide support for?

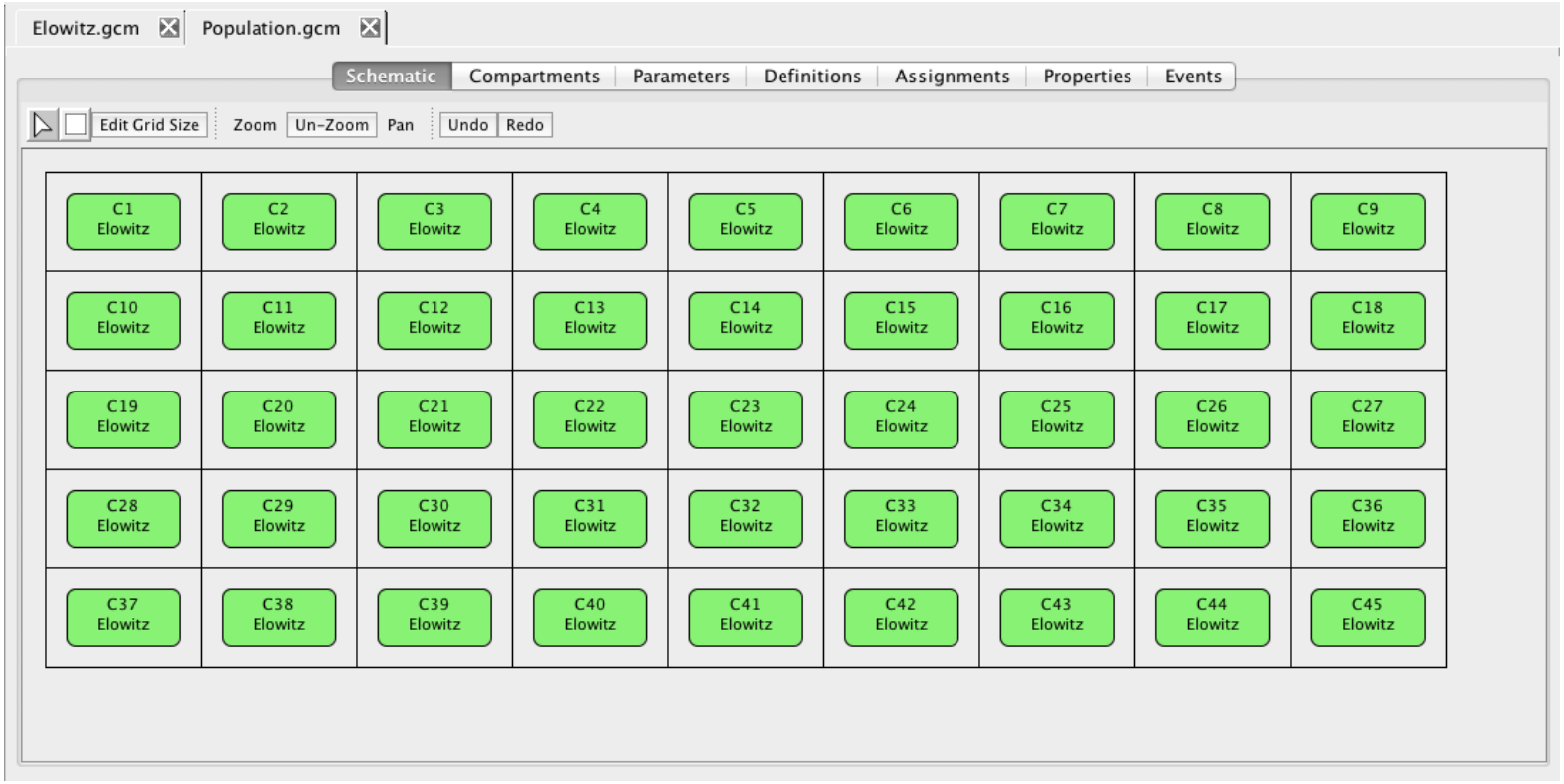
Cell Behavior Ontology

- *Cell Behavior Ontology* (CBO):
  `http://cbo.biocomplexity.indiana.edu/cbo`
- *Property Processes* (object structure remains static):
  - Movement
  - Growth
  - Secretion
  - Absorption
  - Diffusion
  - Decay
  - Advection
- *Entity Processes* (object structure changes):
  - Polarization
  - Differentiation
  - Division
  - Death

Dynamic Modeling Using SBML Core

- Support for property processes is not too difficult:
  - Growth is simply change in compartment size.
  - Secretion, absorption, diffusion, and decay modeled with reactions.
  - Movement is possible with special parameter for location, but difficult to maintain environmental interactions.
- Support for entity processes is possible, but it is a hack:
  - All possible objects that may be needed must be statically instantiated.
  - Cell death is easy, but model objects remain, making simulation inefficient.
  - Cell differentiation is easy, but all needed objects always present.
  - Cell division sort of works, but it is difficult to get just right.

Dynamic Modeling in iBioSim



- Grid supported using arrays and a special location parameter.
- Membrane/transport reactions added automatically for diffusible species.
- Special events for cell division, death, and movement.
- Unfortunately, semantics largely built into the simulator.

Dynamic Structures Package Discussion

- What is required to support modeling dynamic processes?
  - Special events for cell division, death, and movement.
  - A variable that stores a cells location (spatial package?).
  - What else?
- Do any SBML elements other than submodels need to be “dynamic”?
- How precise should semantics be and how much left to the software? Encoding model interconnections is particularly challenging.
- What additional things are needed to support multi-agent modeling?