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**Two Qualitative Dynamics Semantics for SBGN Process Description Maps**

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**Context**

- Larger and larger reaction networks modelling various biological processes (from databases, automatic inference)
- Standards to represent reaction networks: e.g. Systems Biology Graphical Notation Process Description language (SBGN-PD)
- Analysis of the dynamics to understand and control these processes

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**Motivations**

- Qualitative semantics allows to capture important dynamical features (e.g. attractors, reachability) without numerical parameters
- Model SBGN-PD maps under qualitative semantics
  We propose two semantics formalized by asynchronous automata networks: the general semantics, together with a refinement called process conflicts, and the stories semantics

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**Asynchronous Automata Networks**

**General Semantics**

<table>
<thead>
<tr>
<th>State transition graph:</th>
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<tbody>
<tr>
<td>[ a_0 b_1 c_0 \rightarrow a_0 b_0 c_0 ]</td>
</tr>
<tr>
<td>[ a_1 b_1 c_0 \rightarrow a_1 b_1 c_1 ]</td>
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<tr>
<td>[ a_1 b_0 c_0 \rightarrow a_1 b_0 c_1 ]</td>
</tr>
</tbody>
</table>

Each chemical entity is modelled by one automaton

**Refinement 1: Process Conflicts**

Processes \( p \) and \( q \) cannot occur at the same time

**Refinement 2: Stories Semantics**

**Story:**

- accounts for successive transformations of a chemical entity
- a set of entities that cannot be present at the same time, i.e. that are mutually exclusive

**Identification of stories:**

- automatic computation
- relevance determined by expert knowledge

The stories semantics is a refinement of the general semantics driven by expert knowledge

**Example: the AT\(_1\)R-induced network**

**Conclusion and Prospects**

- Main features of SBGN-PD are supported
- The stories semantics is a refinement of the general semantics that:
  - models several chemical species with a unique variable
  - reduces the state space, increasing the scalability of the exhaustive computation of the dynamics
- The dynamics of SBGN-PD maps modelled under both semantics can be analyzed with state-of-the-art tools (PRISM, NuSMV . . .)

**Ongoing work and prospects:**

- Application to a large network, the E2F/RB pathway:
  - 153 out of 208 molecules in 28 stories
  - No. of automata reduced from 367 to 242
- Explore the relationship between the stories semantics and Boolean semantics applied to SBGN-AF maps