CHEMORG III

The Bio-Chemical Information Processing Metaphor as a Programming Paradigm for Organic Computing

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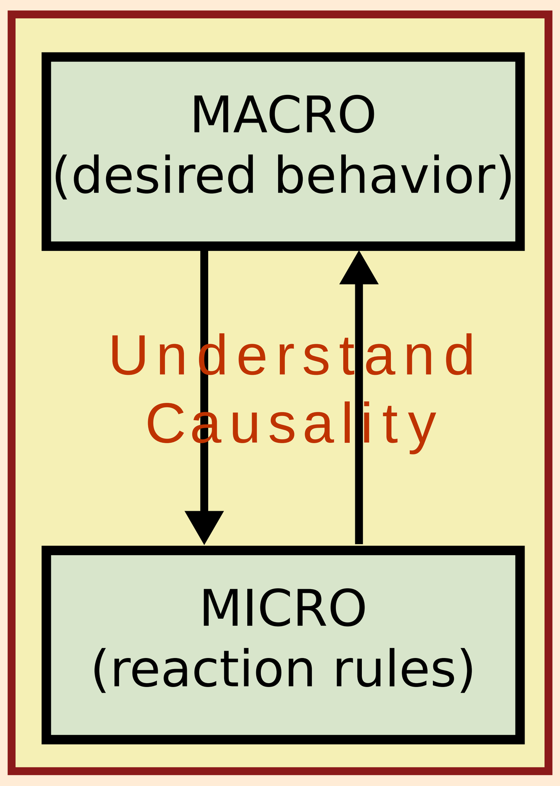
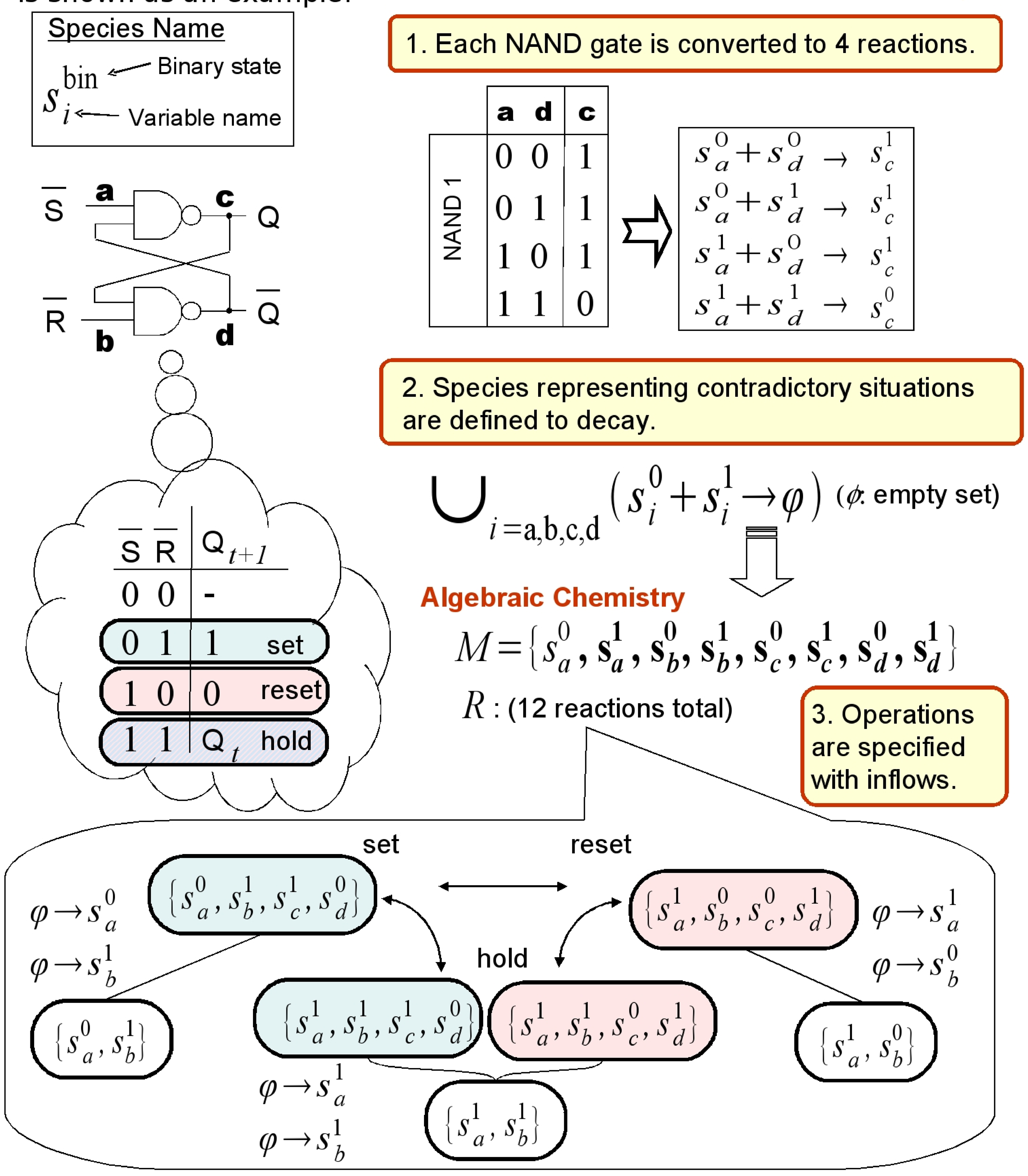
Summary

Employing a large number of entities, it becomes difficult to rationalize the systems' behavior on the global (macro) level, emerging from the interactions on the local (micro) level between entities. There is a gap betwen those two levels, and our fundamental challenges include how to establish the bridge over the gap. In our project, interactions betweem entities are restricted to those describable in the form of chemical reaction rules. In Phase I, we excercised chemical programming [7,10], and organization-oriented programming principles are derived [8]. The maximal independent set problem (MIS) is, then, tackled [1] for evaluating chemical computing quantitatively. We also discussed about an architecture for controlling those emerging behaviors, and components are arranged as a feedforward process. It neccesitates the development of *macro-to-micro translator.*



Logic circuit (RS flip-flop):

Organization-oriented programming for a chemical logic circuit is discussed in [7]. A NAND-based RS flip-flop is shown as an example.



Organization-Oriented Chemical Programming Principles [1,4,8]

P1: There should be one organization for each output behavior class

P2: The result should be in the closure of the input

P3: The input should generate the organization representing the desired output

P4: Eliminate organizations not representing a desired output

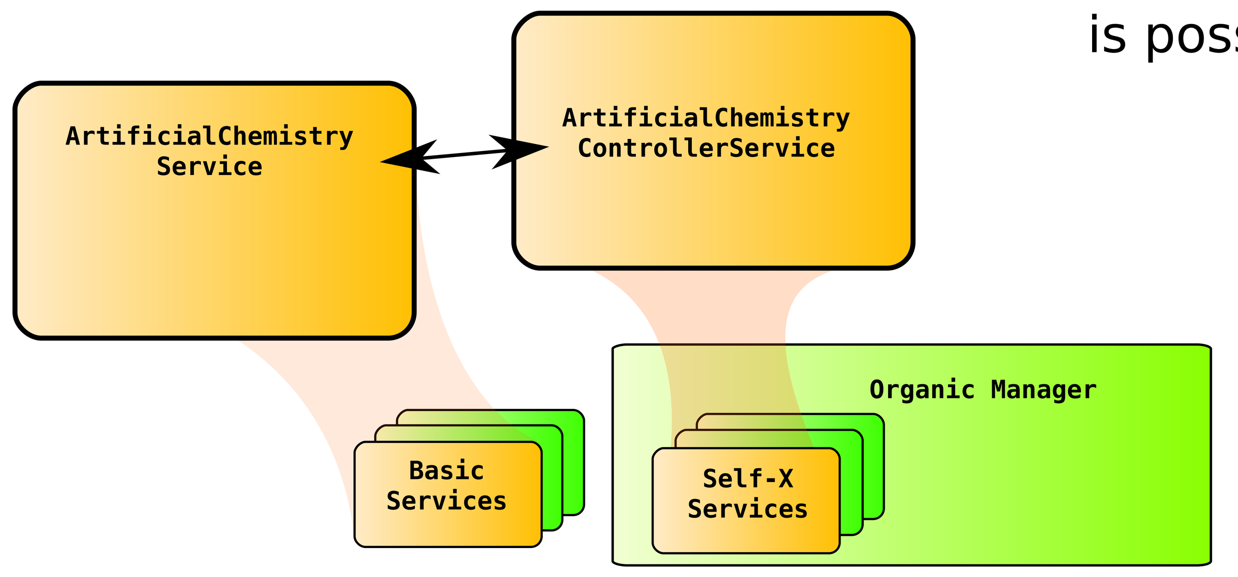
P5: An output organization should have no organization below

P6: Assure, if possible, stoichiometrically the stability of an output organization

P7: Use kinetic laws for fine-tuning

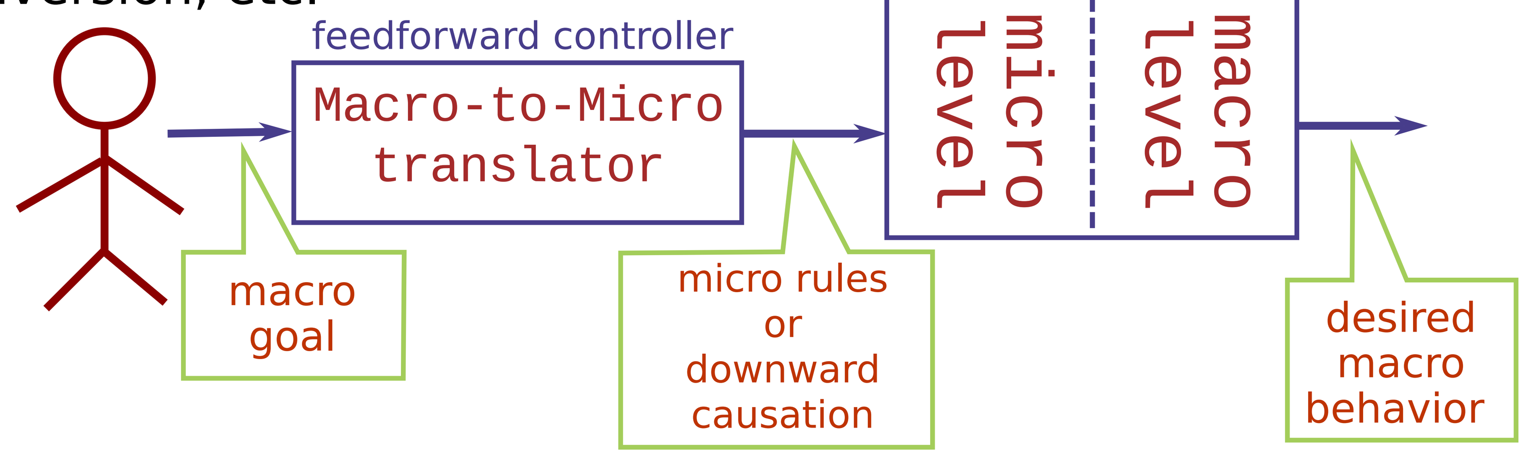
A chemical service for OCμ

In order to achieve self-configure, self-optimize, and self-healing system across a network of nodes, the OCμ framework offers a Java middleware to implement organic services. We have implemented ACservice and ACControllerService providing (artificial) chemical services. Integrations of our chemical programs into OCμ framework is possible.



Emergent Control

We conceived an architecture for controlling emerging behaviors as a feedforward process. The macro-to-micro translator converts users' demand into interactions on the local level. Feedback dynamics can be contained in the controlled system. As an extension, feedback loop can be formed from the controlled system to the controller. However, it should not be necessary for the moment. The development of translator is demanded. Strategies for building a macro-to-micro translator: manual "intelligent" design, evolution, theory, mimicking, compiling, experiment and numerical inversion, etc.



Primary Results

— Phase II —

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3. N. Matsumaru, T. Lenser, F. Centler, P. Speroni di Fenizio, T. Hinze, P. Dittrich: **Common Organizational Structures within Two Chemical Flip-Flops**, In *Natural Computing - 3rd International Workshop on Natural Computing*, 2008
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— Phase I —

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Secondary Results

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