Flavors of Boolean Network Reprogramming in the CoLoMoTo Notebook Environment (poster abstract)

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Boolean networks (BNs) are prominently employed for modeling cell fate and differentiation processes [3,2]. In recent years, methods and tools have been developed to predict, from BNs, perturbations to control the phenotype of the cell. Albeit designed for a similar goal, these methods have different settings, both for the specific control problem they tackle and for the kind of perturbations considered.

We present here a joint distribution of tools implementing different flavors of BN reprogramming with a unified interface and terminology. We integrated the tools in the CoLoMoTo Notebook environment [5] for the analysis of logical models of biological networks based on Jupyter and Docker technologies. The interface allows editing so-called notebooks, mixing textual information and Python code invoking the tools, and which can be easily shared and re-executed. The environment is distributed as pre-installed Docker images, and is compatible with all major operating systems. The images are timestamped so that notebooks can be re-executed in the exact same environment, even years later, providing guarantees for the reproducibility of computational analyzes.

Selected tools are *ActoNet*, based on causal reasoning by logical abduction [1]; *CABEAN*, based on symbolic computation of the state transition graph [6,4]; *Caspo*, based on three-valued logic [7]; and *StableMotifs*, based on the interaction motifs of trap spaces [8]. These tool implement different flavors of BN reprogramming, with different settings on the type of control (target or source-target control), type of perturbations (instantaneous, temporary, permanent), and for their application (one-step, sequential).

For each of these tools, we developed a Python interface to ease their call and the processing of their result. We developed the Python library *algorecell_types* which provides a unified representation of reprogramming results. Besides a programmatic treatment of returned control strategies, the library offers several forms of visualization: plain text, graphs – especially useful for sequential reprogramming, and tables summarizing the components involved in predictions.

This collaborative effort aims at promoting and facilitating the accessibility and comparison of different tools for reprogramming BNs. Thanks to the CoLoMoTo Notebook environment, models can be readily downloaded or imported from diverse formats, such as SBML-qual, GINsim, and plain text.

Example notebooks on case studies can be visualized and reproduced following instructions at github.com/algorecell/flavors-of-reprogramming#readme. The results underline the complementarity of the different approaches, giving access to a range of different reprogramming strategies: *ActoNet* and *Caspo* are focused on permanent perturbations, which may induce new attractors; whereas *ActoNet* is restricted to fixpoints, *Caspo* can output non-minimal solutions; on the other hand, *StableMotifs* temporary perturbations are robust to the initial state of the network, and *CABEAN* can provide very different solutions by considering the initial state and sequential reprogramming.

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