Abstract: One ultimate goal of synthetic biology is to program complex biological networks that could achieve desired phenotype and produce significant metabolites in purpose of real world application, by fabricating standard components from an engineering-driven perspective. This project explores the application of theoretical approaches to automatically design synthetic complex biological networks with desired functions defined as dynamical behavior and input-output property. We propose a novel design scheme highlighted in the notion of trade-off that synthetic networks could be obtained by a compromise between performance and robustness. Moreover, series of eligible strategies, which consist of various topologies and possible standard components such as BioBricks, provide multiple choices to facilitate the wet experiment procedure. Description of all feasible solutions takes advantage of SBML and SBGN standard to guarantee extensibility and compatibility.

Prof. X really wants to enjoy sunshine and beach but the exhausting experiments haven’t succeed. He summons Dr. Ding for help to save his leisure time... What Dr. Ding needs are professor’s desired behaviors and his vacation time. Then his RA should tell Dr. Ding something about his lab condition and some special restrictions. Then follow Dr. Ding’s instruction on ABCD. After full speed running of ABCD engine and great support from BioBricks, feasible solutions will be handed to Prof. X after his vacation. Great, Dr. Ding’s recipe is really helpful in the lab.

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Sponsor: Teaching Affairs Office, Foreign Affairs Office, Graduate School, School of Information Science and Technology, School for the Gifted Young, Mathworks

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With ABCD, we DEFINE, we QUANTIFY
1. Characterize a bio-network with all its bio-chemical reactions (temporarily limited to binary reactions)
2. Transform reactions to ODE Array from a pool of interaction forms/terms
3. Repeatedly identify the system, if parameters fall in same confidence interval, accept the values as definitions of those parameters

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Construction of a Simplified Model
Raw data (black dot) Identification result (discrete lines)

Perfect Adaptation with Two Topology: Realize ab-initio design! GA works for topology identification. We set target a constant value and perturbation a step change stimulus.

Global sensitivity analysis demonstrate adaptation.

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Tunable Oscillator: Realize portion design!

Amplitude Tunable

Frequency Tunable

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Bistable Toggle Switch
PSO works for parameter identification. Realize identification for nonlinear systems.

Species 1

Species 2

Incoherent Feedback

Negative Feedback