BioModel Engineering

- from structure to behaviour -

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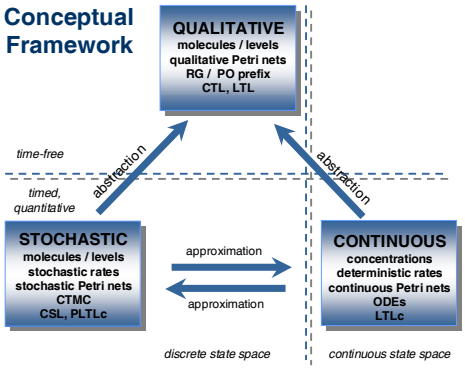
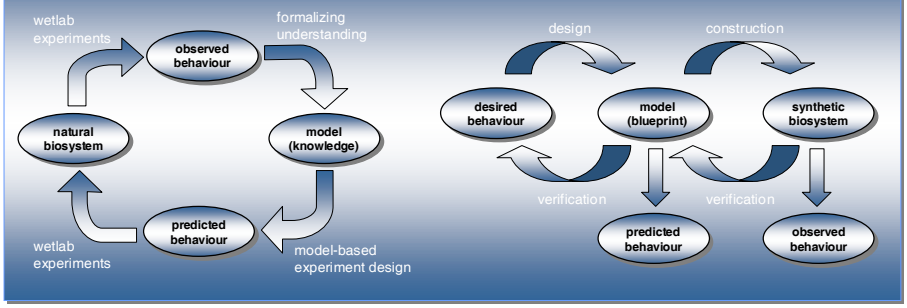
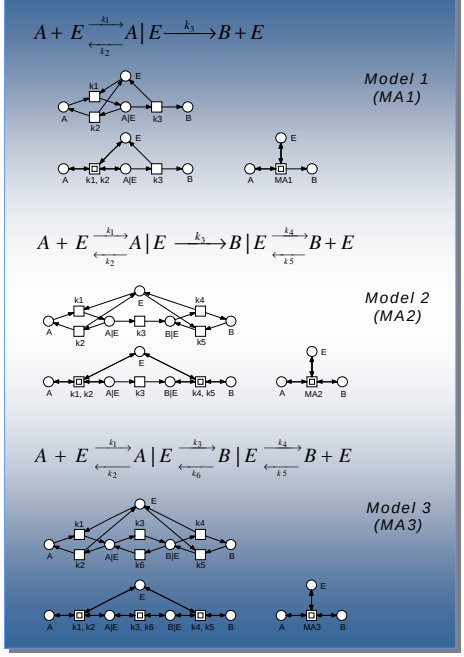
Conceptual Framework



Models as Key Players in Systems Biology and Synthetic Biology



Mass / Action Patterns for Enzyme Reactions



Engineering Computational Models of Biological Systems

Identification
bio pathway of interest
related bio questions to answer

Construction
abstract by simplifying assumptions
composition of building blocks

Execution / Animation
experience the model behaviour

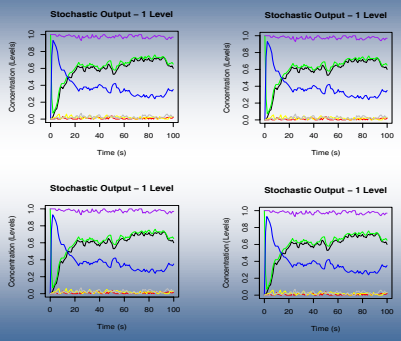
Analysis / Simulation
investigate the model behaviour

Management / Development
Model Version Control System

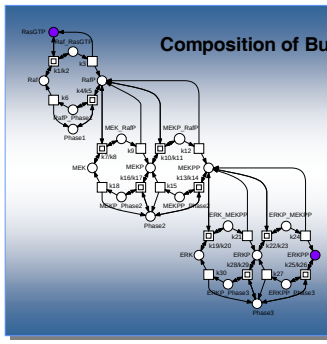
STATIC ANALYSIS

place invariants (moieties)
transition invariants (EMs / EPs)
input / output relationships, pathway length, etc.
modularisation / decomposition into subnetworks
correlated subsets, flux-coupling assessment
identification of bottlenecks / fragile nodes
design of knockout experiments
initial marking (state) construction
semi-decision of general behavioural properties, etc.

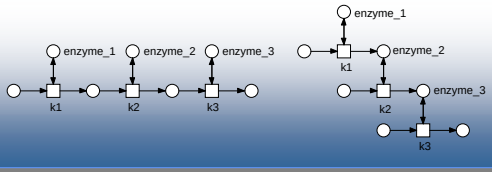
Stochastic vs. Continuous Behaviour

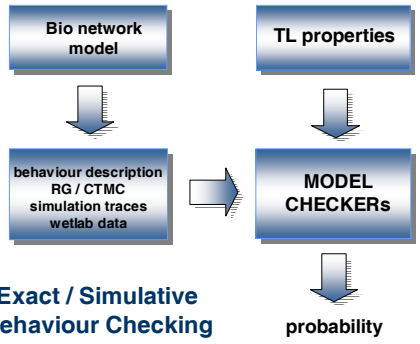


Composition of Building Blocks



Metabolic Pathway vs Signalling Cascade





References

Methodology

[1] R Breitling, D Gilbert, M Heiner, R Orton:
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[2] M Heiner, D Gilbert, R Donaldson:
Petri Nets for Systems and Synthetic Biology; Springer LNCS 5016, 2008.

Case Studies

[3] D Gilbert, M Heiner, S Rosser, R Fulton, X Gu, M Trybilo:
A Case Study in Model-driven Synthetic Biology; IFIP WCC 2008/BICC, IFIP 2008.

[4] D Gilbert, M Heiner, S Lehrack:
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[5] D Gilbert, M Heiner:
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