Computational Methods for Systems Biology and Synthetic Biology

François Fages,
Constraint Programming Group,
INRIA Rocquencourt

mailto:Francois.Fages@inria.fr
http://contraintes.inria.fr/

Overview of the Lectures

1. Introduction
   - Transposing concepts from programming to the analysis of living processes
2. Rule-based Modeling in Biocham
   - Macromolecules, compartments and elementary processes in the cell
   - Boolean, Differential and Stochastic interpretations of reaction rule models
   - Cell signaling, cell cycle models
3. Temporal Logic constraints in Biocham
   - Qualitative properties in propositional Computation Tree Logic CTL
   - Quantitative properties in quantifier-free Linear Time Logic LTL(R)
   - Parameter optimization and robustness w.r.t. temporal logic properties
- Conclusion
- *Killer lecture: abstract interpretation in Biocham*

Conclusion

- New focus in Systems Biology: formal methods from Computer Science
  - Beyond diagrammatic notations: formal semantics, abstract interpretation
  - Beyond curve fitting: high-level specifications in temporal logic
  - Automatic model-checking. Parameter optimization

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  - Beyond discrete machines: stochastic or continuous or hybrid dynamics
  - Quantitative transition systems
  - Temporal logic constraint solving, continuous satisfaction degree, optimization

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- Synthetic Biology
  - Program the living with programming tools
  - Computational design and optimization tools

Acknowledgments

" Contraintes group at INRIA Paris-Rocquencourt on this topic:

Grégory Batt, Sylvain Soliman, Elisabetta De Maria, Sylvain Pradalier, Aurélien Rizk, Steven Gay, Faten Nabli, Dragana Jovanovska

" EraSysBio C5Sys (follow up of FP6 Tempo) on cancer chronotherapies, coord. *Francis Lévi*, INSERM; *Jean Clairambault* INRIA; &

Coupled models of cell and circadian cycles, p53/mdm2, cytotoxic drugs.

" INRIA/INRA project Regate coord. *F. Clément* INRIA; *E. Reiter, D. Heitzler*

Models of GPCR Angiotensine and FSH signaling.

" ANR project Calamar, coord. *C. Chaouiya, D. Thieffry* Univ. Marseille, *L. Calzone* Curie Institute

Modularity and Compositionality in regulatory networks.