Complexity

Special Issue on
Mathematical Modeling and Dynamic Analysis of Complex Biological Systems

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CALL FOR PAPERS

From microscopic to macroscopic levels, mathematical modeling of biological systems has gained increased importance over the years. Metabolic networks of various cell strains and microorganisms have been established, and techniques such as Metabolic Flux Analysis (MFA), Flux Balance Analysis (FBA), or Flux Variability Analysis (FVA) are being used to determine (intervals for) the flux distribution within the cells as a function of the extracellular medium concentrations. These techniques have been extended to time-varying conditions, leading to Dynamic Metabolic Flux Analysis (DMFA). Model reduction techniques, for instance, based on the concept of Elementary Flux Modes (EFM) or Extreme Rays (ER), have also been explored, yielding macroscopic representations of the culture behavior in terms of the sole reactant and product concentrations in the extracellular medium. These developments have partly bridged the existing knowledge in data-driven, macroscopic modeling, where biologically inspired black box models are inferred from the time evolution of the component concentrations in the culture medium. There, techniques, such as Principal Component Analysis (PCA), Partial Least Squares (PLS), Neural Networks (NNs), and nonlinear estimation in general, are at the core of the model development, parameter estimation, and validation. Once established, these models can be used, depending on their level of description, to get a better insight into the cell metabolism and the influence of the culture conditions, to analyze the system dynamics, and to study their behavior notably in terms of equilibrium multiplicity and stability. These dynamic representations can sometimes be even further reduced or simplified, using sensitivity analysis, slow-fast approximations, and lower-dimensional manifolds, so as to generate representations suitable to model-based process optimization and control.

The aim of this special issue is to present a collection of recent results in the above-mentioned areas of research, either at the conceptual (theoretical) level or in view of challenging applications in environmental sciences or biopharmaceutical sectors.

Potential topics include but are not limited to the following:

- Topics that are related in some way to biosystem dynamics and could include the following methods:
  - Dynamic metabolic flux analysis, flux balance analysis, and flux variability analysis
  - Multiscale modeling
  - Individual-based modeling
  - Population models
  - Distributed parameter systems
  - Data driven modeling
  - Analysis of nonlinear system dynamics
  - Nonlinear identification and estimation
  - Robust state estimation
  - Dynamic optimization and optimizing control
  - Model-based process control
- Applications areas that include the following systems and processes:
  - Biological solid waste and wastewater treatment
  - Cultures of microalgae in photo-bioreactors or raceway ponds
  - Cultures of yeast, bacteria, animal, plant, and insect cells in bioreactors
  - Food microbiology

Authors can submit their manuscripts through the Manuscript Tracking System at https://mts.hindawi.com/submit/journals/complexity/mmdac/.

Papers are published upon acceptance, regardless of the Special Issue publication date.

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