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Modelling the Population Dynamics in a Cell Culture at two different scales

Abstract

In this thesis the development of three novel models at two different scales are presented for population dynamics in cell cultures. Biological knowledge and empirical observations are used to design an agent-based discrete-time model at meso-scale, which then serves as a simulation environment and provides the necessary insight for lumped-parameter models at macro-scale. After demonstrating on basis of meso-scale simulation results that the flask-wide distribution of the population does not consistently become heterogeneous it is concluded that the population dynamics can also be represented at macro-scale. Two continuous time, differential equation-based, compact macro-scale models are developed.

Both macro-scale models can be parameter-tuned and employed for predicting the evolution of the population size for given uniformly distributed initial populations. The thesis provides a procedure for estimating the parameter values of the macro-scale models via some simple tests to be conducted on the cell culture at hand. How well the macro-scale models can predict the evolution of the population size in comparison to the Meso-scale Model is evaluated on basis of four practically significant criteria. Furthermore; the robustness of the macro-scale models with respect to different initial energy distributions is evaluated.

Finally, a philosophical perspective about modelling dynamic phenomena at different scales and how to deal with modelling challenges are presented.

PUBLICATIONS

Journals

- **Habiboğlu M.G.**, Denizhan Y., "Development of a macro-scale model from a meso-scale model for cell culture population dynamics", *Mathematical and Computer Modelling of Dynamical Systems* (accepted).

Conferences

- **Habiboğlu M.G.** , "Modelling the Population Dynamics in a Cell Culture at two Different Scales", *Extended Abstracts Spring 2013*, Trends in Mathematics Vol. 2., Research Perspectives CRM Barcelona, 2014, pp. 33-38.
- **Habiboğlu M.G.** , Modelling the Population Dynamics in a Cell Culture at two Different Scales, *joint crm-imperial college school and workshop in complex systems*, Barcelona, 2013. (poster)
- **Habiboğlu M.G.** , Micro and Macro-Scale Models of Population Dynamics in a Cell Culture, *XXXIII Dynamics Days Europe*, Madrid, 2013.

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