

Concepts and Methods from Chemical Reaction Engineering and Process Systems Engineering for Exploring and Managing Metabolic Complexity

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Abstract:

Metabolic engineering and synthetic biology involve the design, retrofitting, and repair of genome-scale metabolic networks through the manipulation of enzyme activities and cellular processes. Two of the central problems in metabolic engineering are the expansion of our current knowledge of biochemical reactions and compounds and the identification of targets for manipulating metabolism with the minimum possible impact on cells physiology. We will present and discuss our work in addressing these two problems using concepts and methods from chemical reaction engineering and process systems engineering.

In the first case we will present and discuss the ATLAS of biochemistry, a database of all the biochemically plausible reactions between compounds reported to occur in living organisms. ATLAS uses KEGG as the reference database with 16,000 metabolites and 10,000 reactions and it contains more than 130,000 new reactions. The mining of ATLAS will undoubtedly offer new opportunities for the design of synthetic pathways and metabolic engineering. In the second case, we will present ORACLE (Optimization and Risk Analysis of Complex Living Entities), a workflow for the development of large, genome-scale kinetic models of metabolic networks under uncertainty, and we will introduce RBA (Response Balance Analysis), an optimization framework that (i) uses a kinetic representation of metabolic networks, and (ii) identifies enzyme manipulations that can optimize a metabolic function while maintaining metabolite concentrations and reaction rates within physiological ranges. We will demonstrate the application of ORACLE and RBA for the design and optimization of the production of industrial chemicals by microorganisms.

Bio:

Dr. Vassily Hatzimanikatis is currently Associate Professor of Chemical Engineering and Bioengineering at Ecole Polytechnique Fédérale de Lausanne (EPFL), in Lausanne, Switzerland. Vassily received a PhD and an MS in Chemical Engineering from the California Institute of Technology, and his Diploma in Chemical Engineering from the University of Patras, in Greece. After the completion of his doctoral studies, he held a research group leader position at the Swiss Federal Institute of Technology in Zurich (ETHZ), Switzerland. Prior to joining EPFL, Vassily has been assistant professor at Northwestern University, at Illinois, USA, and he worked for three years in DuPont and Cargill. Vassily is editor-in-chief of the *Metabolic Engineering Communications*, Senior Editor of *Biotechnology Journal*, and associate editor of the journals *Metabolic Engineering* and *Biotechnology & Bioengineering*. He has published over 100 articles and he is co-inventor in three patents and patent applications. Vassily is a fellow of the American Institute for Medical and Biological Engineering (2010), he was a DuPont Young Professor (2001-2004), and he has also received the Jay Bailey Young Investigator Award in *Metabolic Engineering* (2000), the ACS Elmar Gaden Award (2011), and the Metabolic Engineering Award from the International Society of Metabolic Engineering (2014). Award (2016) and Outstanding Research Award in (2012). Editorial Boards for PLoS Computational Biology, BMC Systems Biology, IEEE Life Sciences, Biotechnology Journal and Metabolic Engineering; Fellow of the American Institute of Medical and Biological Engineering (AIMBE); Reviewer for NSF, NIH and DOE; Research interests: Computational protein design; enzyme and antibody engineering; reconstruction, curation and analysis of metabolic networks; computational strain design and synthetic biology; metabolism of photosynthetic organisms; metabolism of obligatory anaerobes; modeling of microbial communities; optimization theory and algorithms.



26 April 2017, 11am
Sir David Davies LT, Roberts Building, G08

Sir David Davies LT, (G08) Roberts Building, UCL, Gower Street, WC1E 6BT, London.
Refreshments before the seminar in Room 105b, Roberts Building.
This event is free and open to the public. No registration is required.

