COMPUTATIONAL SYSTEMS BIOLOGY

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PRE-REQUISITES : Basic knowledge of a high-level programming language (preferably MATLAB)

INDUSTRIES APPLICABLE TO : Bioprocess industries / Computational Biology Companies, e.g. MedGenome, Vantage Research

INTENDED AUDIENCE : Interested learners

COURSE OUTLINE :

Every living cell is the result of beautifully concerted interplay of metabolic, signalling and regulatory networks. Systems biology has heralded a systematic quantitative approach to study these complex networks, to understand, predict and manipulate biological systems. Systems biology has had a positive impact on metabolic engineering as well as the pharmaceutical industry. This course seeks to introduce key concepts of mathematical modelling, in the context of different types of biological networks. The course will cover important concepts from network biology, modelling of dynamic systems and parameter estimation, as well as constraint-based metabolic modelling. Finally, we will also touch upon some of the cutting-edge topics in the field. The course has a significant hands-on component, emphasizing various software tools and computational methods for systems biology.

ABOUT INSTRUCTOR :

Prof. Karthik Raman is a Professor at the Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences, IIT Madras. Karthik's research group works on the development of algorithms and computational tools to understand, predict and manipulate complex biological networks. Broadly spanning computational aspects of synthetic and systems biology, key areas of research in his group encompass microbiome analysis, in silico metabolic engineering, biological network design and biological data analysis. Karthik also co-ordinates the Centre for Integrative Biology and Systems mEdicine (IBSE) at IIT Madras and is a core member of the Robert Bosch Centre for Data Science and Artificial Intelligence (RBC-DSAI). Karthik teaches courses on computational biology and systems biology at IIT Madras, and has also authored a textbook on Computational Systems Biology.

COURSE PLAN :

Week 1 : Introduction to Mathematical Modelling

Week 2 : Introduction to Static Networks

Week 3 : Network Biology and Applications

Week 4 : Reconstruction of Biological Networks

Week 5 : Dynamic Modelling of Biological Systems: Introduction, Solving ODEs & Parameter Estimation

Week 6 : Evolutionary Algorithms, Guest Lectures on Modelling in Drug Development

Week 7 : Constraint-based approaches to Modelling Metabolic Networks

Week 8 : Perturbations to Metabolic Networks

Week 9 : Elementary Modes, Applications of Constraint-based Modelling

Week 10: Constraint-based Modelling Recap, 13C Metabolic Flux Analysis

Week 11: Modelling Regulation, Host-pathogen interactions, Robustness of Biological Systems

Week 12: Advanced topics: Robustness and Evolvability, Introduction to Synthetic Biology, Perspectives & Challenges