BioSystems Science and Engineering

SEMINAR

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MRDG Seminar Hall

Modelling Dynamical Diseases in Physiological Systems : A Primer

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In this talk I will give an overview of the origin, detection and control of pathological rhythms in physiological systems using both simple and biophysically detailed models. Arrhythmias correspond to deviations from the natural rhythm in physiological organs such as the gastro-intestinal complex, the respiratory system and the uterine myometrium. Most prominently, they are known to affect the normal pumping rate in the heart, resulting in life threatening cardiac diseases. Work devoted to arrhythmias comprised investigating the onset of arrhythmia, risk-stratification, and prevention and/or effective treatment.

Advances in the knowledge of cellular properties have resulted in the development of biophysically very realistic and detailed models. These integrated multiscale models make it possible to describe and understand the complex interrelations and feedbacks from the level of the ion-channel all the way up to organ scale. The development of these models is motivated by significant clinical payoffs in terms of development of personalised diagnostic tools, test-beds for new anti-arrhythmic drugs and novel “electroceutical” therapies. An important component of the simulation studies vis-a-vis such detailed models is the use of high-performance computation techniques and sophisticated numerical tools for significant speedup without compromising on numerical accuracy. Dedicated simulation platforms and packages have simplified and expanded access to a wide range of biophysical models based on wide and integrated experimental data.

On the other hand, the investigation of much simpler (2 or 3 variable) models, based on a reduced, simple (“generic”) tissue description, (inspired by the Fitz-Hugh-Nagumo set of coupled differential equations) continue to provide essential information on possible dynamical regimes in a physiological organ. These simple models can help elucidate the physical mechanisms and are sufficiently generic to be applicable to model a range of physiological systems that can display arrhythmia, and in fact, to other chemical or physical systems, sharing similar properties.

About the Speaker

S. Sridhar is a Member Technical Staff at the Robert Bosch Centre for Cyber-physical systems since June 2017. He obtained his PhD degree in theoretical physics from the University of Madras in 2011. His doctoral research carried out at the Institute of Mathematical Sciences, Chennai, involved investigating the nonlinear dynamics of patterns in biological systems and developing control schemes for spatially extended chaos having potential medical applications. After doing a post-doc in the chemistry department at Brandeis University (USA), he joined Scimergent Analytics as postdoctoral scientist in 2013 to work on an data-driven approach to study patterns of urbanization and economic networks in India. During 2015-2016, he worked as a Pegasus Marie Curie Postdoctoral Fellow at the Department of Physics, Ghent University (Belgium). He has co-authored a book on genesis and control of patterns in excitable systems and is currently editing a Research Topic on "Simulating Normal and Arrhythmic Dynamics: From Sub-Cellular to Tissue and Organ Level" for the Frontiers group of publications.