Multiscale Modeling of Biological Systems: Top Down and Bottom Up

Abstract:

Due to the inherent complexity of biological systems, it is recognized that computation can play an important role in both biomedical research and clinical practice. In particular, multiscale approaches need to be considered to formulate mathematical and computational models for biological systems of interest given the events occur at different spatial and temporal scales ranging from $10^{-3}$ to $10^3$ mm in space and from $10^{-6}$ to $10^7$ seconds in time. In this talk, I will discuss a fully coupled space-time multiscale framework consisting of tissue, cellular, and subcellular scale models, which is applicable to model cancerous tumor growth, cell migration, wound healing and bone remodeling. The theoretical foundation is based on so-called mixture theory on the tissue scale, while agent-based method and ODE models are applied to cellular and subcellular scales, respectively. The impact of the multiscale models will be tremendous. To maximize the impact of modeling, we need to move from using computer models to explain or interpret experimental results to serving as effective tools to make discoveries or test hypotheses, along with experiments. Moreover, computer models are crucial in the era of precision medicine, which needs to employ all the information from bottom scale of DNA, RNA, proteins, signaling pathways, cells, tissues, organ and organ systems.

Bio:

Dr. Feng is a Professor of Mechanical and Biomedical Engineering at UT San Antonio, and the Director and co-Founder of NSF-Sponsored Center for Simulation Visualization and Real-Time Prediction (SiViRT). His research areas include computational bioengineering, mathematical modeling, bioheat transfer, nanoparticle mediated laser surgical control, and scientific visualization. Prof. Feng received his Ph.D. in computational mechanics under supervision of Prof. J. Tinsley Oden from the University of Texas at Austin. He earned two Master’s degrees in mechanical engineering and applied mathematics from University of Oklahoma before he came to UT Austin. His undergraduate degree in Engineering Mechanics was obtained from Tsinghua University in China. His professional career started in industry right after he got his Ph.D. However, his intellectual pursue drove him back to academia. He started to teach mathematics, as an assistant professor at Concordia University at Austin in 2002 and as a research scientist at ICES at the same time. He joined the UT San Antonio faculty in 2007. Prof. Feng has been working on computational bioengineering and biomedicine for last 15 years. The NIH/K25 career award assisted him making the smooth transition to the computational biomedical areas. Prof. Feng received numerous awards including Research Excellence Award in Research and Innovator of the Year from UT San Antonio. Currently, his passion is in multiscale modeling of biological systems, particularly, cancer. He still works closely with newly formed Center for Computational Oncology led by Prof. Yankeelov, and becomes the first faculty visitor to Dell Medical School last summer.