Research Seminar
UH Cullen College of Engineering

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9:30 a.m.
Room W122 Engineering Building 2

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Quantifying Structures and Phenomena in Complex and Dynamic Biological Microenvironments from 4D/5D Optical Microscopy Images

Abstract

Many tissue microenvironments that play critical roles in health and disease are complex and dynamic, e.g., tumors, stem-cell niches, brain tissue surrounding neuroprosthetic devices, retinal tissue, cancer stem-cell niches, glands, and immune system tissues. Progress in these areas is much too slow compared to the need. Knowledge is pieced together from large numbers of experiments, each of which yields a small amount of information. Much of the knowledge still remains qualitative. There is a compelling need to accelerate progress towards a quantitative understanding. I will describe strategies based on multi-dimensional optical microscopy and computational image analysis.

Modern optical microscopy has grown into a multi-dimensional imaging tool. It is now possible to record dynamic processes in living specimens in their spatial context and temporal order, yielding information-rich 5-D images (3-D space, time, spectra). The task of analyzing these images exceeds human ability. There is a need for automated systems to map the tissue anatomy, quantify structural associations, identify critical events, map event locations and timing, identify and quantify spatial and temporal dependencies, produce meaningful summaries of multivariate measurement data, and compare 4-D/5-D datasets for testing hypotheses, exploration, and systems modeling. Importantly, there is a need for “computational sensing” methods capable of exceeding human ability.

In this talk, I will use examples from neuroscience, cancer histopathology, immunology, and retinal stem-cell biology to show the practicality of multi-dimensional image analysis and computational sensing.