BDR SEMINAR (Kobe & online hybrid)

Mechanobiology Seminar Series presents

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Thursday, May 22, 2025

11:00-12:00

1F Auditorium, DB Building C, Kobe / Broadcast online via Zoom

*This seminar is open only for BDR members.
Please contact the seminar host for participation.

Bridging Microscopy data and Biophysical Models through Optimisation and AI

Summary

Fluorescence microscopy is one of the most widely used techniques for quantifying biological systems, ranging from the subcellular to the tissue scale. However, extracting meaningful physical information from 3D fluorescent images remains a significant challenge. Concurrently, physical and computational models of tissues are becoming increasingly realistic, yet direct comparison, calibration, or initialization of these models using biological images remains largely unattained.

In this presentation, I will discuss our recent efforts to bridge the gap between fluorescent microscopy images and biophysical models of tissues. I will begin by introducing a novel segmentation and 3D tension inference method that enables the generation of detailed 3D mechanical atlases of embryos or tissues comprising up to a thousand cells from microscopy images. Next, I will showcase our cell-resolved computational foam-like models of 3D tissues. These models incorporate viscous dissipation at cell interfaces, accommodate cell divisions and other topological changes, and can be coupled with biochemical signaling networks to simulate multicellular mechanochemical feedback.

Finally, I will demonstrate a generic pipeline that closes the loop between mechanical models and microscopy images by generating realistic fluorescence microscopy images from simulation meshes. This pipeline, which is fully differentiable, paves the way for seamlessly solving inverse mechanical problems. I will conclude with novel perspectives on learning cell behavior in development, integrating biophysical models with artificial intelligence.

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