ACMS Applied Math Seminar

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Thursday, November 7, 2019
154 Hurley Hall
3:30 - 4:30 P.M.

Reaction-Diffusion Modeling to Design Synthetic Biological Systems

Natural biochemical processes are exquisitely organized in space and time, and synthetic biologists are now engineering spatially-based strategies to enhance desired chemical reactions. A fundamental question is: what is the optimal organization strategy for an arbitrary biosynthetic pathway of interest? Using numerical and analytic analysis of reaction-diffusion systems, I demonstrate that the optimal organizational choice depends on kinetic characteristics of the pathway and external factors setting the boundary conditions. For example, the benefits of compartmentalization change depending on the thermodynamic reversibility of the reactions. I will also discuss ongoing efforts to use Bayesian parameter estimation to determine key parameters from indirect time-series measurements. By mapping out and constraining the design space for these strategies in terms of external conditions and enzyme kinetics, we can elucidate design rules for synthetic biologists to optimize biosynthesis of biofuels, biodegradable plastics, pharmaceuticals, and other high-value chemicals.