FUDAN UNIVERSITY
Applied Math Ph.D. Seminar

An Improved Approach for Calculating Energy Landscape of Gene Networks from Moment Equations

Speaker: Shirui Bian (Fudan University)

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Location: Rm 1801, Guanghua East Tower

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Abstract: The energy landscape theory has been widely applied to study the stochastic dynamics of biological systems. Different methods have been developed to quantify the energy landscape for gene networks, e.g., using Gaussian approximation (GA) approach to calculate the landscape by solving the diffusion equation approximately from the first two moments. However, how high-order moments influence the landscape construction remains to be elucidated. Also, multistability exists extensively in biological networks. So, how to quantify the landscape for a multistable dynamical system accurately, is a paramount problem. In this work, we prove that the weighted summation from GA (WSGA), provides an effective way to calculate the landscape for multistable systems and limit cycle systems. Meanwhile, we proposed an extended Gaussian approximation (EGA) approach by considering the effects of the third moments, which provides a more accurate way to obtain probability distribution and corresponding landscape. By applying our generalized EGA approach to two specific biological systems: multistable genetic circuit and synthetic oscillatory network, we compared EGA with WSGA by calculating the KL divergence of the probability distribution between these two approaches and simulations, which demonstrated that the EGA provides a more accurate approach to calculate the energy landscape.