Mathematical & Computational Biology Seminar

Organizer: Lior Pachter

Wednesday, 2:00–3:00pm, 939 Evans

Feb. 25 **Perry de Valpine**, UC Berkeley

Nonlinear stage-structured population dynamics: models, data, and statistics with examples from insects and fish

Research on ecological population dynamics poses many exciting mathematical and statistical problems. In addition to their role in basic ecological and evolutionary research, population models are often used by applied ecologists for tasks such as fisheries management, agricultural herbivore management, and population viability analysis of endangered species. Demography of plants, insects, fish, birds and other taxa can include delayed nonlinear feedbacks and other features that lead to complex dynamics. Real populations are also subject to large amounts of stochasticity and forcing by many (often unknown) factors. Empirical attempts to understand population dynamics are further hindered by high sampling variability in our data. The models most often used for real applications omit aspects of biological realism and are not estimated from data as well as possible. I will introduce a general method to include realistic variation in organismal development into population models structured by organismal life stages. The resulting demographic equations involve intractable, high-dimensional integrals. I will show an efficient sequential Monte Carlo numerical integration strategy that can be intuitively comprehensible to applied practitioners. Then I will introduce the problem of fitting population models to noisy data using statistical state-space models for nonlinear, non-Gaussian time-series. For different reasons, these also lead to intractable high-dimensional integrals for maximum likelihood parameter estimation and calculation of the likelihood normalizing constant. I explain efficient Monte Carlo methods for fitting stage-structured models and approximating normalizing constants. Examples from fishery management and agricultural insect dynamics will be given.