Probability and Biology
Probabilités et Biologie
(Org: **Lea Popovic** (Concordia))

IDDO BEN-ARI, University of Connecticut
Diffusion with Redistribution

We will discuss a model of diffusion with spontaneous redistribution, recently presented by R. Pinsky. This could be viewed as a model for continuous diffusive behavior with occasional "catastrophic" redistribution events, resetting the system. The redistribution occurs at a spatially dependent rate. The diffusion and the redistribution processes are each well-understood classical objects, yet the interplay between the "fast", continuous diffusion and the "slow", non-local redistribution process is less studied. We will study this interaction as it appears through the exit time and exit distribution of the process from a domain. We will focus on the behavior when the rate of the redistribution tends to infinity, a regime in which the stark difference between the processes is amplified, and in which the interaction is the most interesting.

DON DAWSON, Carleton University
Multitype mutation-selection-migration dynamics and a set-valued dual

We consider multitype populations undergoing mutation, selection, migration and resampling. We develop a class of set-valued processes with Boolean dynamics which is used to produce a dual representation of the corresponding system of interacting Fleming-Viot processes. These set-valued processes are used to prove ergodic theorems, and to study the emergence of rare mutants, multilevel selection and multispecies models. This is based on joint work with Andreas Greven.

RICK DURRETT, Duke
A branching process model of ovarian cancer

Ovarian cancer is usually diagnosed at an advanced stage, rendering the possibility of cure unlikely. To date, no cost-effective screening test has proven effective for reducing mortality. To estimate the window of opportunity for ovarian cancer screening, we develop a branching process model for ovarian cancer growth and progression accounting for three cell populations: Primary (cells in the ovary or fallopian tube), Peritoneal (viable cells in peritoneal fluid), and Metastatic (cells implanted on other intra-abdominal surfaces). Growth and migration parameters were chosen to match results of clinical studies. Using these values, our model predicts a window of opportunity of 2.9 years, indicating that one would have to screen at least every other year to be effective. The model can be used to inform future efforts in designing improved screening and treatment strategies.

JONTHAN MATTINGLY, Duke University
A Numerical Method for the SDEs from Chemical Equations

I will discuss a novel numerical methods for simulating the stochastic differential equations associated with chemical reaction networks. The method is weak order 2 but is explicit and simple to implement unlike most order 2 methods. The method has its roots in a time change representation of the process. I will also discuss convergence of the numerical methods invariant measure to the systems true invariant measure.

SCOTT MCKINLEY, University of Florida
Sensing and Decision-Making in Random Search

Many organisms locate resources in environments in which sensory signals are rare, noisy, and lack directional information. Recent studies of search in such environments model search behavior using random walks (e.g., Lévy walks) that match

empirical move- ment distributions. We extend this modeling approach to include searcher responses to noisy sensory data. The results of numerical simulation show that including even a simple response to noisy sensory data can dominate other features of random search, resulting in lower mean search times and decreased risk of long intervals between target encounters. In particular, we show that a lack of signal is not a lack of information. Searchers that receive no signal can quickly abandon target-poor regions. On the other hand, receiving a strong signal leads a searcher to concentrate search effort near targets. These responses cause simulated searchers to exhibit an emergent area-restricted search behavior similar to that observed of many organisms in nature.

RAOUL NORMAND, University of Toronto
A model of migration under constraint

We will present a random model of population with migrations, where individuals live on islands and migrate to another one whenever they run out of resources. Our main goal is to study how the population spreads over the different islands, when the number of initial individuals and available resources tend to infinity. Finding this limit relies on asymptotics for critical random walks and (not so classical) functionals of the Brownian excursion.

ED PERKINS, U. British Columbia
Phase Transition for Measure-valued SIR Epidemic Processes

We study a scaling limit of the long range SIR epidemic model in which infected individuals cannot be reinfected. The limit, which exists in up to 3 dimensions, has been studied by Lalley and Zheng and is reminiscent of a one-dimensional model proposed by Durrett and studied by Mueller and Tribe. It is a measure-valued process similar to super-Brownian motion with drift θ but with an additional killing term proportional to its local time. We show there is a non-trivial phase transition in θ for dimension 2 and 3, above which the process survives and below which it goes extinct, and prove that in one dimension there is always extinction. Moreover we show that in any dimension there is always extinction on compact sets. This is joint work with Steve Lalley and Xinghua Zheng.

DANIEL VALESIN, University of British Columbia
Extinction time of the contact process on finite trees

We consider the contact process on finite trees. We assume that the infection rate is larger than the critical rate for the one-dimensional process. We show that, for any sequence of trees with increasing number of vertices and degree bounded by a universal constant, the expected extinction time of the process grows exponentially. Additionally, the extinction time divided by its expectation converges in distribution to the unitary exponential distribution. This is joint work with Thomas Mountford, Jean-Christophe Mourrat and Qiang Yao.

XIAOWEN ZHOU, Concordia University
Support properties of a class of Lambda-Fleming-Viot processes with underlying Brownian motion

The Λ-Fleming-Viot process is a Fleming-Viot process with re-sampling mechanism associated to Λ coalescent, the coalescent allowing multiple collisions. For such a Λ-Fleming-Viot process with underlying Brownian motion, we show that its support is almost surely compact at any fixed positive time when the associated Λ-coalescent comes down from infinity fast enough. We also find both upper and lower bounds on Hausdorff dimension of the support. The lookdown construction of Donnelly and Kurtz plays a key role in our arguments.

This talk is based on joint work with Huili Liu.