Abstracts

Note: Due to a large number of speakers, we will have some talks in parallel on Saturday and Sunday. For room assignments, see schedule.

Friday, May 2nd

11:00-11:20 Shawn Drenning: TBA

11:25-11:45 Katharina Zaglauer: *Option Pricing in a Regime-Switching Black-Scholes Market* Joint work with Richard H. Stockbridge. We consider a Black-Scholes market in which the coefficients of the geometric Brownian motion modeling the stock price process evolve according a finite-state, continuous-time Markov chain that is independent of the driving Brownian motion process. The Markov-modulated model for stock prices is an incomplete market model. We characterize the equivalent martingale measures in terms of their relation to the Esscher transform and indicate how to determine the possible value(s) of the options. This work extends that of Elliott, Chan and Siu (2005) who investigate option pricing with the Esscher transform.

12:05-12:25 Shirshendu Chatterjee: *Contact process on random graphs with power law degree distributions has critical value 0*

12:30-12:50 Ivan Matic: *Large Deviations for Hamilton - Jacobi PDE* Random Hamilton-Jacobi equation is the equation of the form

$$u^{\varepsilon}(x,t,\omega) + H(\nabla_x u^{\varepsilon}(x,t,\omega), x/\varepsilon, \omega) = 0$$

with initial conditions $u^{\varepsilon}(x,0,\omega) = g^{\varepsilon}(x)$. We are investigating the class of Hamiltonians for which it is possible to establish the large deviations for u^{ε}.

15:00-15:50 **Amir Dembo: TBA**

16:00-16:20 John McSweeney: *Most Recent Common Ancestor Problem* The "Most Recent Common Ancestor" (MRCA) problem goes as follows: given a set of indi-

viduals in a current population, and various assumptions on a random reproduction mechanism, how far back in the past do we have to go, on average, to find an ancestor common to every one of these individuals? I will discuss the origins of this question as it relates to Kingman's work on the coalescent and also recent progress made by myself and my advisor Boris Pittel. I will also mention some surprising connections of this problem to Computer Scicence.

16:40-17:00 Scott McKinley: TBA

17:10-17:50 Alexandra Chronopoulou: *Hurst Index Estimation via Chaos Expansion for Hermite Processes* We study the behavior of Hermite processes of order q with self-similarity index $H \in (\frac{1}{2}, 1)$. Since these processes are self-similar, have stationary increments and exhibit long range dependence, it is of great importance to estimate the parameter H that describes their behavior. Using Wiener-Itô multiple stochastic integrals and Malliavin calculus we prove that the variations of a general Hermite process converge in $L^2(\Omega)$ to a Rosenblatt random variable with self-similarity order $\frac{2(H-1)}{q} + 1$, which is an element of the second Wiener chaos. Moreover, from a theoretical point of view, we study the reproduction property of Hermite processes, that is the terms of Hermite processes appearing in the decomposition of their variations give birth to other Hermite processes of different orders and self-similarity parameters.

Saturday, May 3rd

10:00-10:50 **Davar Khoshnevisan: TBA**

11:00-11:40 Jia Yeum & George Rus

Jia Yeum: *Solvability probability of system of random boolean equations* The probability of solvability of the system of random boolean equations which is obtained from random graph $G(n, p)$ is studied. In the case when the right hand side of each boolean equation is 0 or 1 with probability 1/2,respectively and $G(n, p)$ is at the critical range

with $p = (1 + \lambda n^{-1/3})/n$, the limiting probability is $n^{-1/12+o(1)}$.

George Rus: *Numerical Solution for Singular Stochastic Processes* The focus of this talk will be a long-term average stochastic control problem involving a controlled diffusion on a bounded region. I will first introduce an infinite-dimensional Linear Programming (LP) formulation for the problem. Convergence results will then allow to reduce the problem to a finite-dimensional LP. A projection argument will be used in order to approximate the solution using a least squares finite element approach. I will illustrate this approach on a particular problem, where the controlled diffusion is bounded on the interval $[0, 1]$.

12:00-12:40 Ivan Corwin & Bret Hanlon

Ivan Cowin: *Title: Benford's Law and the Modulo One Central Limit Theorem* We start by considering the peculiar distribution of first digits (most significant) for powers of two. A simple argument confirms that the most common digit is one (about 30% of the time) and the frequency progressively declines to the least common digit of nine (about 5% of the time). The distribution of first digits follows the famous Benford's Law and is observable in many "natural" sets of data such as stocks, company accounting and physical constants. We account for this ubiquitousness in two ways. First we show that Benford's Law uniquely satisfies certain scaling and base-invariance properties expected of "natural" data. Secondly we prove that Benford's Law arises as the limiting distribution for a large class of random dynamical systems (as we might find at play in the natural world).

Bret Hanlon: *Estimating the Density of the Martingale Limit Obtained from a Supercritical Branching Process* In general terms, this talk concerns the use of kernel density estimation to study a density which is "associated with" a supercritical branching process, i.e. the mean of the offspring distribution is greater than unity. To be more specific, let $\{Z_n : n \geq 1\}$ be a supercritical Bienaymé-Galton-Watson (BGW) branching process. Consider the sequence obtained from scaling Z_n by its mean, namely

$W_n \equiv \frac{Z_n}{EZ_n}$. It is easily verified that W_n is a non-negative martingale and thus has an almost sure limit, denoted W. Under "mild conditions," W is an absolutely continuous random variable; hence, the question of estimating its density is reasonable.
The talk will begin with a review of kernel density estimation (KDE) for independent and identically distributed data. We will then review the known probabilistic results for W. Finally, we will present our ideas for how to estimate the density of W using KDE techniques.

14:30-15:10 Wei Xiong & Nathaniel Blair-Stahn

Wei Xiong: *Hydrodynamics of particles immersed in a thermally fluctuating, viscous, incompressible fluid* My current work concerns the hydrodynamics of particles immersed in a thermally fluctuating, viscous, incompressible fluid. The governing equations stipulate conservation of momentum in the fluid, conservation of linear and angular momentum of the particle, and no-slip boundary conditions on the boundary of the particle. Is there existence and uniqueness for the solution? What are the limit theorems when time goes to infinity? These problems not only provide more detailed study of physical Brownian motions but also give a testing ground for the techniques in stochastic partial differential equations.
In this talk, I will focus on particles passively advected by the fluid. I will give existence and uniqueness results for passive particles (point particles as well as finite size particles) immersed in the fluid, and I will give limit theorems when the time goes to infinity.

Nathaniel Blair-Stahn: *Survival and limiting configurations in the two-type Richardson model* In 1998, Häggström and Pemantle introduced the two-type Richardson model, an interacting particle system in which two growing species compete for space on the lattice $\mathbf{Z}^d$. The model can be defined using two independent first-passage percolation processes on the underlying lattice, allowing an analysis based on subadditive ergodic theory. The main question of interest is whether there is a nonzero probability that both species simultaneously grow without bound, or whether almost surely one ends

up surrounded by the other. A 2007 paper of Deijfen and Häggström investigates the case where one of the species initially occupies an unbounded region. I will describe a generalization of some of their results, along with some related problems that I am considering.

15:20-16:00 Thomas Zamojski & Hongzhong Zhang

Thomas Zamojski: *Boundary theory and μ-processes* To a Lie group G is associated a homogeneous compact space $B(G)$ called the universal boundary. Boundary theory has played an important role in diverse subjects such as rigidity theorems, harmonic analysis, and representation theory. We will discuss how it is defined via μ-processes, a generalisation of random walks on groups, and we will provide simple examples. Knowledge of Lie groups will not be assumed, and it will only be used minimally or not at all.

Hongzhong Zhang: *One shot schemes for decentralized detection* In this work we consider the problem of quickest detection with N distributed sensors that receive continuous sequential observations from the environment. These sensors employ cumulative sum (CUSUM) strategies and communicate to a central fusion center by one shot schemes. One shot schemes are schemes in which the sensors communicate with the fusion center only once; when they must signal a detection. The communication is clearly asynchronous and the case is considered in which the fusion center employs a minimal strategy, which means that it declares an alarm when the first communication takes place. It is assumed that the observations received at the sensors are independent and that the time points at which the appearance of a signal can take place are different. It is shown that in fact there is no loss of performance of one shot schemes as compared to the centralized case in an extended Lorden min-max sense, since the minimum of N CUSUMs is asymptotically optimal as the mean time between false alarms increases without bound.

16:20-16:40 Veena Paliwal & Georgios Fellouris

Veena Paliwal: *Collaterized Debt Obligation*

Georgios Fellouris: *Asymptotically optimum tests for decentralized change detection* We discuss a novel, asymptotically optimum test for the problem of decentralized sequential change detection in the case that the sensors have full local memory. According to our scheme, the sensors perform locally repeated SPRTs and communicate, asynchronously, their one-bit decisions to a fusion center. The fusion center in turn uses the sequentially acquired information to perform a CUSUM test in order to decide whether a change took place or not. We prove that the average detection delay of the proposed test differs from the optimum centralized CUSUM test only by a constant. This fact suggests order-2 asymptotic optimality as compared to existing schemes that are optimal of order-1. This is joint work with Prof. George V.Moustakides (University of Patras).

16:50-17:10 Robert Masson & Bruce Rogers

Robert Masson: I will give a new proof of a result by Kenyon that the growth exponent for planar loop-erased random walk is 5/4. The proof will use the convergence of LERW to SLE_2.

Bruce Rogers: *Consensus under Bounded Confidence* Consider n actors each with some opinion, x_i, whose value is a real number. The problem of consensus is finding some algorithm which forces all the opinions of the actors to agree on a common value. One such algorithm pairs random actors and updates their opinion by some weighted average. However, two actors may have opinions sufficiently far apart that they refuse to update their opinions. This is called *bounded confidence*. We will review some results on convergence of opinions under bounded confidence and show how the consensus problem relates to products of random matrices.

17:20-17:40 Hao He & Jonathon Peterson

Hao He: *Utility Maximization of a portfolio that includes an illquid asset* The presence of illiquid assets complicates the problem of portfolio optimization. In this thesis, I consider an expected-utility-maximizing investor who, over a given time horizon, holds a portfolio which consists of an illiquid asset and a liquid asset. He can invest in the illiquid asset by transferring funds from the liquid asset but can not move funds from the illiquid asset to the liquid asset. The only time he can take money out of the illiquid asset is at some time $T > 0$. The goal is to maximize the expected utility of the wealth at the exercise time T and to obtain a complete characterization of the optimal solution. The problem is analyzed from both linear programming and dynamic programming point of view, the optimization is realized by using singular control, and the approximate numerical solution is obtained by using the continuous-time finite-states Markov chain approximation.

Jonathon Peterson: *Asymptotics for RWRE* This talk will concern the research that I am doing with my advisor, Ofer Zeitouni, on the asymptotic behavior of multi-dimensional RWRE.

Sunday, May 3th

10:00-10:20 Chia-Hung Wang & Hua Zhou

Chia-Hung Wang: *Blocking Probabilities of Multiple Classes in IP Networks with QoS Routing* This talk addresses the problem of bandwidth allocation on multi-class communication networks. We propose a mathematical model for calculating blocking probabilities with optimal bandwidth allocation and QoS routing. This scheme is performed by means of a two-phase procedure. The first step determines optimal paths under network constraints. The second step computes the blocking probability with predetermined optimal solutions. We derive the relationship between the user's utility and the allocated bandwidth, and analyze the relationship between the blocking probability and the bandwidth allocation.

Hua Zhou: *Composition Markov chains* Many classical Markov chains are special cases of what we prefer to call composition chains. A composition chain follows the fate of n particles. If each particle can occupy one of d states, then the composition chain records the number of particles $n_1, \ldots, n_d$ in each of the d states. The natural assumption in many applications is that all particles evolve independently according to a common transition probability matrix (kernel) M, which, inspired by applications from genetics, we term the mutation kernel. In some applications it is more convenient to move a random subset of the particles at each step while leaving the remaining particles fixed. It turns out this class of chains admit a system of multivariate Krawtchouk polynomials constructed by Griffiths as eigenfunctions, and the eigenvalues are also explicitly known. Our applications include the Ehrenfest chain and its generalizations, the recent Hoare and Rahman chain, the dermal-patch model of Rao et al., and the coalescence problem of Tian and Liu.

10:25-10:45 Jungyeon Yoon & Libor Pospisil

Jungyeon Yoon: *Option pricing with stochastic volatility models and an approximation scheme* Stochastic volatility models have gradually emerged as a useful way of modeling time-varying volatility with significant potential applications, especially in finance. Stochastic volatility models alone have not proven entirely empirically successful. We use the stochastic volatility models that allow random jumps to occur in stock prices. While we keep analytical tractability that is challenged by many alternative models to Black-Scholes model by using the generalized Black-Scholes formula, we cannot avoid the computational cost that is caused by the integrals in the option pricing formula. In this paper, we propose an approximation scheme to those integrals. With MCMC algorithm, the scheme is tested and validated on simulated data. Our method is proven to be accurate and computationally much more efficient.

Libor Pospisil: *Drawdowns and Drawups of Diffusion Processes* In this talk, I will discuss properties of drawdowns and drawups of diffusion processes. First, I will in-

troduce the maximum drawdown of a process as a financial contract and derive the probabilistic representation of its sensitivity to the running maximum and the running maximum drawdown of the process. In the second part of the talk, I will calculate the joint distribution of the maximum and the minimum of a diffusion process stopped at the first time, it drops by a certain amount. This result will allow me to obtain a formula for the probability that a drawdown of size a will precede a drawup of size b.

11:05-11:25 Tony Jhwueng & Rohini Kumar

Tony Jhwueng: *Probability Model in Phylogenetic analysis* The phylogenetic comparative models have been applied widely in analyzing the tree phylogeny and the corresponding species data set. When dealing with a various of real data, the performance of each model can be evaluated via its AIC and BIC number. In this article, a new model is created and several models will be accessed. Also, the better model will be suggested when applied with the real biological data set.

Rohini Kumar: *Current Fluctuations for Independent Random Walks*

11:30-11:50 Rachel Thomas & Ankit Gupta

Rachel Thomas: *Randomness in Networks* Given a network governed by a system of differential equations with stochastic input, how does the structure of the network effect how randomness propagates through it? This is a fun mix of probability, graph theory, and differential equations.

Ankit Gupta: *Stochastic Model for Concentration in Yeast Cell* We study the model proposed by Altschuler, Angenent and Wu for the diffusion of particles in a yeast cell. For any finite population size N we model the phenomenon as a discrete Markov chain. We show that under suitable scaling these discrete particle processes converge to a measure valued diffusion process as N goes to infinity. We characterize its stationary distribution and draw inferences about localization of particles on the membrane

in the infinite population limit.

12:00-12:20 Ang Wei & David Anderson

Ang Wei: *On the zeros of random harmonic polynomial* We study the distribution of complex zeros of Gaussian harmonic polynomials with independent complex coefficients. The expected number of zeros is evaluated by applying a formula of independent interest for the expected absolute value of quadratic forms of Gaussian random variables.

Dsvid Anderson: TBA

12:25-12:45 Johannes Ruf: *Pricing corporate bonds in an arbitrary jump-diffusion model based on an improved Brownian-bridge algorithm* In this paper, we provide an efficient algorithm for the computation of bond prices in a structural default model with jumps. Our algorithm allows jump-diffusion processes with arbitrary jump-size distribution as a model for the logarithm of the value process of a firm. Moreover, the algorithm is unbiased and is capable of capturing stochastic recovery rates, which are endogenously generated by structural default models with jumps. The algorithm requires the evaluation of integrals with the density of the first-passage time of a Brownian bridge as integrand. In order to further accelerate their barrier-option pricing algorithm, Metwally and Atiya (2002) suggested an approximation of these integrals. We significantly improve this approximation in terms of precision. It is well known that allowing a sudden default by jumps results in a positive limit of credit spreads at the short end of the term structure. We provide an explicit formula for this limit, which depends only on the Lévy measure of the logarithm of the firm-value process, the recovery rate, and the distance to default.

12:50-13:10 Ruoting Gong: *Dynamic Contracting under Imperfect Information and Diffusion Pay-off Process* We develop a dynamic model to assess how risk and imperfect information affect principal-agent relationship. In this framework, both the

principal and the agent take actions affecting the projects output. The pay-off process is modeled as a diffusion whose solution also affects the agents utility function, which in turns, affects the contract.