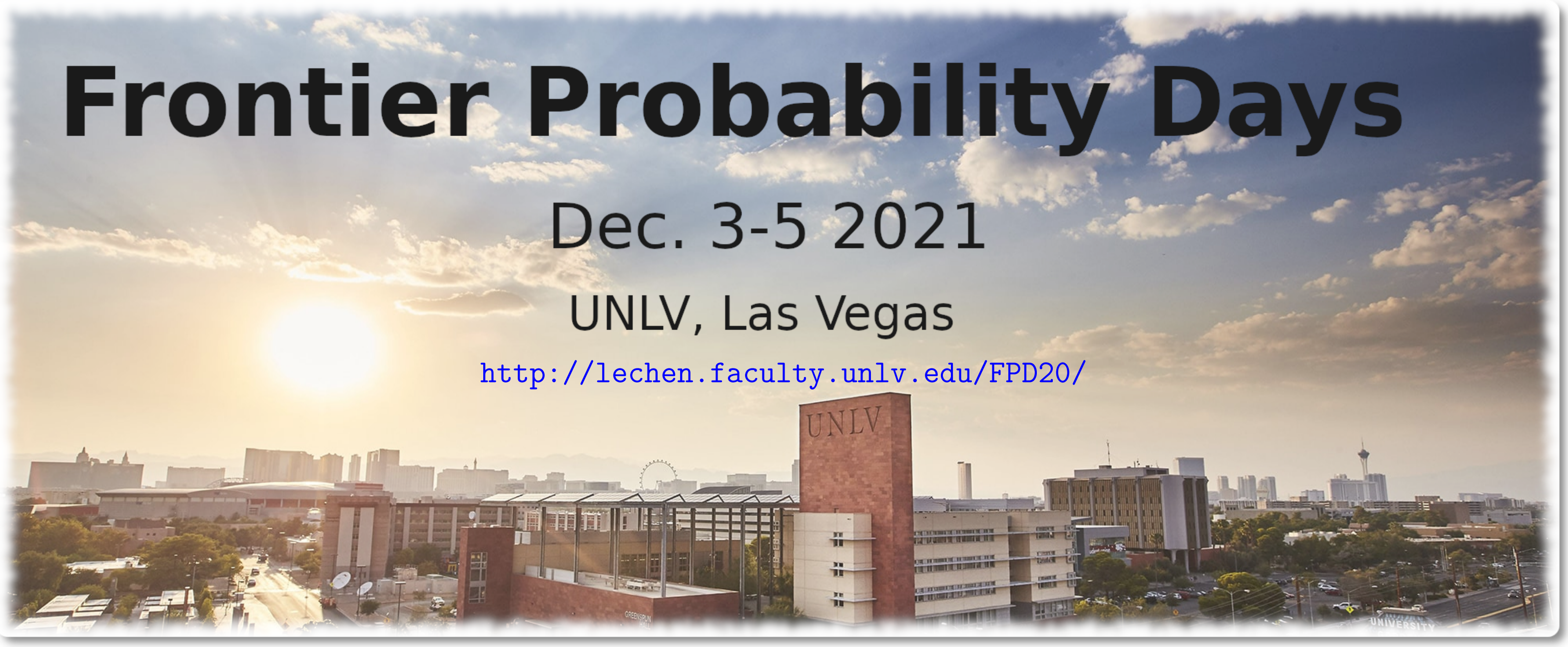

Main Speakers:

Hakima Bessaih
Florida International University

Ioana Dumitriu
University of California, San Diego

Jeffrey Kuan
Texas A&M University

Natesh Pillai
Harvard University

Samy Tindel
Purdue University

Atilla Yilmaz
Temple University

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Tom Alberts
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Auburn University

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University of Utah

Yevgeniy Kovchegov
Oregon State University

Firas Rassoul-Agha
University of Utah

Sunder Sethuraman
University of Arizona

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Last updated Saturday 4th December, 2021

Frontier Probability Days 2021' (FPD'21) is a regional workshop, taking place at the University of Nevada, Las Vegas, on Dec. 3–5 2021. Its purpose is to bring together mathematicians, both regionally and globally, who have an interest in probability and its applications. FPD aims to complement other regional conferences in Probability that are held annually elsewhere in the united states.

Note: The conference was originally scheduled to take place on May 8–10, 2020. Due to the Covid pandemic, it was postponed to the current dates.

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1 Schedule

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8:45-9:00		Opeing	
9:00-9:50	Plenary Talks	**Dumitriu, Ioana** *Spectra of random hypergraphs*	
10:00-10:50	Plenary Talks	**Pillai, Natesh** *Kac's random walk and its variants: mixing times and applications*	
11:00-11:20		Coffee Break	
11:20-11:40	Short Talks	**Panzo, Hugo** *Improved upper bounds for the Hot Spots constant*	**Sarantsev, Andrey** *A stock market model based on CAPM & market size*
11:40-12:00	Short Talks	**Onyido, Maria Amarakristi** *Nonlocal dispersal equations with almost periodic dependence*	**Wang, Haixiao** *Partial recovery for non-uniform random hypergraph*
12:00-12:20	Short Talks	**Javad Latifi, Mohammad** *Verblunsky coefficients, loop groups and lattice models*	**Cao, Fei** *Wealth distributions from biased exchange of money - some models and results*
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14:00-14:50	Plenary Talk	**Bessaih, Hakima** *Markov properties and invariant measures for stochastic 2D damped Euler equations*	
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15:20-15:40	Short Talks	**Chong, Carsten** *The stochastic heat equation with multiplicative Lévy noise: Existence, moments, and intermittency*	
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11:00-11:20		Coffee Break and Group Photo	
11:20-11:40	Short Talks	**Ouyang, Cheng** *Equivalence of control distances*	**Mason, David** *Self-standardized central limit theorems for trimmed subordinators*
11:40-12:00	Short Talks	**Nguyen, Hung** *Short memory limits for a stochastic Coleman-Gurtin model of heat conduction*	**Wu, Qiang** *Mean field spin glass model under weak external fields*

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14:00-14:50	Plenary Talk	**Kuan, Jeffrey**	Title		
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		TASEP back in time			
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		Non-existence of non-trivial bi-infinite geodesics in geometric last passage percolation		*Analysis of systems of stochastic delay differential equations and applications*	
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Sunday, Dec. 5, 2021

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9:20-9:40		**Krishnan, Kesav**	
		Disordered monomer-dimer model on cylinder graph	
9:40-10:00	Coffee Break		
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		Mesoscopic CLT for Kronecker random matrices	
10:20-10:40		**Wang, Zhichao**	
		Nonlinear random matrix theory for neural networks	
10:40-11:00		**Benigni, Lucas**	
		Spectrum of random feed-forward neural networks.	
11:00-11:20	Coffee Break		
11:20-11:40	Short Talks	**Wu, Peixue**	
		Heat kernel estimates for non-local operator with multi-singular critical killing potential	
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12:00-12:10	Ending		

Legend for talks
Planery speakers
Graduate student speakers
Postdoc speakers
Faculty speakers

2 Plenary talks

Markov properties and invariant measures for stochastic 2D damped Euler equations

Bessaih, Hakima
Florida International University
hbessaih@fiu.edu
Fri, 14:00–14:50
HOS 380

We study the two-dimensional Euler equations, damped by a linear term and driven by an additive noise. The existence and uniqueness of weak solutions are proven pathwise in a space that is not separable. We prove the Markov property and then the existence of an invariant measure in a non Markovian setting. A Krylov-Bogoliubov's type method is used by working with the weak-star and the bounded weak-star topologies.

1

Spectra of random hypergraphs

Dumitriu, Ioana
University of California, San Diego
idumitriu@ucsd.edu
Fri, 9:00–9:50
HOS 380

Random graphs have served for many decades as models for random networks, from social to electrical and biological. Their spectra in particular have been used to understand network properties and provide guarantees for certain algorithms that seek to describe network structure. Hypergraphs are a somewhat more recent generalization of graphs, defining more complex relationships between sets of vertices; naturally, this makes them good candidates for modeling more complex networks. Unsurprisingly, their spectra behave largely like graph spectra (assuming that we look at things from the correct perspective). I will talk about some hypergraph eigenstatistics for two key random models, and highlight some of the methods and tools one needs to borrow from random matrix theory to calculate them.

2

Joint moments of multi–species q–Boson

Kuan, Jeffrey
Texas A&M University
jkuan@math.tamu.edu
Sat, 14:00–14:50
HOS 380

The Airy_2 process is a universal distribution which describes fluctuations in models in the Kardar–Parisi–Zhang (KPZ) universality class, such as the asymmetric simple exclusion process (ASEP) and the Gaussian Unitary Ensemble (GUE). Despite its ubiquity, there are no proven results for analogous fluctuations of multi–species models. Here, we will discuss one model in the KPZ universality class, the q–Boson. We will show that the joint multi–point fluctuations of the single–species q–Boson match the single–point fluctuations of the multi–species q–Boson. Therefore the single–point fluctuations of multi–species models in the KPZ class ought to be the Airy_2 process. The proof utilizes the underlying algebraic structure of the multi–species q–Boson, namely the quantum group symmetry and Coxeter group actions.

3

Kac's random walk and its variants: mixing times and applications

Pillai, Natesh
Harvard University
pillai@fas.harvard.edu

Fri, 10:00–10:50
HOS 380

Determining the mixing time of Kac's random walk on the n-sphere was a long-standing open problem. In this talk, I will discuss my joint work with Aaron Smith on obtaining the optimal mixing time bounds for this talk and its variants. In addition to discussing the key coupling construction underlying our proof, I will discuss its connections and applications to random matrix theory, dimension reduction methods, and other statistical applications. In particular, we will exhibit a Johnson-Lindenstrauss (JL) transform using Kac's walk that is memory-optimal and outperforms existing algorithms in certain regimes, confirming a conjecture of Ailon and Chazelle.

This is joint work with Aaron Smith, Vishesh Jain, Ashwin Sah, Mehtaab Sawhney.

4

A coupling between Sinai's random walk and Brox diffusion

Tindel, Samy
Purdue University
stindel@purdue.edu

Sat, 9:00–9:50
HOS 380

Sinai's random walk is a standard model of 1-dimensional random walk in random environment. Brox diffusion is its continuous counterpart, that is a Brownian diffusion in a Brownian environment. The convergence in law of a properly rescaled version of Sinai's walk to Brox diffusion has been established 20 years ago.

In this talk, I will explain a strategy which yields the convergence of Sinai's walk to Brox diffusion thanks to an explicit coupling. This method, based on rough paths techniques, opens the way to rates of convergence in this demanding context. Notice that I'll try to give a maximum of background about the objects I'm manipulating, and will keep technical considerations to a minimum.

5

Stochastic homogenization of viscous Hamilton-Jacobi equations in one dimension

Yilmaz, Atilla
Temple University
atilla.yilmaz@temple.edu

Sat, 10:00–10:50
HOS 380

After giving a general introduction to the homogenization of Hamilton-Jacobi (HJ) equations, including the classical results in the cases where the Hamiltonian is periodic in the spatial variable x or convex in the gradient variable p, I will focus on viscous HJ equations in one space dimension with Hamiltonians of the form $G(p) + V(x, \omega)$, where G is a nonconvex function and V is a stationary & ergodic random potential that satisfies a natural valley & hill condition (which excludes the periodic case). I will present several recent results on this class of HJ equations (by various combinations of A. Davini, E. Kosygina, O. Zeitouni and myself), where homogenization is established by showing that, outside of the intervals where the effective Hamiltonian turns out to be flat (due to the valley & hill condition), there is a unique sublinear corrector (which is a notion I will introduce) with certain properties. In the special case where G is the minimum of two identical parabolas, these sublinear correctors have convenient representations involving Brownian motion in a random potential. More generally, their existence & uniqueness can be proved using ODE methods that bypass the need for explicit representations, which I will demonstrate when G is quasiconvex.

6

3 Short talks

Effect of small noise on the speed of propagation for reaction-diffusion equations with non-lipschitz drift

Barnes, Clayton Postdoc
Technion-Israel Institute of Technology Fri, 15:00–15:20
clayleroy2@gmail.com HOS 380

The Fisher-KPP equation is a reaction-diffusion equation motivated by population genetics, whose solutions exhibit traveling waves that propagate through time. Recently there has been interest in studying solutions for the stochastic FKPP equation where we add a noise term the classical FKPP equation. The solutions are random fields that also exhibit travelling waves. We determine the asymptotic speed of these solutions when the coefficient representing the strength of the noise approaches zero. This is joint work with Leonid Mytnik and Zhenyao Sun.

1

Spectrum of random feed-forward neural networks.

Benigni, Lucas Postdoc
University of Chicago Sun, 10:40–11:00
lbenigni@uchicago.edu HOS 380

We discuss recent and ongoing progress on the study of eigenvalues of a model of random neural networks in the random matrix regime. We first give the asymptotic empirical eigenvalue distribution which is given by a deterministic compactly supported measure and give some of its properties. We will then discuss the behavior of its largest eigenvalue whose position is nonuniversal w.r.t the entry distribution and the dependence on the activation function is different than that of the e.e.d. This talk is based on joint works with Sandrine Péché.

2

Efficient truncated realized variance in the presence of infinite variation jumps

Boniece, Benjamin Postdoc
University of Utah Sat, 17:00–17:20
bcboniece@math.utah.edu HOS 334

A quantity known as integrated variance (IV) a plays an important role in financial econometrics, and its estimation has received considerable attention over the past two decades. Though IV can be estimated in a straightforward manner when the underlying process is continuous, in the presence of jumps, naive estimation of IV fails to be consistent, and accordingly several methods have been proposed to accommodate models with jump behavior. However, many of these methods are not efficient when the jump behavior in the underlying process is too extreme. A fundamental estimator known as the Truncated Realized Variance (TRV), in particular, displays non-negligible bias that prevents efficiency when jumps are of infinite variation, even in the fundamental case of a Lévy process. In this talk, I will discuss an iterative debiasing procedure for TRV applied to a Lévy model that allows for efficient estimation of IV. This is based on joint work with Yuchen Han and José E. Figueroa-López.

3

Wealth distributions from biased exchange of money - some models and results

Cao, Fei Graduate student
Arizona State University Fri, 12:00–12:20
fcao5@asu.edu HOS 334

We are interested in using kinetic theory to better understand the time evolution of wealth distribution and their large scale behavior such as the evolution of inequality (e.g. Gini index). We investigate three type of dynamics denoted unbiased, poor-biased and rich-biased exchange models. At the individual level, one agent is picked randomly based on its wealth and one of its dollar is redistributed among the population. Proving the so-called propagation of chaos, we identify the limit of each dynamics as the number of individual approaches infinity using both coupling techniques and martingale-based approach. Equipped with the limit equation, we identify and prove the convergence to specific equilibrium for both the unbiased and poor-biased dynamics. In the rich-biased dynamics, however, we observe a more complex behavior where a dispersive wave emerges. Although the dispersive wave is vanishing in time, its also accumulates all the wealth leading to a Gini approaching 1 (its maximum value). We characterize numerically the behavior of dispersive wave but further analytic investigation is needed to derive such dispersive wave directly from the dynamics.

4

The stochastic heat equation with multiplicative Lévy noise: Existence, moments, and intermittency

Chong, Carsten Faculty
Columbia University Fri, 15:20–15:40
chc2169@columbia.edu HOS 380

We study the stochastic heat equation (SHE) $\partial_t u = \frac{1}{2}\Delta u + \beta u \xi$ driven by a multiplicative Lévy noise ξ with amplitude $\beta > 0$, in arbitrary dimension $d \geq 1$. We prove the existence of solutions under an optimal condition if $d = 1, 2$ and under a close-to-optimal condition if $d \geq 3$. Under an assumption that is general enough to include stable noises, we further prove that the solution is unique. Next, by establishing tight moment bounds on the multiple Lévy integrals arising in the chaos decomposition of u, we show that the solution has finite pth moments for $p > 0$ whenever the noise does. Finally, for any $p > 0$, we derive upper and lower bounds on the moment Lyapunov exponents of order p of the solution, which are asymptotically sharp in the limit as $\beta \to 0$. One of our most striking findings is that the solution to the SHE exhibits full intermittency for any non-trivial Lévy measure, at any disorder intensity $\beta > 0$, in any dimension $d \geq 1$.

5

Efficient rare event sampling for branching random walks

Conroy, Michael Postdoc
University of Arizona Fri, 16:40–17:00
michaelconroy@math.arizona.edu HOS 334

We develop an unbiased and strongly efficient importance sampler for tail events of the all-time maximum of a branching random walk. The sampler is based on a representation of the tail events after a change of measure, generalizing non-branching representations that are standard in Cramer-Lundberg theory. Related to spine changes of measure often used in the branching process literature, the new measure tilts only one path of the walk, inducing a structure on the underlying branching process that allows for even more efficient algorithms to approximate tail events for branching random walks, in particular one whose computation time is not slowed by the branching rate of the walk.

6

Numerical approximation of nonlinear stochastic differential equations with continuously distributed delay

Gallage, Roshini Graduate student
Southern Illinois University Carbondale Sat, 16:40–17:00
roshi@siu.edu HOS 334

Stochastic delay differential equations (SDDEs) are systems of differential equations with a time lag in a noisy or random environment. Much research has been done using discrete delay where the dynamics of a process at time t depend on the state of the process in the past after a single fixed time lag . We are researching processes with continuously distributed delay which depend on weighted averages of past states over the entire time lag interval [t- ,t]. We give generalized Khasminskii-type conditions which along with local Lipschitz conditions are sufficient to guarantee the existence of a unique solution of certain nonlinear SDDEs with continuously distributed delay. Further, we give conditions under which Euler-Maruyama numerical approximations of such nonlinear SDDEs converge in probability to their exact solutions. Joint work with Dr. Harry Randolph Hughes

7

Large deviations for slow-fast systems driven by fractional Brownian motion

Gasteratos, Ioannis Graduate student
Boston University Fri, 17:00–17:20
igaster@bu.edu HOS 380

In this talk, we consider a class of slow-fast systems in which the slow component is driven by small fractional Brownian motion (fBm) with Hurst index $H > 1/2$. As the scale separation and noise intensity parameters vanish, the typical behavior of such systems is captured by averaging/homogenization principles which have been recently established by several authors. We study large deviations from the averaging limit by means of the weak convergence method. The lack of semi-martingale property introduces the necessity to specify an interpretation for the stochastic integral with respect to the fBm. Using a variational representation for functionals on abstract Wiener spaces and techniques from fractional and Malliavin calculus, we obtain tightness estimates under three different sets of assumptions regarding the range of H, the diffusion coefficient of the slow dynamics and the choice of stochastic integral. The rate function is obtained in variational form and its differences with the Brownian case ($H = 1/2$) will be discussed. This is joint work with Siragan Gailus.

8

Non-existence of non-trivial bi-infinite geodesics in geometric last passage percolation

Groathouse, Sean Graduate student
University of Utah Sat, 16:20–16:40
sean@math.utah.edu HOS 380

We consider geometric last-passage percolation, in which the vertices of Z^2 are assigned i.i.d. Geometric weights with a fixed parameter. The last-passage time between two points is the largest total weight of an up-right path between the points. Up-right paths which achieve this maximum are called geodesics. We show that with probability one, the only bi-infinite geodesic paths are horizontal and vertical lines. We also highlight two claims that, if verified, would extend our proof to a more general class of distributions. Based on joint work with C. Janjigian and F. Rassoul-Agha.

9

Mixing and stabilization in the abelian sandpile model

Hough, Robert
Stony Brook University, New York
robert.hough@stonybrook.edu

Faculty
Sun, 9:00–9:20
HOS 380

In the abelian sandpile model on a finite graph G = (V, E) the states consist of an allocation of chips at each non-sink vertex. If the number of chips at a vertex is at least the degree, the vertex topples, passing one chip to each neighbor; any chip which falls on the sink is lost from the model. Sandpile dynamics consist of dropping a chip on a uniformly random vertex and performing any available topplings. In joint work with Jerison and Levine, we have determined the asymptotic mixing time and proved a cut-off phenomenon for sandpile dynamics on the discrete torus $(\mathbb{Z}/n\mathbb{Z})^2$ with nearest neighbor edges and a single sink. We also consider the stabilization problem for i.i.d. sandpiles on $\mathbb{Z}^2$. In joint work with Hyojeong Son, we prove a cut-off phenomenon for sandpile dynamics on growing pieces of plane or space tilings given periodic or open boundary conditions. In two dimensions, we show that the asymptotic mixing time is the same with periodic and open boundary conditions. In 4 dimensions, we show that on the D4 lattice, the open boundary condition causes the model to mix more slowly asymptotically.

10

Verblunsky coefficients, loop groups and lattice models

Javad Latifi, Mohammad
University of Arizona
mjlatifi@math.arizona.edu

Graduate student
Fri, 12:00–12:20
HOS 380

In this talk, we start with stating the correspondence of Gaussian free field on the unit circle and associated Verblunsky coefficients. We then explore the natural appearance of certain exactly solvable lattice models and their connection with loop group factorization.

11

Disordered monomer-dimer model on cylinder graph

Krishnan, Kesav
University of Illinois Urbana-Champaign
kesavsk2@illinois.edu

Graduate student
Sun, 9:20–9:40
HOS 380

We analyse the monomer-dimer model on a family of graphs called cylinder graphs, where we have i.i.d. random weights on the vertices as well as edges. We prove convergence of the mean free energy and establish a central limit theorem for the same. We also prove a law of large numbers and a central limit theorem for the number of unpaired vertices, and finally Brownian motion fluctuations for the number of unpaired vertices in specific sections of the graphs. This is joint work with Partha S. Dey.

12

Convergence of densities of spatial averages for stochastic heat equation

Kuzgun, Sefika Graduate student
University of Kansas Fri, 16:40–17:00
sefika.kuzgun@ku.edu HOS 380

The purpose of this talk is to show a recent results on the uniform convergence of the density of the normalized spatial averages on an interval $[-R, R]$, as R tends to infinity, to the density of the standard normal distribution, assuming some non-degeneracy and regularity conditions on the nonlinear coefficient σ in the first case and after renormalization of the solution in the second case. The proof is based on a combination of the techniques of Malliavin calculus with Stein's method for normal approximations. This is a joint work with David Nualart.

13

Stochastic solution of an elliptic-parabolic system arising in flow in porous media

Landoulsi, Oussama Postdoc
Florida International University Fri, 16:00–16:20
olandoul@fiu.edu HOS 380

In this talk, we prove existence of weak solution to the single-phase, miscible displacement of one incompressible fluid by another in a porous medium with random forcing. Our system is described by a parabolic concentration equation driven by an additive noise coupled with an elliptic pressure equation. We use a pathwise argument combined with Schauder's fixed point theorem.

14

Numerical rough integrals and limit theorems

Liu, Yanghui Faculty
Baruch College, City University of New York Sat, 12:00–12:20

yanghui.liu@baruch.cuny.edu HOS 380

Rough paths techniques give the ability to define solutions of stochastic differential equations driven by low-regularity signals which are not semi-martingales. In this context, rough integrals are usually Riemann-Stieltjes integrals with correction terms that are sometimes seen as unnatural. As opposed to those somewhat artificial correction terms, in this talk I will introduce a trapezoid rule for rough integrals driven by general d-dimensional Gaussian processes. Namely we shall approximate a generic rough integral by Riemann sums avoiding the usual higher order correction terms, making the expression easier to work with and more natural. Our approximations apply to all controlled processes and to a wide range of Gaussian processes including fractional Brownian motion with a Hurst parameter H > 1/4. This is a joint work with Zachary Selk and Samy Tindel.

15

Self-Standardized Central Limit Theorems for Trimmed Subordinators

Mason, David Faculty
University of Delaware Sat, 11:20–11:40
davidm@udel.edu HOS 334

We prove under general conditions that a trimmed subordinator satisfies a self-standardized central limit theorem [CLT]. Our basic tools are a classic representation for subordinators and a distributional approximation result of Zaitsev (1987). Among other results, we obtain as special cases of our main result the recent self-standardized CLTs of Ipsen, Maller and Resnick (2019) for trimmed subordinators and a trimmed subordinator analog of a CLT of S. Csorgo, Horvath and Mason (1986) for intermediate trimmed sums in the domain of attraction of a stable law. We then discuss how our methods extend to proving similar theorems for spectrally positive Levy processes and then to general Levy processes.

16

Mesoscopic CLT for Kronecker random matrices

Nemish, Yuriy Postdoc
University of California, San Diego Sun, 10:00–10:20
ynemish@ucsd.edu HOS 380

For a general class of symmetric Kronecker random matrices we establish the Central Limit Theorem of the linear spectral statistics on mesoscopic scales inside the bulk. The result is obtained through the analysis of the characteristic function of the linear statistics, and relies on the detailed study of the resolvent of the Kronecker random matrices and the corresponding Dyson equation. This is a joint work with Torben Krüger.

17

Short memory limits for a stochastic Coleman-Gurtin model of heat conduction

Nguyen, Hung Postdoc
University of California, Los Angeles Sat, 11:40–12:00
hungdnguyen@math.ucla.edu HOS 380

We consider a stochastically driven Coleman-Gurtin model, which is a reaction-diffusion equation with diffusive integro-differential memory terms, polynomial non-linearities and perturbed by additive noise. In the short memory limit, i.e., as the memory collapses to a Dirac mass, we establish both the finite time and time asymptotic validity of the system toward the classical reaction-diffusion equation. The proofs require estimates on suitable Wassernstein distances, that must be uniform with the respect to the memory. This talk is based on a joint work with Nathan Glatt-Holtz.

18

Analysis of systems of stochastic delay differential equations and applications

Nguyen, Nhu Graduate student
University of Connecticut Sat. 16:20–16:40
nguyen.nhu@uconn.edu HOS 334

In this talk, I fully classify the longtime behavior of systems of stochastic functional (delay) differential equations (SFDEs, SDDEs). It is well-recognized that analyzing SFDEs possesses many challenges due to the solution processes are non-Markov, not strong Feller, etc. Thus, that requires novel approaches and significant efforts. Our techniques include the uses of newly functional Itô formula, asymptotic coupling methods, Harislike theory, subtle analysis of the solution processes and randomized occupation measures (in infinite dimensional spaces), and the log-Laplace transform. As an application, we generalize the previous biological and ecological systems by providing a unified framework using SFDEs. The characterization gives sufficient and (almost) necessary conditions for the extinction and persistence of the species in a general setting with a population having n individuals that live in a stochastic environment, and their nonlinear interactions depend on the past history. These applications also significantly improve many existing works in the theory of stochastic delay systems and in mathematical biology and ecology. When the delays disappear, our result covers the previous results of diffusion systems.

19

Nonlocal dispersal equations with almost periodic dependence

Onyido, Maria Amarakristi Graduate student
Auburn University Fri, 11:40–12:00
mao0021@auburn.edu HOS 380

Nonlocal dispersal equations are used to model the dynamics of populations having a long-range dispersal strategy. This model of spatial spread is obtained by replacing the Laplacian in the usual reaction-diffusion equation with an integral operator, i.e., Δu is replaced with $\int_D \kappa(y-x)[u(t,y)-u(t,x)]dy$, where $\kappa(y-x)$ is the probability of a species jumping from location x to y. This talk will examine the principal spectral theory of nonlocal dispersal operators with almost periodic dependence from two aspects: top Lyapunov exponents and generalized principal eigenvalues. Among others, we shall discuss the relations between the top Lyapunov exponents and generalized principal eigenvalues and the effects of time and space variations on them.

20

Equivalence of control distances

Ouyang, Cheng Faculty
University of Illinois at Chicago Sat, 11:20–11:40
couyang@uic.edu HOS 380

We show that for a hypo elliptic SDE driven by a fractional Brownian motion (fBm), the control distance of the system is locally equivalent to the corresponding sub-Riemannian distance. In a particular case when the solution is the signature of the fBm the equivalence is global.

21

Improved upper bounds for the Hot Spots constant

Panzo, Hugo Postdoc
Technion-Israel Institute of Technology Fri, 11:20–11:40
hugo.panzo@uconn.edu HOS 380

The Hot Spots constant was recently introduced by Steinerberger as a means to control the global extrema of the first nontrivial eigenfunction of the Neumann Laplacian by its boundary extrema. We use probabilistic techniques to derive a general formula for a dimension-dependent upper bound that can be tailored to any specific class of bounded Lipschitz domains. This formula is then used to compute upper bounds for the Hot Spots constant of the class of all bounded Lipschitz domains in $\mathbb{R}^d$ for both small d and for asymptotically large d that significantly improve upon the existing results. Joint work with Phanuel Mariano and Jing Wang.

22

A Bayesian approach to linking mechanistic disease models to geostatistical prevalence distributions of soil-transmitted helminths

Patel, Swati Faculty
Oregon State University Sat, 16:00–16:20
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In this talk, I will discuss applying a recently developed approach to estimate parameters of a disease transmission model for soil-transmitted helminths (STH). STH are parasitic worms that infect an estimated 1.5 billion people worldwide. We will use data coming from geostatistical methods, which provide a probability distribution for the prevalence of this disease in 5183 spatial units across sub-Saharan Africa (where more exact prevalences are often unknown). The approach is analogous to Approximate Bayesian Computation, extended for this distributional data, and additionally we employ an adaptive multiple importance sampling algorithm for computational efficiency. Fitting parameters of a transmission model enables us to project the prevalence of the disease under various mitigation strategies being implemented by public health organizations.

23

Concentration inequalities for ultra log-concave distributions

Pathirannehelage, Heshan Aravinda Bandara Graduate student
University of Florida Fri, 16:20–16:40
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We will define the class of ultra-log concave (ULC) probability distributions, which is an important subclass of one dimensional discrete log-concave distributions. Examples include hypergeometric, sums of independent binomial with arbitrary parameters and poisson distributions. A natural question is whether ULC random variables are concentrated around their expectation. It turns out the answer is yes. In this talk, we will discuss this result and its proof techniques. We will also talk about an interesting application of this result in convex geometry. More specifically, our result implies a concentration bound for the intrinsic volumes of a convex body, which generalizes and improves a result of Lotz, McCoy, Nourdin, Peccati, and Tropp (2019).

This is joint work with Arnaud Marsiglietti & James Melbourne.

24

Random butterfly matrices and growth factors

Peca-Medlin, John Postdoc
University of Arizona Fri, 17:00–17:20
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The recursive structure of butterfly matrices has been exploited to accelerate common methods in computational linear algebra. Recent interest in butterfly matrices has spiked in the machine learning and AI communities, where butterfly structures have been integrated into architectures used in learning fast solvers for large linear systems and in image recognition. These growing applications have often eclipsed the mathematical understanding of how or why butterfly matrices are able to accomplish these tasks. I will focus on the particular application to remove the need for pivoting in Gaussian elimination. I will explore the impact of preconditioning a linear system by butterfly matrices on the growth factor, which controls the numerical stability of Gaussian elimination. These results will be compared to other common methods found in randomized linear algebra.

25

An evaluation on Benford's law in music

Prince Nelson, Sybil Faculty
Washington and Lee University Fri, 16:00–16:20
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Western Music history can be divided into six major categories: Medieval, Renaissance, Baroque, Classical, Romantic and Post War. We analyzed a large collection of music from each time period and discovered a clear mathematical connection. Within each time period, we found that the note frequencies measured in hertz (Hz) and note durations are all Benford distributed. We also found that as music progressed through time, note lengths adhered closer and closer to the Benford distribution with the exception of the Post War time period

26

Renormalization of crossing probabilities in the dilute Potts model

Rigas, Pete Graduate student
Cornell University Sat, 17:00–17:20
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A renormalization argument due to Duminil-Copin and Tassion from 2019 was first applied to the random cluster model to establish four regimes of behavior, with crossing probabilities taken under wired and free boundary conditions. To apply the novel renormalization argument to other models of interest without making use of self-duality as in classical Russo-Seymour-Welsh arguments which provide bounds on crossing probabilities, we present the loop O(n) model and discuss how the argument transfers from the random cluster model case. The loop O(n) model has not been extensively studied in the literature, and through connections with the dilute Potts model originally studied by Nienhuis in 1991 with vacancy and occupancy representations, allows for a similar classification of a quadrichotomy of four possible behaviors. The components of the argument heavily rely on making use of comparison between boundary conditions (CBC) and the spatial Markov property (SMP) to obtain strip and renormalization inequalities, which will be established for the loop O(n) model in the high temperature regime in the presence of two external fields. After discussing the loop O(n) model, similarities between RSW arguments and crossing across symmetric domains for the six-vertex model will be provided, in order to further examine sloped boundary conditions.

27

TASEP back in time

Saenz Rodriguez, Axel Faculty
Oregon State University Sat, 15:00–15:20
saenzroa@oregonstate.edu HOS 380

We introduce a Markov process that maps the distribution of the TASEP with step initial condition at time t >0 to some earlier time s, with t > s > 0. This result is obtained by analyzing the action of the Yang-Baxter equation on the set of weighted interlacing arrays or, equivalently, Gelfand-Tsetlin patters or Schur processes.

28

A stock market model based on CAPM & market size

Sarantsev, Andrey Faculty
University of Nevada, Reno Fri, 11:20–11:40
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We introduce a new system of stochastic differential equations which models dependence of market beta and unsystematic risk upon size, measured by market capitalization. We fit our model using size deciles data from Kenneth French's data library. This model is somewhat similar to generalized volatility-stabilized models. The novelty of our work is twofold. First, we take into account the difference between price and total returns (in other words, between market size and wealth processes). Second, we work with actual market data. We study the long-term properties of this system of equations, and reproduce observed linearity of the capital distribution curve.

29

Estimating drift and minorization coefficients for Gibbs sampling algorithms

Spade, David Faculty
University of Wisconsin-Milwaukee Fri, 16:20–16:40
spade@uwm.edu HOS 334

Gibbs samplers are common Markov chain Monte Carlo (MCMC) algorithms that are used to sample from intractable probability distributions when sampling directly from full conditional distributions is possible. These types of MCMC algorithms come up frequently in many applications, and because of their popularity, it is important to have a sense of how long it takes for the Gibbs sampler to become close to its stationary distribution. To this end, it is common to rely on the values of drift and minorization coefficients to bound the mixing time of the Gibbs sampler. This manuscript provides a computational method for estimating these coefficients. Herein, we detail the several advantages of the proposed methods, as well as the limitations of this approach. These limitations are primarily related to the "curse of dimensionality," which for these methods, is caused by necessary increases in the numbers of initial states from which chains need be run and the need for an exponentially increasing number of grid points for estimation of minorization coefficients.

30

On convergence of the cavity and Bolthausen's TAP iterations to the local magnetization

Tang, Si Faculty
Lehigh University Sat, 16:00–16:20
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The cavity and TAP equations are high-dimensional systems of nonlinear equations of the local magnetization in the Sherrington-Kirkpatrick model. In the seminal work, Bolthausen introduced an iterative scheme that produces an asymptotic solution to the TAP equations if the model lies inside the Almeida-Thouless transition line. However, it was unclear if this asymptotic solution coincides with the local magnetization. In this work, motivated by the cavity equations, we introduce a new iterative scheme and establish a weak law of large numbers. We show that our new scheme is asymptotically the same as the so-called Approximate Message Passing algorithm, a generalization of Bolthausen's iteration, that has been popularly adapted in compressed sensing, Bayesian inferences, etc. Based on this, we confirm that our cavity iteration and Bolthausen's scheme both converge to the local magnetization as long as the overlap is locally uniformly concentrated. This is a joint work with Wei-Kuo Chen (University of Minnesota).

31

Stein's method for conditional central limit theorem

Terlov, Grigory Graduate student
University of Illinois Urbana-Champaign Sat, 12:00–12:20
gterlov2@illinois.edu HOS 334

It is common in probability theory and statistics to study distributional convergences of sums of random variables conditioned on another such sum. In this talk I will present a novel approach using Stein's method for exchangeable pairs that allows to derive conditional central limit theorem of the form $(X_n|Y_n = k)$ with explicit rate of convergence as well as its extensions to multidimensional setting. We will apply these results to particular models including pattern count in a random binary sequence and subgraph count in Erdös-Rényi random graph.

32

Partial recovery for non-uniform random hypergraph

Wang, Haixiao Graduate student
University of California, San Diego Fri, 11:40–12:00
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The non-uniform random hyper-graph SBM, which can be treated as a superposition of several k-uniform stochastic block models with different parameters, is a more realistic model to study higher-order interaction on networks. While exact and almost exact recovery on dense hyper-graphs has been studied, the result for partial recovery under sparse regime is still limited. In this paper, we discussed the efficiency and accuracy of spectral clustering method in partial recovery for sparse hypergraphs. We proved that the at least half of the vertices would be clustered correctly when the signal to noise ratio is sufficiently large. This is a joint work with Ioana Dumitriu and Yizhe Zhu.

33

Intermittency properties for a large class of stochastic PDEs driven by fractional space-time noises

Wang, Xiong Graduate student
University of Alberta Sun, 11:40–12:00
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We study intermittency properties for various stochastic PDEs with varieties of space-time Gaussian noises via matching upper and lower moment bounds of the solution. Due to the absence of the powerful Feynman-Kac formula, the lower moment bounds have been missing for many interesting equations except for the stochastic heat equation. This work introduces and explores the Feynman diagram formula for the moments of the solution and the small ball nondegeneracy for the Green's function to obtain the lower bounds for all moments which match the upper moment bounds. Our upper and lower moments are valid for various interesting equations, including stochastic heat equations, stochastic wave equations, stochastic heat equations with fractional Laplacians, and stochastic diffusions which are both fractional in time and in space. This is joint work with Yaozhong Hu.

34

Nonlinear random matrix theory for neural networks

Wang, Zhichao Graduate student
University of California, San Diego Sun, 10:20–10:40
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In this talk, we would like to introduce recent random matrix theory in deep learning theory. In deep learning theory, there are two important kernel matrices, conjugate kernel and neural tangent kernel. We will talk about the limiting eigenvalue distributions of these two kernel matrices of the fully-connected neural networks at random initialization. Also, non-asymptotic concentration of these kernel matrices will be presented. These random matrix results are related to random feature regression and help us to understand the deep learning theory. These are the joint work with Zhou Fan and Yizhe Zhu.

35

Mean field spin glass model under weak external fields

Wu, Qiang Graduate student
University of Illinois Urbana-Champaign Sat, 11:40–12:00
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We study the fluctuations of free energy in mean field spin glass models under weak external fields. We proved that at high temperatures, there are 3 different sub-regimes with respect to the strength of magnetic field $h = \eta N^{-\gamma}$. In the super-critical regime $\gamma \in [0, 1/4)$, the variance order of log-partition function is $O(N^{1-4\gamma})$. In the critical $\gamma = 1/4$ and sub-critical regime $\gamma \in (1/4, \infty]$, the fluctuation order is $O(1)$. In all those 3 different regimes, we give the explicit expression of asymptotic mean and variance, and prove Central limit theorems. Our arguments are of 2 different types. One utilizes quadratic coupling and Guerra's interpolation scheme, which can be extended to many other spin glass models, but the CLT can only be proved at some very high temperature. The other one is the cluster expansion approach, which was first used in the seminal work due to Aizenman, Lebowitz and Ruelle for zero external field case. In this way, we can prove the results up to the critical temperature in the case of SK model when $h \in [1/4, \infty]$. This is based on a joint work with Partha S. Dey.

36

Heat kernel estimates for non-local operator with multi-singular critical killing potential

Wu, Peixue Graduate student
University of Illinois Urbana-Champaign Sun, 11:20–11:40
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Given an open set D with boundary $\partial D = \bigcup_{k=1}^{d} \bigcup_{j=1}^{m_k} \Gamma_{k,j}$, where $\{\Gamma_{k,j}\}_{1 \le k \le d, 1 \le j \le m_k}$ are disjoint, closed, connected $C^{1,\beta}((\alpha - 1)_+ < \beta \le 1)$ submanifold. We show that the heat kernel $p^D(t, x, y)$ of non-local operator with multi-singular critical killing potential

$$(\Delta^{\alpha/2} + \kappa)(f)(x) := p.v.\ \mathcal{A}(d, \alpha) \int_D \frac{f(y) - f(x)}{|y - x|^{d+\alpha}} dy - \sum_{k=1}^{d} \sum_{j=1}^{m_k} \lambda_{k,j} \delta_{\Gamma_{k,j}}^{-\alpha}(x), \lambda_{k,j} > 0, \alpha \in (0, 2)$$

has the following estimate:

$$p^D(t, x, y) \asymp p(t, x, y) \prod_{k=1}^{d} \prod_{j=1}^{m_k} (\frac{\delta_{\Gamma_{k,j}}(x)}{t^{1/\alpha}} \wedge 1)^{p_{k,j}} (\frac{\delta_{\Gamma_{k,j}}(y)}{t^{1/\alpha}} \wedge 1)^{p_{k,j}},$$

where $p(t, x, y)$ is the heat kernel of α stable process. Our method is based on the factorization result established in [Cho et al. Journal de Mathématiques Pures et Appliquées 143 (2020): 208-256] and a detailed analysis of the geometry of $C^{1,\beta}$ manifold.

37

On the right tail of the two-time distribution of the KPZ fixed point

Zhang, Ruixuan Graduate student

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Sat, 16:40–17:00
HOS 380

The limiting space-time fluctuation field of the models in the Kardar-Parisi-Zhang universality class is believed to be universal and it is called the KPZ fixed point, which was first characterized by Matetski, Quastel and Remenik [MQR17] as a Markov process with explicit transition probabilities and variational formulas. The KPZ fixed point is expected to be universal for all the models in the Kardar-Parisi-Zhang universality class, and it only depends on the initial condition. For the step initial condition, the multipoint distributions of the KPZ fixed point along the time direction were recently obtained by Johansson and Raham [JR19] and Liu [Liu19] independently. In this talk, we will discuss the right tail of the two-time distribution of the KPZ fixed point using the formula in [Liu19]. We will show that, for the step initial condition, if the height function at an earlier time goes to infinity, the increment of the height function after this time has the Tracy-Widom GUE distribution, plus a smaller order of perturbation which can be interpreted as the derivative of the Tracy-Widom GUE distribution. This is joint work with Ron Nissim (NYU).

38

Orthogonal polynomial duality functions for multi-species SEP$(2j)$ and ASEP(q, j)

Zhou, Zhengye
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Graduate student
Sat, 15:20–15:40
HOS 380

In this talk, I present the orthogonal polynomial self dualities for the multi-species symmetric exclusion process (SEP$(2j)$) and asymmetric exclusion process (ASEP(q, j)), which allow up to $2j$ particles to occupy a site. We are interested in orthogonal duality because the expectations of orthogonal polynomials duality functions give all moments of the process.

We show that multi-species SEP$(2j)$ is self-dual with orthogonal duality functions given by homogeneous products of multivariate Krawtchouk polynomials and the multi-species ASEP(q, j) is self-dual with nested products of multivariate q-Krawtchouk polynomials. We use different methods for each process, yet both of the methods use representations of Lie algebras. For multi-species SEP$(2j)$, the duality functions come from unitary intertwiners between different $*$-representations of Lie algebra $\mathfrak{sl}_{n+1}$, while for multi-species ASEP(q, j), we apply unitary operators in $U_q(\mathfrak{gl}_{n+1})$ to delta functions.

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4 List of participants

Name	**Affiliation**	**Status**
Adepoju, Kazeem	University of Minnesota	Faculty
Alberts, Tom	University of Utah	Faculty
Amei, Amei	University of Nevada, Las Vegas	Faculty
Barnes, Clayton	Technion - Israel Institute of Technology	Postdoc
Ben-David, Emanuel	US Census Bureau	Faculty
Benigni, Lucas	University of Chicago	Postdoc
Bessaih, Hakima	Florida International University	Faculty
Birrell, Jeremiah	University of Massachusetts Amherst	Postdoc
Biswas, Ratul	University of Minnesota, Twin Cities	Graduate student
Boniece, B. Cooper	University of Utah	Postdoc
Cao, Fei	Arizona State University	Graduate student
Chen, Le	Auburn University	Faculty
Cho, Hokwon	University of Nevada, Las Vegas	Faculty
Chong, Carsten	Columbia University	Faculty
Clemen, Felix	University of Illinois Urbana - Champaign	Graduate student
Conroy, Michael	University of Arizona	Postdoc
Costa, David	University of Nevada, Las Vegas	Faculty
Cranston, Michael	University of California, Irvine	Faculty
Dumitriu, Ioana	University of California - San Diego	Faculty
Ethier, Stewart	University of Utah	Faculty
Fraiman, Nicolas	University of North Carolina at Chapel Hill	Faculty
Gallage, Roshini	Southern Illinois University, Carbondale	Graduate student
Gasteratos, Ioannis	Boston University	Graduate student
Ghosh, Indranil	University of North Carolina at Wilmington	Faculty
Ghosh, Kaushik	University of Nevada, Las Vegas	Faculty
Gibson, Lydia	California State University, East Bay	Graduate student
Graham, Theodore	University of Nevada, Las Vegas	Undergraduate student
Groathouse, Sean	University of Utah	Graduate student
Hebbar, Pratima	Duke University	Postdoc
Hough, Robert	SUNY Stony Brook	Faculty
Huynh, Edward	University of Nevada, Las Vegas	Graduate student
Jantai, Wasamon	Oregon State University	Graduate student
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Kacaku, Floran	Oregon State University	Faculty
Khachatryan, Mariam	Auburn University	Graduate student
Kim, Daesung	University of Illinois Urbana - Champaign	Postdoc

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Kuzgun, Sefika	University of Kansas	Graduate student
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Leung, Tim	University of Washington	Faculty
Liu, Yanghui	Baruch College, CUNY	Faculty
Liu, Wenjian	City University of New York	Faculty
Mason, David	University of Delaware	Other
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Nguyen, Nhu	University of Connecticut	Graduate student
Nguyen, Hung	University of California, Los Angeles	Postdoc
Ning, Ning	University of Michigan, Ann Arbor	Postdoc
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Panzo, Hugo	Technion - Israel Institute of Technology	Postdoc
Patel, Swati	Oregon State University	Faculty
Peca-Medlin, John	University of Arizona	Postdoc
Pillai, Natesh	Harvard University	Faculty
Prince Nelson, Sybil	Washington and Lee University	Faculty
Rezapour, Mohsen	University of Texas, Health Science Center at Houston	Postdoc
Rigas, Pete	Cornell University	Graduate student
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