Veronica Berrocal

Veronica Berrocal received her Ph.D. in Statistics, University of Washington in 2007.

Her interest is in spatial and environmental statistics and in environmental epidemiology. She focused on probabilistic weather forecasting, in particular on developing statistical methods to post-process outputs from numerical weather prediction models while accounting for spatial dependence for her doctoral dissertation.

During her postdoctoral work at the US Environmental Protection Agency and later at Duke University, she focused on air quality and the relationship between air pollution and health outcomes expanding her research interests to environmental epidemiology.

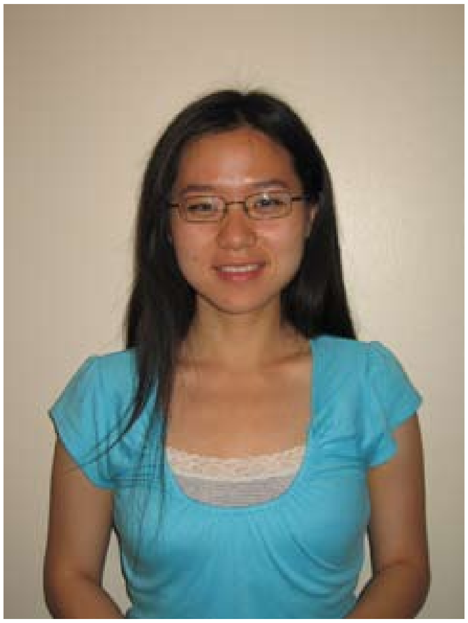
Oliver R. Diaz-Espinoza

Oliver Diaz, who is a permanent US resident, received his PhD from the University of Texas at Austin in 2006.

Diaz has focused his work on a classical problem: how to model water waves when the bottom is irregular. For coastal engineering and for understanding ocean wave dynamics, the unevenness of the ocean floor is a critical feature because waves change dramatically as they pass over shoals. Even small irregularities in the ocean floor can create significant perturbation of the waves. The mathematical nature of the problem changes with changes in the relative length of the wave to the size of the shoals. Diaz' work considers random "roughness" where the length of the wave is long relative to the irregularity of the ocean floor. His theoretical results relate the attributes of the ocean floor irregularities to the disturbance of the long wave.

Problems that fascinate Diaz can be recast as extensions of dynamics of one-dimensional critical dynamical systems to higher dimension, e.g, small perturbations of complex critical maps. Applications also include both the mathematical models and real-world examples of the dynamics of directed polymers, where impurities act to disrupt the smooth behavior of a polymer attracted to a positive environment and repelled by sites where the environment is negative.

Emily Lei Kang

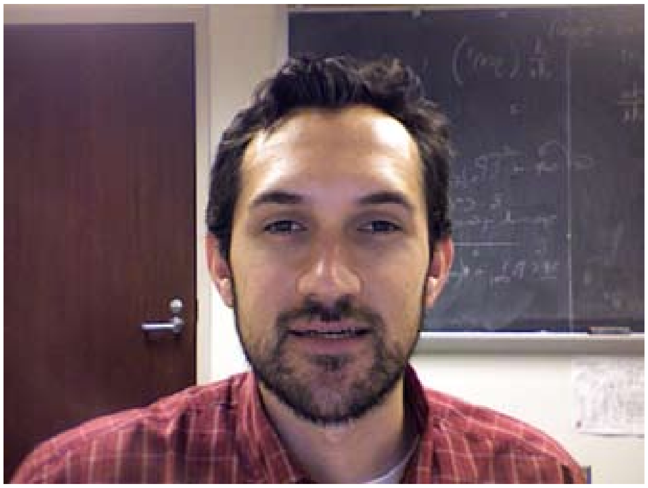


Emily Lei Kang obtained her PhD in Statistics from Ohio State University in 2009.

Kang's research interest is in the spatial and spatio-temporal processes. Her work has focused on Bayesian methodology and hierarchical modeling with applications in remote-sensing networks and climate model outputs. Processing massive amounts of spatial-temporal data from remote-sensing platforms to provide current estimates of the hidden state is challenging, since a large number of spatial locations observed through time can quickly lead to an overwhelmingly high-dimensional statistical model. Kang's work considers a spatio-temporal random effects model to reduce the problem to one of fixed dimension and develops fast statistical solutions for filtering, smoothing, and forecasting. The model provides a highly flexible class of covariance functions but also allows speed-ups in computation with large-matrix manipulation. The idea of dimension reduction has also been considered in a meta-analysis in which outputs from different regional climate models are combined. Kang's research studies inferences in both empirical-Bayesian and fully Bayesian frameworks. Different choices of prior distributions to be put on the covariance matrices has been studied and a prior based on the spectral decomposition and Givens angles is proposed.

Besides the current research with most applications to geostatistical data, Kang is also interested in the spatial/spatio-temporal processes with lattice data, which can be linked to graphical models and Bayesian networks. And estimation of the covariance matrix in these fields can be related to Kang's current work on covariance modeling with large datasets.

John McSweeney

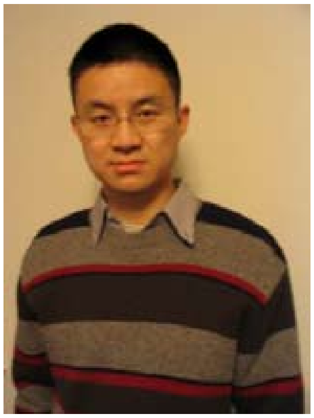


John McSweeney, who is a US citizen, received his PhD in Mathematics from Ohio State University in 2009.

He is working on stochastic coalescent processes that are motivated by applications to Computer Science and Biology. The theory of branching processes describes the forward-time behavior of a randomly reproducing population, but there are many features that are more naturally, or more easily, viewed backwards in time; this then yields a coalescent process. We would like to know what global features of an evolutionary tree we might be able to infer from knowledge of the random reproduction mechanism: times to common ancestry, allele distributions in the presence of mutation process, limiting continuous-time behavior under proper scaling, etc. The problem of bounding the running time of certain random sampling algorithms is actually an isomorphic issue to bounding times to common ancestry in randomly evolving populations, which illustrates the robustness of these coalescent models.

These problems often require a combination of combinatorial, probabilistic and analytical methods, as each new extension of the classical Kingman coalescent model creates the need for new mathematical techniques. A main feature of classical coalescent models is that we must assume a small sample size relative to the population size; we have made use of some new methods to find, for example, the time to common ancestry of an entire population, and not just a small subset of it. I hope to be able to study more and more general and biologically realistic models, possibly allowing for the use of classical results from random graph theory.

Yi Sun



Yi Sun, who is a permanent US resident, received his PhD in Applied and Computational Mathematics from Princeton University in 2006.

Sun's research focuses on problems arising in neuroscience and modeling processes of brain function. These processes operate over a wide range of time scales and an equally vast range of magnitudes, from single proteins to the whole brain. Therefore in order for modeling a single process at a particular scale to be meaningful, it must concord with what is occurring at the next scale (both larger and smaller). This is the linkage that is the focus of Sun's work on the dynamics of neuronal networks – the relationship of the firing of individual neuron to the behavior of the network of neurons as a whole. As a computational scientist, Sun has developed new, faster computational methods to investigate the dynamics of Hodgkin-Huxley-like network models.

Sun's interests extend to multi-scale problems arising in other venues as well, such as thin-film epitaxial growth and tracking combustion fronts. In a joint effort with others at UT Austin, UCLA and Los Alamos National Laboratory, he was able to bridge the gap (on both time and space scales) between micro- and macro-scopic models using a macroscale solver for the diffusion equation on a coarse grid combined with Monte Carlo simulation for random walks of particles as a microscopic model that supplies the necessary input to the model of the macroscale fluxes.

Xueying Wang

Xueying Wang is receiving her PhD from The Ohio State University in 2009.

Wang is interested in the development of a more biologically realistic and theoretically accessible approach to study two-alternative perceptual decision making processes. At the level of a single neuron or a neural group, firing pattern responding to stimulus can be thought about as a decision between two alternatives. A biophysically-based mathematical model has been proposed for simple perceptual decision making. However it includes at least a thousand neurons, which poses both mathematical and computational difficulties. A much studied alternative is phenomenological – that is, it models observed responses at an aggregate level. It has the advantage of being more easily computed, but the disadvantage that it does not address what is transpiring at the neuron/neural level. So, the difficult question is: When are these two different kinds of models consistent with each other?

Wang used mathematical theory from dynamical systems and stochastic differential equations to find the precise mathematical conditions for these two models to coincide, and then went further to determine the limits on the parameter specifications for the mathematical model of the physiology that can reproduce psychological experimental data.

Jun Zhang

Jun Zhang, who is a US permanent resident, received his PhD in Statistics from the University of Wisconsin in 2009.

Zhang's work in mathematics for modeling events in time and space has important applications from environmental science to medical images for diagnostics. All these can be thought about as maps that change through time – gypsy moths defoliate a forest, an epidemic spreads across the country, the earth's climate warms (or cools) and medical images show the diffusion of contrast medium along the spinal column or through the vasculature or show the opening / occlusion of a heart valve. Problems with interpreting such images occur when gaps occur; for example, clouds obscure a satellite view, or a patient breathes and reorients his heart slightly as his lungs expand and then contract. By implementing a computationally advanced, high-dimensional regression-based algorithm, these kinds of dynamic maps and images can be rectified, missing data can be filled in and patterns in the images can be modeled and analyzed with essentially no loss of resolution.

High-dimensional data, particularly when data are massive, are not always susceptible to interpretation via classical, unconstrained least-squares algorithms. Consequently, using a large scale L1 constrained algorithm to produce a sparse representation, and then an inverse wavelet transformation provides an estimated parameter surface for analysis. Introduction of BIC penalty function in the objective function together with subsampling and partial wavelet bases models to reduce computational requirements enables analysis and inferences of large images and other high-dimensional data bases.