Plenary Lectures
Conférences plénières

ANDREA BERTOZZI, University of California, Los Angeles
Geometric graph-based methods for high dimensional data

I will talk about a new class of problems in machine learning: segmenting large datasets using penalized graph cuts. One class of methods is based on interface models in Partial Differential Equations such as motion by mean curvature, the Allen-Cahn equation, and the MBO scheme, which already have been used for low dimensional image processing problems. Instead we consider large discrete datasets with a similarity graph connecting the discrete pieces of information. I will review both analytical results for these discrete problems, such as Gamma convergence, and show the behavior of the methods on real datasets.

ANDREW GRANVILLE, University de Montreal and University College, London
The pretentious Riemann Hypothesis and beyond

We give some insights into the "alternative approach" to analytic number theory being developed by Soundararajan and the speaker. For example we will motivate the original approach of Riemann to counting primes, and then, using simple ideas from a first complex analysis course, state a version of the Riemann Hypothesis that does not involve zeros of the Riemann zeta function, nor its analytic continuation. We discuss some aspects of the new approach, some of the most exciting recent developments, and the key role it has played in the recent resolution of the Erdos discrepancy problem.

RACHEL KUSKE, University of British Columbia
Interactions of noise and non-smooth dynamics: transitions and qualitative changes

While there have been recent advances for analyzing the complex deterministic behavior of systems with discontinuous dynamics, there are many open questions about understanding and predicting noise-driven and noise-sensitive phenomena in the non-smooth context. Stochastic effects can often change the picture dramatically, particularly if multiple time scales are present. We demonstrate novel approaches for exploring and explaining surprising phenomena driven by the interplay of nonlinearities and randomness in specific applications with piecewise smooth dynamics - network excitability, relay control, impacting dynamics, and conceptual climate models. Effective techniques typically depend on the combination of mathematical techniques, multiple scales approximations, and phenomenological intuition from seemingly unrelated canonical models of biophysics, mechanics, and chemical dynamics. The appropriate strategy is not always immediately obvious from the area of application or model type. This gap may follow from the limited attention that stochastic models with discontinuous dynamics have received in the past, or it may be the reason for this limited attention. Combining the geometrical perspective with asymptotic approaches in physical and phase space appears to be a critical part of developing effective approaches.

YUVAL PERES, Microsoft
Search games and optimal Kakeya sets

A planar set that contains a unit segment in every direction is called a Kakeya set. These sets have been studied intensively in geometric measure theory and harmonic analysis since the work of Besicovich (1919); we find a new connection to game theory and probability. A hunter and a rabbit move on an n-vertex cycle without seeing each other until they meet. At each step, the hunter moves to a neighboring vertex or stays in place, while the rabbit is free to jump to any node. Thus they are engaged in a zero sum game, where the payoff is the capture time. We show that every rabbit strategy yields a Kakeya set; the optimal rabbit strategy is based on a discretized Cauchy random walk, and it yields a Kakeya set K consisting of 4n triangles, that has minimal area among such Kakeya sets. (Talk based on joint work with Y. Babichenko, R. Peretz, P. Sousi and P. Winkler).

TATIANA SHUBIN, San Jose State University
Navajo Math Circles - Lessons Taught and Learned

The goal of the project has always been to bring the spirit of mathematics to the Navajo Nation and to spark interest and joy in problem solving in the students and teachers who participate. In its five years of existence, NNMC has grown in size and complexity; last year alone it connected nearly 2000 students and 250 teachers on the Navajo Nation with more than 40 working mathematicians and scientists from across the United States. We hope the project will develop into a model that may be used to help other under-served populations. In the talk we will discuss seven interrelated components of the project, its implementation and outcomes; we will also share some interesting mathematical ideas.