Plenary Speakers
Conférences plénières

LEAH EDELSTEIN-KESHET, UBC
Mathematics of Cell Polarization and Motility

In my talk, I will introduce the phenomena of cell motility and explain what are some of the open problems and challenges in this interdisciplinary field. I will then survey some interesting mathematical and computational issues that such research motivates. I will describe work in my group on the partial differential equations that we used to describe how a cell polarizes (decides where is its front and back). Such PDEs describe a phenomenon of wave-pinning stemming from bistable kinetics, substrate depletion, and large disparity in rates of diffusion. I will also briefly describe our computations of 2D cell motility models and what we learned about the interaction between reaction-diffusion and geometry in the evolving cell.

This work is joint with Yoichiro Mori, Alexandra Jilkine, AFM (Stan) Maree, Ben Vanderlei, and William Holmes.

OLGA HOLTZ, UC Berkeley; TU Berlin
Zonotopal algebra: approximation theory meets algebra and combinatorics

What do 1) integer points in polyhedra 2) hyperplane arrangements 3) parking functions on graphs 4) multivariate polynomial interpolation 5) kernels of differential operators have in common?

I will discuss recent mathematical developments motivated by the multivariate spline theory that demonstrate surprising connections between these (and some other) seemingly unrelated subjects in algebra, analysis and combinatorics.

FRANÇOIS LALONDE, University of Montreal, CRM
The New Real Algebraic Geometry

Recently, Jean-Yves Welschinger introduced new Gromov-Witten types of invariants for real algebraic geometry. This led to a revolution in our understanding of real algebraic geometry. I will describe these invariants and other invariants introduced by Shengda Hu and myself that relate the locus of Lagrangian submanifolds to the geometry of the ambient spaces.

BJORN POONEN, MIT
$x^2 + y^3 = z^7$

There are 16 solutions to $x^2 + y^3 = z^7$ in relatively prime integers, one of which is $(21063928, -76271, 17)$ (joint work with Ed Schaefer and Michael Stoll). I will explain why the existence of such solutions is not surprising, and I will sketch how one proves statements like this.

ROMAN VERSHYNIN, University of Michigan
Random matrices: invertibility, structure, and applications

At the heart of random matrix theory lies the realization that the spectrum of a random matrix H tends to stabilize as the dimensions of H grow to infinity. This phenomenon is captured by the limit laws of random matrix theory, in particular by Wigner's semicircle law, Girko's circular law, and Marchenko-Pastur law. These limit laws offer us a clear global and asymptotic picture of the spectrum of H.

In the last few years, a considerable progress was made on the more difficult local and non-asymptotic regimes. In the non-asymptotic regime, the dimensions of H are fixed rather than grow to infinity. In the local regime, one zooms in on a small part of the spectrum of H until one sees individual eigenvalues. The location of the eigenvalue nearest zero determines the invertibility properties of H. This essentially determines whether the matrix H is well conditioned, which is a matter of importance in numerical analysis.

Examples of recent developments include the proofs that a random matrix H with independent entries (whether symmetric or not) is singular with an exponentially small probability, that the condition number of H is linear in the dimension, and that the eigenstructure of H is delocalized and unstructured – the eigenvectors are spread out and their coefficients are highly incommensurate.

We will see some examples of heuristics, results, and problems of the non-asymptotic random matrix theory in the local regime. Applications and problems in related areas will be discussed, in particular for covariance estimation in statistics.