Special Guest Lectures

Computing Accurate Eigenvalues -- from Electrical Impedance Tomography to 3D Target Recognition

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Abstract:
Many practical problems in elasticity, medical imaging, etc., when modeled mathematically, reduce to the matrix eigenvalue problem. Rounding errors severely limit the accuracy of the computed eigenvalues-- the conventional matrix algorithms (e.g., the ones employed by MATLAB) usually compute only the largest eigenvalues accurately. The tiny ones are lost to roundoff even though often they are accurately determined by the data and of most physical significance. The obvious remedy in this situation is to increase the precision, but it often comes with a prohibitively high computational cost. In contrast, for several classes of structured matrices we recently developed algorithms that compute the full spectrum to full machine precision without the need for extra precision and in time comparable to that of the conventional algorithms. In this talk I will present several of our techniques that allowed us to preform such accurate computations. The picture is different and much more challenging with (the distributions of) the eigenvalues of random matrices. These distributions are critical in many multivariate statistical tests and a variety of applications -- 3D target recognition, wireless networks, genomics, etc. Interestingly, there are explicit formulas for these eigenvalue distributions, but only in terms of the hypergeometric function of a matrix argument-- a notoriously slowly converging series of (generalized) Schur functions whose efficient computation had eluded researchers for over 40 years. It is the combinatorial properties of the Schur function that ultimately allowed us to develop the first efficient algorithm for computing the hypergeometric function of a matrix argument. As a result, 3D target classification is now possible and efficient, as are multivariate statistical methods in genomics, wireless communications, etc. I will present the key ideas in the development of our algorithm as well as the impact it has had on the above applications.

Speaker's Bio:
Dr. Koev received his Ph.D. in Mathematics from the University of California, Berkeley, in 2002. He is currently an Instructor of Applied Mathematics at the Massachusetts of Technology. His interests are in accurate and efficient matrix computations, special functions, and multivariate statistical analysis.

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