Matrix Computations & Scientific Computing Seminar

Organizer: James Demmel & Ming Gu

Wednesday, 11:00AM–12:00Noon, 380 Soda

Nov. 6 **Rencang Li**, UT Arlington

The Hyperbolic Quadratic Eigenvalue Problem

The hyperbolic quadratic eigenvalue problem (QEP) was shown to admit the Courant-Fischer type min-max principles in 1955 by Duffin and Cauchy type interlacing inequalities in 2010 by Veselić. It is regarded as the closest analogue (among all kinds of quadratic eigenvalue problems) of the standard Hermitian eigenvalue problem (among all kinds of standard eigenvalue problems). In this talk, we will present our recent study on HQEP both theoretically and numerically. In the theoretic front, we generalize Wiedlandt-Lidskii type min-max principles and, as a special case, Ky-Fan type trace min/max principles and establish Weyl type and Mirsky type perturbation results when an HQEP is perturbed to another HQEP. In the numerical front, we justify the natural generalization of the Rayleigh-Ritz procedure with the existing and our new optimization principles and, as consequences of these principles, we extend various current optimization approaches – steepest descent/ascent and nonlinear conjugate gradient type methods for the Hermitian eigenvalue problem – to calculate few extreme quadratic eigenvalues (of both pos- and neg-type). A detailed convergent analysis is given on the steepest descent/ascent methods. The analysis reveals the intrinsic quantities that control convergence rates and consequently yields ways of constructing effective preconditioners. Numerical examples are presented to demonstrate the proposed theory and algorithms.

This is a joint work with Mr. Xin Liang of Peking University, China.