Fast algorithms from low-rank updates

Daniel Kressner
EPFL
daniel.kressner@epfl.ch

The development of efficient numerical algorithms for solving large-scale linear systems is one of the success stories of numerical linear algebra that has had a tremendous impact on our ability to perform complex numerical simulations and large-scale statistical computations. Many of these developments are based on multilevel and domain decomposition techniques, which are closely linked to Schur complements and low-rank updates of matrices. In this talk, we explain how these tools carry over to other important linear algebra problems, including matrix functions and matrix equations. Fast algorithms are derived from combining divide-and-conquer strategies with low-rank updates of matrix functions. The convergence analysis of these algorithms is built on a multivariate extension of the celebrated Crouzeix-Palencia result. The newly developed algorithms are capable of addressing a wide variety of matrix functions and matrix structures, including sparse matrices as well as matrices with hierarchical low rank and Toeplitz-like structures. Their versatility will be demonstrated with several applications and extensions. This talk is based on joint work with Bernhard Beckermann, Alice Cortinovis, Leonardo Robol, Stefano Massei, and Marcel Schweitzer.