Randomization for solving difficult linear algebra problems

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Randomized algorithms are becoming increasingly popular in matrix computations. Recent software efforts, such as RandLAPACK, testify that randomization is on the brink of replacing existing deterministic techniques for several large-scale linear algebra tasks. The poster child of these developments, the randomized singular value decomposition is nowadays one of the state-the-of-art approaches for performing low-rank approximation. In this talk, we will discuss numerous further examples for the potential of randomization to facilitate the solution of notoriously difficult linear algebra tasks. This includes a simple numerical algorithm for jointly diagonalizing a family of nearly commuting matrices, the solution of challenging singular and nonlinear eigenvalue problems, as well as the low-rank approximation of matrix functions and matrix-valued functions. A common theme of all these developments is that randomization helps turn linear algebra results that only hold generically into robust and reliable numerical algorithms.