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Numerical Linear Algebra

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EDITORIAL NOTE

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EDITORIAL NOTE

One of the great breakthroughs of computer science is Numerical Linear Algebraic (NLA). We could now answer small and medium-scale algebraic problems consistently and automatically on most computer platforms with extreme accuracy. These new techniques have sped up ordinary computations for small and medium-sized issues, and they've made large-scale calculations possible that were previously impossible.

NLA covers a wide range of topics, such as:

- Solution of dense and sparse linear systems
- Orthogonalization, least-squares, and Tikhonov regularisation
- Eigenvalues, eigenvectors, and invariant subspaces determination
- Complete least-squares and Singular Value Decomposition (SVD)

Despite this list of accomplishments, significant problems remain certain information (terabytes and beyond) are too large for traditional NLA methods to handle. Modern computer architectures (GPUs, multi-core CPUs, highly distributed systems) are strong, but only methods that minimise data movement and are developed from the start with parallel processing in mind can fully exploit their potential. All of these issues can be addressed with the use of randomization. The paper examines these novel concepts, provides thorough explanations of techniques with a track record, and describes the mathematical approaches used to evaluate these approaches. For centuries, nevertheless, numerical researchers considered randomised techniques as a last choice, to be used only when no other deterministic option was available. However, probabilistic approaches have a number of drawbacks. To begin with, Monte Carlo algorithms frequently give output that is inaccurate. This is a result of the central limit principle, and it cannot be prevented in many instances. Secondly, most computational scientists adhere to the installation procedure that two consecutive runs of the same method should yield the same findings. This criterion facilitates debugging and is crucial for situations when safety is important, such as infrastructures simulation or aviation operations. This is not always the case with randomised approaches. Nonetheless, randomised algorithms began to make advances into NLA in the 1980s. A few of the early work focuses on spectral analyses, when model was first proposed was already common practise. Lacking a gap between first and second eigenvalues, a version of the power technique with a random start demonstrably approximates the maximum eigenvalue of a Positively Semi Definite (PSD) matrix.