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Fast and Slow Mode Decomposition in Krylov Methods Using Neural Networks

Communication Info

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Abstract

Directly solving very large linear systems $Ax = b$ is often computationally infeasible due to the high dimensionality of A. Iterative methods such as GMRES overcome this challenge by projecting the problem onto low-dimensional subspaces [1], quickly capturing the dominant components (fast modes). However, components associated with near-zero eigenvalues, called slow modes, converge much more slowly [3], which limits overall efficiency.

The Neural Subspace GMRES method tackles this issue by employing a neural network to automatically identify and approximate the slow modes [2]. After these modes are extracted, the system is decomposed: GMRES efficiently resolves the fast modes [4], while a small auxiliary system accurately handles the slow modes. This hybrid approach accelerates convergence and improves solution accuracy for large-scale and block linear systems.

References

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