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Krylov methods for linear inverse problems in Hilbert spaces

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In this talk, we present a general methodology for solving linear inverse problems modeled by injective compact operators on separable Hilbert spaces, using singular value decomposition combined with a carefully designed Krylov subspace method. Intuitively, a compact operator on a separable Hilbert space can be thought of as an infinite-dimensional matrix; it behaves like a matrix but in an infinite-dimensional setting.

A key advantage of our approach is that it requires no predefined low-rank approximation; we do not fix a Hilbert basis or truncate manually. Instead, the method automatically selects an appropriate basis and truncation level based on the residual. Once a suitable low-rank approximation is obtained, the linear inverse problem can be solved accordingly.

To illustrate the approach, we apply it to the unique continuation problem for Herglotz wave functions as discussed in [1].

Keywords: linear inverse problem, injective compact linear operators, singular value decomposition, low-rank approximation, Krylov subspace method

MSC2020: 35P15, 35R25, 35R30

References

- [1] P.-Z. Kow, M. Salo, and S. Zou. Increasing resolution and instability for linear inverse scattering problems. *J. Funct. Anal.*, 289(1), 2025. Article number 110923, 37 pages. doi:10.1016/j.jfa.2025.110923.