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Cross-eyed preconditioning for normal equations arising from PDEs

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We explore preconditioning strategies for solving non-symmetric linear systems arising from PDE discretizations. In particular, we analyze the performance of Krylov subspace methods when applied to normal equations. We introduce the idea of cross-eyed preconditioning and discuss its advantages in cases involving convection-diffusion equations. By leveraging physical insights from PDEs, we propose novel preconditioners and evaluate their effectiveness through numerical experiments. Our results demonstrate that the physical nature of the normal equations can be leveraged to construct novel preconditioners, whose convergence properties are better understood compared to GMRES.

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