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Accelerating Nonexpansive Iterative Schemes with On-the-fly Reduced Order Modeling

Whether for solving nonlinear equations, optimization problems, or autonomous dynamical systems, fixed-point-type iterations are widely used in numerical sciences. However, when the goal is to iteratively solve a problem that depends on the solution of a partial differential equation, a large linear system typically needs to be solved at each iteration. On-the-fly reduced-order modeling enables the construction of a low-dimensional, self-correcting approximation of the solution to this system during the iterative process. When the process itself is nonexpansive, theoretical guarantees regarding convergence can be established. Numerical examples will illustrate that, in some cases, this methodology can lead to speedups compared to a classical fixed-point scheme.