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Novel sampling strategies for dynamic mode decomposition[1]

JONATHAN H. TU, DIRK M. LUCHTENBURG, CLARENCE W. ROWLEY, Princeton University, STEVEN L. BRUNTON, J. NATHAN KUTZ, University of Washington — Originally introduced in the fluid mechanics community, dynamic mode decomposition (DMD) has emerged as a powerful tool for analyzing the dynamics of nonlinear systems. We present a theoretical framework that extends the understanding of DMD to nonsequential, potentially rank-deficient, time series and strengthens the connections between DMD and Koopman operator theory. This is in contrast to existing DMD theory, which deals primarily with sequential time series for which the snapshot (measurement) size is much larger than the number of snapshots (measurements). We demonstrate the benefits of applying DMD to nonsequential time series using two examples. First, we sample the simulated flow past a two-dimensional cylinder nonuniformly in time. The result is a more efficient DMD computation, with little effect on the accuracy of the dominant DMD modes and eigenvalues. Next, we combine particle image velocimetry data from multiple runs of a bluff-body wake experiment in a single DMD computation. This greatly mitigates the effects of noise and more clearly isolates the dominant modes.

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