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Data-driven discovery of Koopman eigenfunctions for control EURIKA KAISER, J NATHAN KUTZ, STEVEN L. BRUNTON, University of Washington — Koopman operator theory has emerged as a principled framework to obtain linear embeddings of nonlinear dynamics, enabling the estimation, prediction and control of strongly nonlinear systems using standard linear techniques. Here, we present a data-driven control architecture that utilizes Koopman eigenfunctions to manipulate nonlinear systems using linear control theory. We approximate these eigenfunctions with data-driven regression and power series expansions, based on the partial differential equation governing the infinitesimal generator of the Koopman operator. In particular, we show that lightly damped eigenfunctions may be faithfully extracted using sparse regression. These lightly damped eigenfunctions are particularly relevant for control, as they correspond to nearly conserved quantities that are associated with persistent dynamics, such as the Hamiltonian. We formulate the control problem in these intrinsic eigenfunction coordinates and design nonlinear controllers using standard linear optimal control theory. The architecture is demonstrated on a variety of Hamiltonian systems and the double-gyre model for ocean mixing.

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