

## Adjoining Chaos

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The adjoint method, among other sensitivity analysis methods, has trouble with chaotic dynamical systems. These methods often predicts huge sensitivities, often orders of magnitude too large, when applied to a long time averaged quantity. This failure is known to be caused by ill-conditioned initial value problems. We work to overcome this failure by avoiding the initial value problem, and replace it with the well-conditioned least squares shadowing (LSS) problem. The LSS problem is then linearized in our sensitivity analysis algorithm, which computes a derivative that converges to the derivative of the infinitely long time average. We demonstrate our algorithm in several dynamical systems exhibiting both periodic and chaotic oscillations, and discuss future opportunities in this direction.

Contributions from: Blonigan, Patrick; Charter, Mario; Gomez, Steven; Hu, Rui; Gauger, Nico; Diskin, Boris; Nielson, Eric; Farrell, Patrick