

Gradient Free Descent: shadowing and state estimation using limited derivative information

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Abstract

Shadowing trajectories can play an important role in assessing the reliability of forecasting models, they can also play an important role in providing state estimates for ensemble forecasts. Gradient descent methods provide one approach for obtaining shadowing trajectories, which have been shown to have many useful properties. There remains the important question whether shadowing trajectories can be found in very high-dimensional systems, like weather and climate models. The principle impediment is the need to compute the derivative (or adjoint) of the system dynamics. In this paper we investigate gradient descent methods that use limited derivative information. We demonstrate the methods with an application to a moderately high-dimensional system using no derivative information at all.