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Nowcasting with Indistinguishable States

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Constructing ensembles of indistinguishable states (Judd and Smith, 2001) provides an attractive new, alternative approach to data assimilation in high dimension non-linear systems. In this setting, Ensemble Kalman Filtering (EKF) approaches are hampered by foundational assumptions of dynamical linearity, while particle filters require vast ensemble sizes to perform well in even moderately high dimensional spaces. The indistinguishable states approach is contrasted with an Ensemble Kalman Filtering (EKF) approach in terms of nowcasting; specifically the statistics of the predictive mass placed within an epsilon ball about the True state are computed as a function of epsilon. Specific cases are presented in detail to reveal why the indistinguishable states approach systematically outperforms this EKF; conditions under which it may be expected to outperform the plethora of other variants of the Kalman Filter are noted (unsurprisingly, the relevant shortcomings of the KF were first noted by Kalman (Kalman 1960) himself). The improved performance comes at the cost of not being a one-step method, which, on the other hand, allows an enhanced balance between the extracting information from the dynamic equations and information in the observations themselves. Results are presented in the 12 and 48-dimensional Lorenz 1996 system (Lorenz 1995) as well as illustrated with lower dimensional systems to ease visualization of the state space.

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