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A very brief introduction to Data Assimilation

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The term data assimilation from the geosciences refers to reconstructing the current state of a dynamical system from current and past observations of the system. Here "current" and "past" refer to the time in which the system evolves.
By "observation" we mean the value of a function taken at the current state of the system; these observation functions are typically not injective. The system itself as well as the observations might be subject to noise; furthermore, the underlying dynamics as well as the observation function are either completely specified as part of the problem statement, or contain unknown parameters which might be of interest as well. In geophysical applications, the dynamical systems under concern are typically infinite dimensional, while observations are finite dimensional (albeit with very large dimensions). Data assimilation is necessary as a precursory step to every weather forecast and thus part of every operational weather forecasting system; data assimilation is therefore of great practical interest. In this contribution, I will try to give a brief overview over data assimilation from a mathematical perspective. A wide range of different approaches exist, due to a large variety of paradigms, criteria of optimality, objectives, and operational constraints. These approaches have been analysed mathematically to a varying degree. I will list what I believe to be the most interesting mathematical questions in relation to data assimilation (this list will clearly be highly subjective), and subsequently discuss some existing results concerning these questions.

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