DATA COMPLETION AND MANIPULATION: WHEN CAN WE GET AWAY WITH IT?

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Abstract. We consider data assimilation problems whose forward operator involves the solution of a partial differential equation (PDE). The PDE depends on some material property – a distributed parameter that forms a surface over the PDE domain, and the purpose of the inverse problem is to calibrate the PDE model by estimating the distributed parameter function. This is done by requiring a given function of the field (i.e., the PDE solution) to match a set of given noisy measured data, and assimilating the data with the (also uncertain) PDE approximate solution. Often in applications the data locations are uncertain, in situations where it is tempting to ignore this. Also, the data is often available only at a restricted set of locations, or situations, while existence and uniqueness theory, or other considerations, demand that a fuller set (e.g., "data everywhere") be given. It is then tempting to "fix and complete the data", e.g. by interpolation, before starting the data assimilation phase. Such data completion, however, has its well-known perils as well.

This talk describes our various techniques for handling (or avoidance) of data completion and manipulation in the context of practical applications that include electromagnetic data inversion in geophysical exploration; soft body motion tracking and calibration in computer graphics; Monte Carlo methods for problems involving many data sets (or experiments); and local volatility surface calibration for commodity markets in finance.

Keywords: data assimilation, inverse problem, Dupire equation, Monte Carlo, model calibration, elastodynamics

Mathematics Subject Classifications (2010): scientific computation.

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