Software for Time-dependent Inverse Problems

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Abstract

Time-dependent simulations share several common features which can be exploited in constructing optimization applications to solve inverse (and similar) problems. Mapping between internal and external representations of parameters (coefficients, right hand side,...) and of data, coupling of time steps for basic simulation with derivative and adjoint derivative time steps, and prediction of multiple data outputs from the same set of parameters (multiexperiments) play similar abstract roles in all such problems. This talk describes a software framework encoding all of these common features in a library of C++ classes, and defining minimal interfaces for the software components unique to each application. The Timestepping Simulation for Optimization ("TSOpt") package groups simulation modules together with those defining partial derivatives with respect to parameters, adjoints of these, etc., as Operator objects as defined in the Rice Vector Library ("RVL"). Optimization algorithms written in terms of the RVL interfaces can be linked directly to simulators written in TSOpt to form solution algorithms for inverse problems. TSOpt incorporates optimal checkpointing, which minimizes the time/memory complexity of adjoint state computations, and parallelizes at both loop level (individual simulations) and task level (multisimulations). The talk will describe the conceptual structure of the library and its user interface, and demonstrate the use of TSOpt to solve an inverse problem from reflection seismology.