Model Order Reduction and its Application to an Inverse Electroencephalography Problem

Abstract:
Model order reduction is a technique to reduce computational times of parameterized PDEs while maintaining good accuracy of the approximated solution. Reduced basis methods (RB) are the most common algorithms for reducing the complexity of parameterized PDEs and nowadays they are widely applied and very actively researched in numerous fields. We propose two ideas to further enhance model reduction: the Fundamental Order Reduction Method (FOR) and offline error estimators for RB methods. The FOR method uses nonlinear combinations of the solutions to build the reduced model and use simple affine evaluations to execute the online stage. On the other hand, offline estimators are a class of estimators that move a-posteriori operations to the offline stage, reducing in this way the load of computations in the online stage. We apply these two ideas to an EEG equation which is useful for detecting the position where an epilepsy seizure begins inside the brain. We present two known ways to solve this equation: direct approach and subtraction approach, and show theoretical and numerical results of the application of the RB and FOR methods. We prove that is not feasible to apply model reduction in the direct approach but show that it is possible in the subtraction approach. Afterwards we solve the inverse problem associated with the EEG equation using a combination of the FOR method and neural networks.

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