Finite element methods for inverse problems

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In this talk we will discuss some recent advances in the use of stabilised finite element methods for ill-posed elliptic problems. Such problems appear in a variety of inverse problems and are notoriously difficult to solve numerically. We will consider the special case of unique continuation where the boundary conditions are unknown, but measurements of the solution are available in some subset of the bulk domain. For this problem we wiill present a theory reminiscent of Lax equivalence theorem where we combine consistency, numerical stability and the physical stability of the problem to obtain error bounds. The influence of data perturbations and solution regularity on the bounds will be discussed. Different finite element methods such continuous Galerkin or a hybridised discontinuous Galerkin method enter the framework and we will illustrate the theory with some numerical examples. If time allows we will also discuss the application of the theory to more complex problems, such as the linearised Navier-Stokes' equations or control problems subject to the wave equation.

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