

Carlos Castro

Numerical Methods for inverse problems.

Short bio:

Carlos Castro has been an Applied Mathematics professor at the Universidad Politécnica de Madrid since 2000. His research areas focus on the analysis of control and optimization problems for partial differential equations and their numerical approximation. Recently, he has also become interested in inverse problems and the design of numerical reconstruction algorithms. At the moment, he coordinates the Master in Advanced Mathematics at the Universidad Politécnica de Madrid.

Short abstract of the Course: “Numerical analysis of inverse problems for PDEs”

The aim of this course is to provide a perspective on some methods used in the reconstruction of inverse problems associated with partial differential equation models, such as the well-known Calderón inverse problem or inverse scattering problems for the Helmholtz equation or elasticity. Specifically, we will analyze two different strategies. The first is based on the direct approximation of the inverse problem through a least-squares formulation, which often requires some regularization term if the problem is ill-posed. The second strategy consists of defining a suitable linearization of the model that allows the inverse problem to be factorized into a linear one, often ill-posed, and a nonlinear but stable one. The solution of the linearized problem, usually referred to as the Born approximation, can be computed explicitly in some cases and, under certain conditions, is good enough to design a stable fixed-point algorithm for the nonlinear problem. We will show some examples where this is the case. On the other hand, the Born approximation can also be a useful tool for training efficient machine learning algorithms to approximate the solutions of the inverse problem.