

## **Infinite Infimal Convolution Regularization: Concepts, Models and Optimization**

Kristian Bredies

Variational methods are a powerful framework for solving inverse problems by combining a data discrepancy term with a regularization term encoding prior knowledge. While infimal convolution is a standard tool to balance finitely many regularizers, we introduce infinite infimal convolution to select from a continuum of penalties, yielding a flexible, data-adaptive model selection mechanism based on an infinite, parameterized family of regularizers. We formulate this as a variational problem over Banach-space valued Radon measures and study well-posedness and convergence for linear inverse problems. The framework covers, in particular, regularization across smoothness scales and parameterized families of functionals, and extends to applications such as relaxed bilinear inverse problems and learning certain classes of regularization functionals. On the computational side, we solve the resulting problems using generalized conditional gradient methods and show how the required subproblems can be handled efficiently via extremal point techniques, leading to practical algorithms with convergence guarantees. This is joint work with Marcello Carioni, Silvio Fanzon, Martin Holler, Yury Korolev, Carola-Bibiane Schönlieb, and Daniel Walter.