Nonlinear Ill-Posed Problems (Applied Mathematical Sciences)

Discretization of variational regularization in Banach spaces

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Abstract

Consider a nonlinear ill-posed operator equation $F(u) = y$ where F is defined on a Banach space X. In general, for solving this equation numerically, a finite dimensional approximation of X and an approximation of F are required. Moreover, in general the given data y^δ of y are noisy. In this paper we analyze finite dimensional variational regularization, which takes into account operator approximations and noisy data. We show (semi-)convergence of the regularized solution of the finite dimensional problems and establish convergence rates in terms of Bregman distances under appropriate sourcewise representation of a solution of the equation. The more involved case of regularization in nonseparable Banach spaces is discussed in detail. In particular we consider the space of finite total variation functions, the space of functions of finite bounded deformation, and the L^∞–space.

Key words: Ill-posed problem, Regularization, Bregman Distance, Strict Convergence

1 Introduction

Let $F : X \to Y$ be a nonlinear operator with domain $\mathcal{D}(F)$, where X is a Banach space and Y is a Hilbert space. We would like to approximate solutions of the ill-posed equation

$$F(u) = y \tag{1}$$

via variational regularization.

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