Optimization, Statistical Inverse Problems, and Sampling

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Abstract

This dissertation approaches five problems through the development of novel techniques based in convex optimization and Bayesian statistics. Two methods focus on solving inverse problems from a purely optimization standpoint: the first adds a divergence-based regularization term for solving vector-field inverse problems and the second exploits the structure of a forward operator to form a variance-based, multiple measurement inverse problem. Two problems focus on solving inverse problems by framing the original inverse problem as a sampling problem: the first incorporate variance-based multiple measurement information into a well-known sampling method, and the second includes variance-based information in construction of a density function for the inverse problem. The final method develops two new robust algorithms for sampling from a general distribution. The original sampling method they are based on is analyzed for failure and the new algorithms developed overcome such failures. Numerical experiments presented in these five problems suggest new methodology for accurate recovery of inverse problem solutions and samples from a distribution.