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Title:

A statistician's perspective on inverse problems in medicine, archaeology, and industrial process engineering

Abstract:

Most research on inverse problems is performed by engineers, physicists and applied mathematicians. Such problems are, however, essentially statistical estimation problems, and the standard methods of solution are basically penalized least-squares. Over the last twenty or thirty years, there have been major advances in the use of statistical approaches to complex and high-dimensional problems, and hence statisticians can have a major impact on inverse problems across the physical sciences. A natural setting to describe and solve these problems is using hierarchical and Bayesian modeling, with estimation often achieved through MCMC algorithms. This talk will describe the basics of inverse problems and will focus on novel modeling approaches using geometric descriptions, rather than the more usual pixel-based methods, and using wavelet representations to achieve sparseness. Methods will be illustrated with a variety of examples in SPECT/PET medical imaging, magnetometry for area surveys and stratigraphy in archaeology, and for electrical tomography in industrial process engineering.