Department of Mathematics,
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Math 278C: Optimization and Data Science

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Optimization in CT Imaging

Abstract:

With the development of nonconventional oil and gas exploration, microscopic analysis of mineral distributions in shale receives much more attention in recent years. Meanwhile X-ray computerized tomography (CT) based on synchrotron radiation (SR), as a non-destructive technique, become an important tool and can be applied to the study of morphology, microstructure, transport properties and fracturing of shale. Traditional methods such as optical and scanning electron microscopy (SEM) are common tools for providing valuable information of microstructures; however, those surface observations are often inadequate in obtaining detailed 3D information of the sample, such as compositional distribution inside the shale. Moreover, samples of shale are usually damaged during serial sectioning. Therefore two scientific issues rose: one is how to generate high level reconstructed image data using SR-CT, another is how to use these CT image data to analyzing compositional microstructures. Therefore, these two issues lead to two kinds of inverse problems.

For X-ray tomographic imaging, the filtered backprojection (FBP) is the conventional algorithm for image reconstruction. There are several variations of the FBP, all of them rely on the Fourier central slice theorem of CT, and all of them incorporate a (linear) filtering operation and a backprojection operation. However, the FBP algorithm is sensitive to noise and is inflexible.

We study both inverse problems in our recent research projects. For the former issue, we consider the sparse regularization technique. For the later one, we consider the CT-data constrained minimization technique. Model-based optimization methods and neural networks-based big data analysis will be addressed.

Host: Jiawang Nie

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