APS Scientific Computation Seminar Series

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Title: Multilevel-Based Multi-Modality Data Analysis

Date: Monday, September 19, 2016

Time: 11:00 a.m.

Location: 401/A1100

Hosts: Nicholas Schwarz and Brian Toby

Abstract:

The rich data sets obtained from multi-modal experiments are vital to the understanding of scientific phenomenon. This data set has the potential to reduce the ambiguity of the prediction, whether as a result of complementary information or as a means to lower measurement noise. In this talk, I will discuss a novel optimization-based, multi-modal analysis framework that is developed for tomographic reconstruction with a focus on data from X-ray fluorescence and transmission measurements. Fluorescence tomographic reconstruction, based on the detection of photons coming from fluorescent emission, can be used to reveal the internal elemental composition of a sample. On the other hand, conventional X-ray transmission tomography can be used to reconstruct the spatial distribution of the absorption coefficient. We integrate X-ray fluorescence and X-ray transmission data modalities and provide a simultaneous reconstruction of both the quantitative spatial distribution of all elements and the absorption effect in the sample. The challenges in X-ray fluorescence tomography, arising mainly from the effects of self-absorption in the sample, are greatly mitigated.

To solve the resulting large-scale inverse problem, I introduce a multilevel-based optimization framework (MG/OPT) which uses calculations on coarser resolutions to accelerate the progress of the optimization at the finest resolution. Multilevel methods have been successfully applied to various problems. I will briefly discuss the applications of multilevel methods in several image-related problems. I will also show how MG/OPT can be used to accelerate tomographic reconstruction and therefore achieves a superior convergence speed with reduced computational cost.

The resulting tool has the potential to be highly scalable, and capable of addressing the challenges in this era of exploding data acquisition.