APS Scientific Computation Seminar Series

Speaker: Saugat Kandel, PhD Candidate, Northwestern University

Title: Generalizing Ptychographic Reconstruction Using Automatic Differentiation

Date: Monday, June 18, 2018

Time: 1:00 p.m.

Location: 401/A1100

Hosts: Nicholas Schwarz and Brian Toby

Abstract:

Ptychography is a CDI technique that acquires a series of diffraction patterns through latitudinal and longitudinal shifts of the specimen (object), then uses these to reconstruct an image of not only the object but also the illumination pattern (probe) itself. Simple but powerful, ptychography has become an increasingly popular technique for microscopy in a range of imaging modalities. For complex imaging schemes, however, the reconstruction algorithms are difficult to formulate mathematically. This has limited the uptake of the generalized ptychographic reconstruction method.

In this work, we use the automatic differentiation technique to implement a generalizable gradient descent framework for ptychographic reconstruction. For this approach, we formulate the gradient descent using the complex (Wirtinger) gradient operator. In our framework, the user needs to only specify the forward propagation model for the specific ptychographic experiment; the gradients are then calculated by backpropagating through this forward model using the Tensorflow deep-learning library. Our use of the popular Tensorflow library provides an additional advantage – access to state-of-the-art machine learning algorithms to accelerate the gradient descent.

We demonstrate the generalizability of our framework through numerical experiments in the near-field, far-field, and Bragg ptychography regimes. Furthermore, we expect that our framework can be straightforwardly extended for applications including multislice ptychography and ptychographic tomography experiments. Our experiments illustrate the promise automatic differentiation holds for solving the general phase reconstruction problem.