On gradient-based methods for ptychography

Ptychography is a lensless imaging technique which became popular among practitioners in last two decades. It considers a series of illuminations of an object of interest, where at a time a small region of the specimen is illuminated and the resulting diffraction pattern is captured by the detector in the far-field. As the regions overlap, this provides a surplus information and allows for a recovery from the collection of the observed diffraction patterns.

In the first part of the talk, we consider three of the methods present in the literature. The first is gradient descend technique applied to the amplitude-based squared loss known as Amplitude Flow. The second is the Error Reduction algorithm, which is the alternating projections approach. The last is the Ptychographic Iterative Engine (PIE), a computationally fast method utilizing a single diffraction pattern at the time.

We show that the later two algorithms can also be viewed as gradient methods for the same amplitude-based squared loss function. More precisely, we show that Error Reduction performs the scaled gradient descent and PIE is nothing else but the stochastic gradient descent. Based on the convergence theory for Amplitude Flow, we further establish the guaranteed convergence of both algorithms and show that the convergence speed is sublinear. We also discuss the implications of the algorithms being the gradient methods for the amplitude-based squared loss in terms of critical points.

In the second part of the talk, a joint recovery of the object and the illumination function is considered, which is also known as blind ptychography. In this case, we propose an alternating minimization version of the Amplitude Flow algorithm and show its sublinear convergence to a critical point.