Exploring Coherent Diffractive Imaging using AI

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Skills 4 Scientists

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The pattern of scattered light from an object is given by its Fourier Transform. In the past, it was generally accepted that retrieval was not possible to have a neural net be able to do it as well.

$$\hat{x}(f) = \int_{-\infty}^{\infty} x(t) e^{-2\pi i f t} dt$$

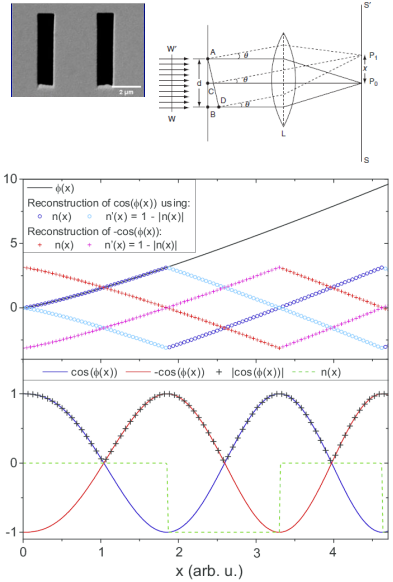
Continuous function, infinite bounds

Bounded version

$$\hat{x}(f_n) = \frac{1}{T} \int_0^T x(t) e^{-2\pi i f_n t} dt$$

$$\hat{x}_n = \sum_{k=0}^{N-1} x_t e^{-2\pi i k n / N}$$

Discrete Fourier Transform

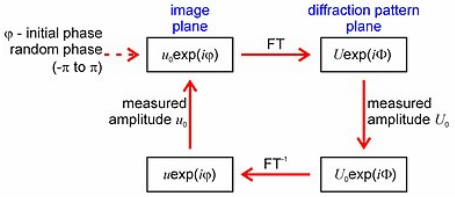


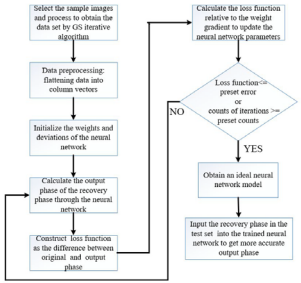
Inverse problem: What was the object that produced a particular pattern is

- Easy if you know to complete phase
- Very hard if you don't know the complete phase

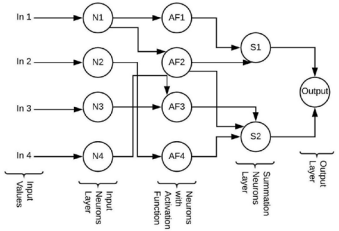
When you detect to light with a normal Charge Coupled Device (CCD) you don't have phase, only $|E|^2$

The main challenge is to see the methods of reconstruction with Neural Networks – for phase reconstruction. The patterns of which both operate are much more different with various levels of inputs and different layers here as shown in the diagram on the right.





The Gerchberg–Saxton algorithm is an iterative phase retrieval algorithm for retrieving the phase of a complex-valued wavefront from two intensity measurements acquired in two different planes.



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