Supplementary Material: Fast Digital Lossy Compression for X-ray Ptychographic Data

The crossing between Fourier ring correlation (FRC) and 1/2 bit threshold is a widely used standard to determine the achieved resolution of the reconstructed image in ptychography. Here we derive the formula of 1/2 bit threshold when the FRC is calculated using 2 full images with independent noise.

Given the required SNR, the corresponding Fourier correlation (which in the 2D case is a Fourier ring correlation or FRC rather than a Fourier shell correlation) can be calculated using Eq. 13 of [1], which we rewrite here as

\[
FRC(r_i) = \frac{\text{SNR}(r_i) + 2/\sqrt{n(r_i)} \sqrt{\text{SNR}(r_i)} + 1/\sqrt{n(r_i)}}{\text{SNR}(r_i) + 2/\sqrt{n(r_i)} \sqrt{\text{SNR}(r_i)} + 1} \quad (1)
\]

where \(n(r_i)\) is the number of voxels in the Fourier shell, \(r_i\). The required SNR of the 1/2-bit threshold can be calculated using

\[
\frac{1}{2} \text{bit} = \log_2(1 + \text{SNR}) = \log_2(1 + 0.4142) \quad (2)
\]

from which we obtained the requirement of \(\text{SNR} = 0.4142\) in the full image.

In the case of calculating the FRC between 2 half images, the required SNR is in each of the half images is also half \((0.4142/2 = 0.2071)\) because the total SNR is twice the SNR value of each of the half images. The 1/2-bit threshold then can be calculated by plugging \(\text{SNR}(r_i) = 0.2071\) into Eq. (1) to get Eq. 17 of [1], which we rewrite here as

\[
T_{1/2-\text{bit}} = \frac{0.2071 + 1.9102/\sqrt{n(r_i)}}{1.2071 + 1.9102/\sqrt{n(r_i)}}. \quad (3)
\]
In our work, we calculated the FRC between 2 full images. Therefore, we plugged the value $\text{SNR} = 0.4142$ directly into Eq. (1), which gives

$$T_{1/2-\text{bit}} = \frac{0.4142 + 2.2872/\sqrt{n_{r_i}}}{1.4142 + 1.2872/\sqrt{n_{r_i}}}. \quad (4)$$

References