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# Deep learning for sparse spectral ptychographic x-ray computed tomography

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X-ray nanotomography is a well-established technique with many applications in material science and biology. The spatial resolution of classical CT can be enhanced when using ptychographic projections [1] measured at different angles to reconstruct a 3D volume.
X-ray Ptychography [2][3] is a coherent diffraction imaging technique based on the acquisition of multiple diffraction patterns obtained through the illumination of the sample at different partially overlapping probe positions. Information about the sample's transmittivity is obtained by an iterative reconstruction, yielding the imaginary and real part of the complex refractive index, δ and ⊠. Repeating the tomographic acquisitions at different energies allows to add spectral capabilities, and gain information about the localization of a chosen element of interest. The invaluable advantage of this technique is its high spatial resolution in the range of some tens of nanometers for large sample volumes. However, the acquisition of ptychographic tomogram can take half a day or more, depending on the size of the sample, the number of projections and the exposure time. Reducing the number of projections and/or the exposure time would reduce the acquisition time, but these solutions will directly affect the resolution and the reconstructed tomogram will be noisy. This problem can be overcome with help of deep learning. Recently, a Generative Adversarial Network (GAN) [4] [5] called TomoGAN [6][7] was proposed to improve the quality of images obtained by high-resolution tomography. TomoGAN model can be trained with limited data, performs well with high-resolution datasets, generates greatly improved reconstructions of low-dose and noisy data, and is very resilient to overfitting. Previous works demonstrated that the number of projections required can be reduced by a factor of at least 8 while keeping high quality of the reconstructed images. We will show here, how this technique can be applied to the case of spectral tomography, as an example, we will take 2 tomograms of the same sample recorded at two different energies, taking advantage of the similarity of the tomograms. By training the networks on one complete high-resolution tomographic dataset at a given energy, we are capable to retrieve images from tomographic dataset at another energy with much fewer projections than what would be necessary for the retrieved good-quality images using standard algorithms.

***Keywords: ptychography, tomography, spectral, sparse, deep learning***

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