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Neural networks for FEL diffraction image separation

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Newly available soft X-ray two-color FEL pulse mode at European XFEL opens a new way to the structural and plasma studies of the nano-scaled object. The first pulse, designated as the pump, characterizes the initial state of the object, whereas the second probe pulse captures the system's evolution following its interaction with the pump. The pulses are separated by an extremely short time interval of less than a picosecond. Due to the short delay between the pump and probe pulses, the state-of-the-art detector is unable to capture two separate diffraction images corresponding to the pump and probe pulses. Instead, it records a single image that is a superposition of both, making it difficult to analyze the effects of each pulse individually. The analysis would ideally provide the electron density of the sample before the interaction with the X-ray and afterwards, which allows us to examine the impact of the excitation in a time-resolved manner.

This talk presents a machine learning-based solutions for separating the overlapping components in such images. We propose two methods: one based on diffusion probabilistic models, a recent and powerful approach in image generation, and another using feed-forward convolutional neural networks to solve the same task.

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