Quantitative Comparison of Deep Learning-Based Image Reconstruction Methods for Low-Dose and Sparse-Angle CT Applications

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Over the last years, deep learning methods have significantly pushed the state-of-the-art results in applications like imaging, speech recognition and time series forecasting. This development also starts to apply to the field of computed tomography (CT). In medical CT, one of the main goals lies in the reduction of the potentially harmful radiation dose a patient is exposed to during the scan. Depending on the reduction strategy, such low-dose measurements can be more noisy or starkly under-sampled. Hence, achieving high quality reconstructions with classical methods like filtered back-projection (FBP) can be challenging, which motivated the investigation of a number of deep learning approaches for this task.

With the purpose of comparing such approaches fairly, we evaluate their performance on fixed benchmark setups. In particular, two CT applications are considered, for both of which large datasets of 2D training images and corresponding simulated projection data are publicly available: a) reconstruction of human chest CT images from low-intensity data, and b) reconstruction of apple CT images from sparse-angle data.

In order to include a large variety of methods in the comparison, we organized open challenges for either task. Our current study comprises results obtained with popular deep learning approaches from various categories, like post-processing, learned iterative schemes and fully learned inversion. The test covers image quality of the reconstructions, but also aspects such as the required data or model knowledge and generalizability to other setups are considered. For reproducibility, both source code and reconstructed images are made publicly available.