Advanced X-Ray Imaging Techniques with Pyro-NN: Differentiable Reconstruction for Artifact Correction and Arbitrary Few-View CT Trajectories

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We present an innovative advance in the field of non-destructive testing through the further development of the Python Reconstruction Operators in Neural Networks (Pyro-NN), a versatile library for differentiable reconstruction. Originally introduced in 2019, Pyro-NN has undergone significant enhancements, can now accommodate arbitrary geometries, and integrates seamlessly with the PyTorch framework. This enhancement significantly expands the applicability of Pyro-NN and allows it to be integrated into deep learning pipelines for a wide range of tasks. A notable benefit of integrating Pyro-NN into deep learning pipelines is the ability to develop end-to-end solutions for artefact correction. This capability has been effectively demonstrated for the scatter and ring artefact correction, showing the potential for robust and accurate image reconstruction even under challenging imaging conditions. In this work, we extend the utility of Pyro-NN to address the complex challenge of few-view reconstruction for arbitrary CT trajectories in flat panel computed tomography. Preliminary results show promising results and highlight the ability of our approach to reconstruct high-quality images from limited projection data efficiently. This has significant implications for fast and cost-effective CT cone beam imaging and paves the way for improved industrial quality control, defect detection, and material characterization. While our initial results are encouraging, an in-depth and comprehensive study is underway to further explore the capabilities and limitations of Pyro-NN for few-view image reconstruction. Ongoing research includes the investigation of various scenarios using both simulated data and real CT scans. The combination of Pyro-NN's differentiable reconstruction capabilities, support for arbitrary geometries, and integration with PyTorch make Pyro-NN a powerful tool for advancing imaging techniques and facilitating artefact correction and reconstruction tasks.