Dirty Tricks for Clean Images – Heuristics for 3D CT Reconstruction

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The goal is the reconstruction of 3D computed tomography (CT) volumes based on real-world X-ray radiographic measurements. We demonstrate this on an example of locally constant data that is reconstructed in the Haar wavelet basis using only the most important coefficients, while the application of heuristics improves the overall reconstruction quality. In order to achieve the goal of memory-efficient processing, we apply a multilevel reconstruction algorithm where only the relevant coefficients are kept before advancing to the next resolution level. The latter is realized by refining the a recti-linear grid of wavelet coefficients adaptively. Then, the Algebraic Reconstruction Technique (ART) is applied for reconstructing the refined regions. Iterating through the resolution levels, the grid locally approaches the maximal resolution while staying sparse.

However, real-world data introduces several challenges to the compressing reconstruction algorithm. We further employ physics-inspired heuristics for manipulating the weights of the rays, e.g., depending on the quality of the detector for a particular measurement. Furthermore, the local gradient behavior in the projection image of the considered rays may indicate the importance of a particular ray. The refinement step itself can be improved by initializing the newly added wavelet coefficients with subdivision-based predictions.

The results show that the heuristics not only improve the data fidelity compared to the original ART algorithm, but also lower the number of wavelet coefficients used, without a negative impact on the calculation time.

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