Robust artefact reduction in tomographic imaging

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Tomography

Tomography is a technique for reconstructing an object from projection data.
Advanced Tomography

synchrotrons

electron microscopes
Artefacts in tomography

(a) ring artefacts

(b) ring artefacts
Artefacts in tomography

metal artefacts
Attenuation along the ray path can be modeled as linear combination of pixel values. Leading to a linear system of equations:

$$W\bar{x} = \bar{p}$$
The reconstruction problem

Solve

\[ W\tilde{x} = \tilde{p} \]

by a least squares method (in \( \ell_2 \)-norm):

\[
\minimize_{\tilde{x}} \frac{1}{2} \| W\tilde{x} - \tilde{p} \|_2^2
\]

Challenges:

- \( W \) is extremely large
- \( W \) is underdetermined, solution is not unique
- no solution exists, if \( \tilde{p} \) is not in the range of \( W \)
Least-squares and Student’s t comparison
Results

randomized projections

- 256 × 256 × 256 test image
- 180 projections were simulated
- 45 projections were replaced by white noise
Results

defective camera pixels

- Effect from defective camera pixels
Conclusions

▶ Be careful using the $\ell_2$-norm for penalizing outliers in the data

▶ With a small adjustment, by using the Student’s t-penalty, we can have radically improved reconstructions
Thank you for your attention!