

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/39638> holds various files of this Leiden University dissertation.

**Author:** Pelt D.M.

**Title:** Filter-based reconstruction methods for tomography

**Issue Date:** 2016-05-03

Propositions accompanying the thesis

# “Filter-based reconstruction methods for tomography”

by Daniël M. Pelt

1. The update equation of the SIRT method for tomographic reconstruction can be written as:

$$\mathbf{x}^{k+1} = \mathbf{x}^k + \alpha \mathbf{W}^T (\mathbf{p} - \mathbf{W} \mathbf{x}^k)$$

See Chapter 3 for notation. A SIRT reconstruction is computed by  $n$  iterations of the equation above, with  $n$  typically smaller than 1000. In parallel-beam geometries and with  $\mathbf{x}^0 = \mathbf{0}$ , these reconstructions can be accurately approximated by the filtered backprojection method with a suitable filter:

$$\mathbf{x}^n \approx \mathbf{W}^T \mathbf{C}_{u_n} \mathbf{p}$$

*(Chapter 3)*

2. Many regularized iterative methods for tomographic reconstruction produce the following reconstructions:

$$\mathbf{x}_{reg} = \operatorname{argmin}_{\mathbf{x} \in D} [\|\mathbf{p} - \mathbf{W} \mathbf{x}\|_2^2 + \lambda g(\mathbf{x})]$$

See Chapter 4 for notation. The objective function that is minimized in the equation above depends on all pixels of the image  $\mathbf{x}$ . As a result, regularized iterative methods typically have a prohibitively high computational cost, even when one is only interested in a small region of the reconstructed image. For many popular types of regularization terms, however, there is a computationally efficient way of computing accurate approximations to  $\mathbf{x}_{reg}$  for a small subset of all pixels. *(Chapter 4)*

3. Machine learning can be effectively applied on real-world tomographic reconstruction problems to obtain accurate reconstructions from data with a highly limited number of projections. *(Chapters 5 and 6)*
4. Powerful frameworks for solving practical problems can be obtained by integrating different open-source software packages, combining the strengths of each individual package. *(Chapter 7)*

5. Severe but familiar reconstruction artifacts are often more acceptable to users of experimental tomography facilities than minor but unfamiliar reconstruction artifacts.
6. Applied mathematical papers introducing new algorithms should be accompanied by computer code that implements the algorithms.
7. Practical problems usually occur when applying new algorithms on real-world data. Algorithm developers should perform additional research and work to solve these problems, rather than relying on others to solve the problems for them.
8. Practical considerations, such as ease of implementation, computation time, and number of tunable parameters, are important but often overlooked properties of algorithms.
9. Visiting (international) workshops and conferences and meeting new people are important parts of a PhD project. Social interaction with other researchers is one of the best ways to keep scientific work interesting and a good source of inspiration for new ideas.