Inverse Problems
(and their computational solution)

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The Legendary Course
University of Helsinki, spring 2015

Goals of the course

1. Learn how to write a practical inverse problem in matrix form: $m = Af + \epsilon$
2. Learn how to detect ill-posedness from a matrix A using Singular Value Decomposition
3. Learn how to overcome ill-posedness by regularization
4. Acquire skills to solve practical inverse problems using Matlab
5. Learn to report your scientific findings in writing

Practical course information

Period III:

Lectures
Tuesday 10-12 (Exactum D123),
Wednesday 12-14 (Exactum D123),
Friday 12-14 (Exactum C123).
Lecturer: Professor Samuli Siltanen

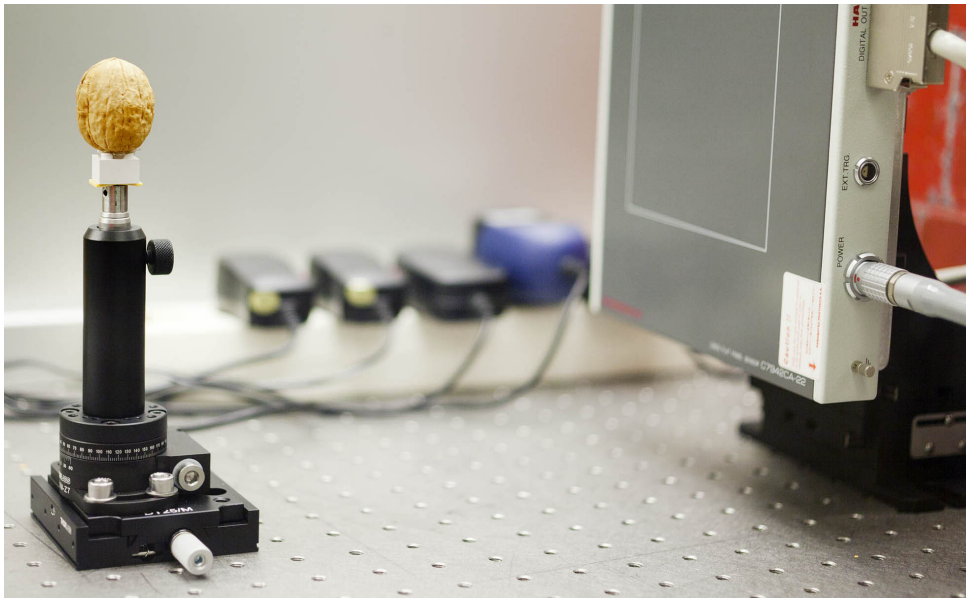
Exercises
Time is decided on January 14.
Teaching assistant:
Andreas Hauptmann

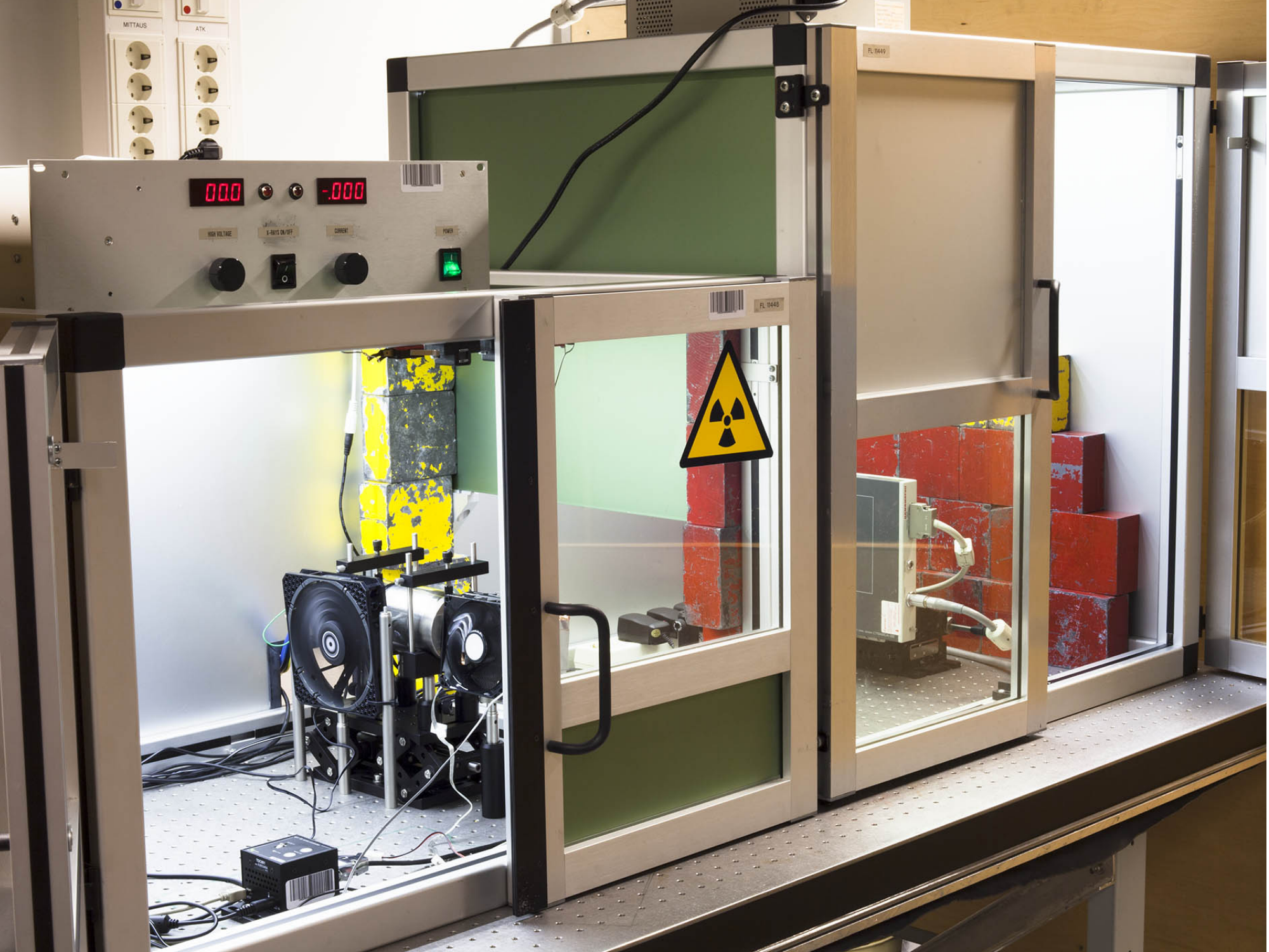
Passing the course (10 sp)
Final exam and completing enough exercises.

Period IV:

Project work (5 sp)
Computational projet done in pairs.
Outcome: poster presentation on a specific day (announced later).

Teaching assistants: Alexander Meaney and Andreas Hauptmann

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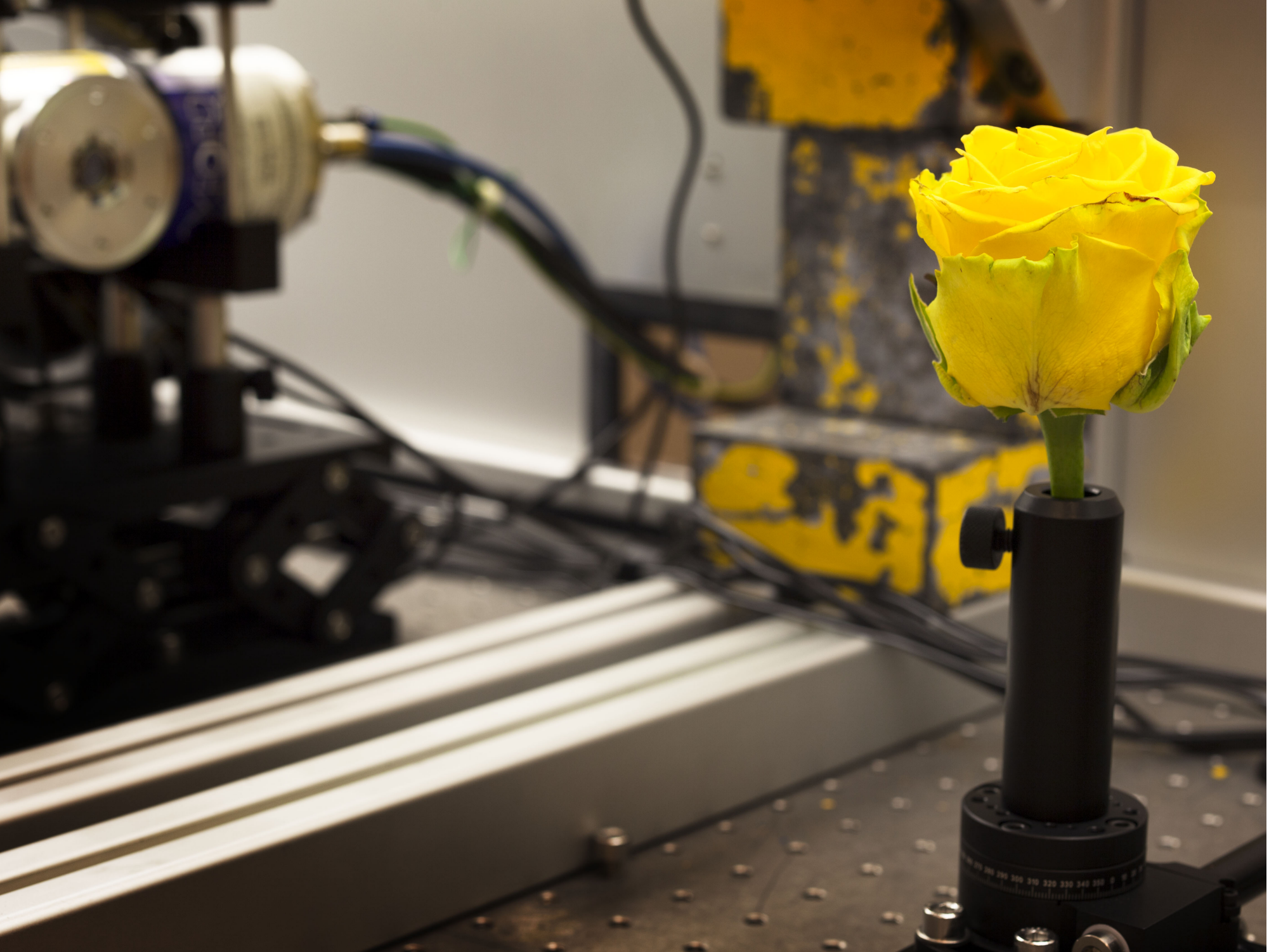

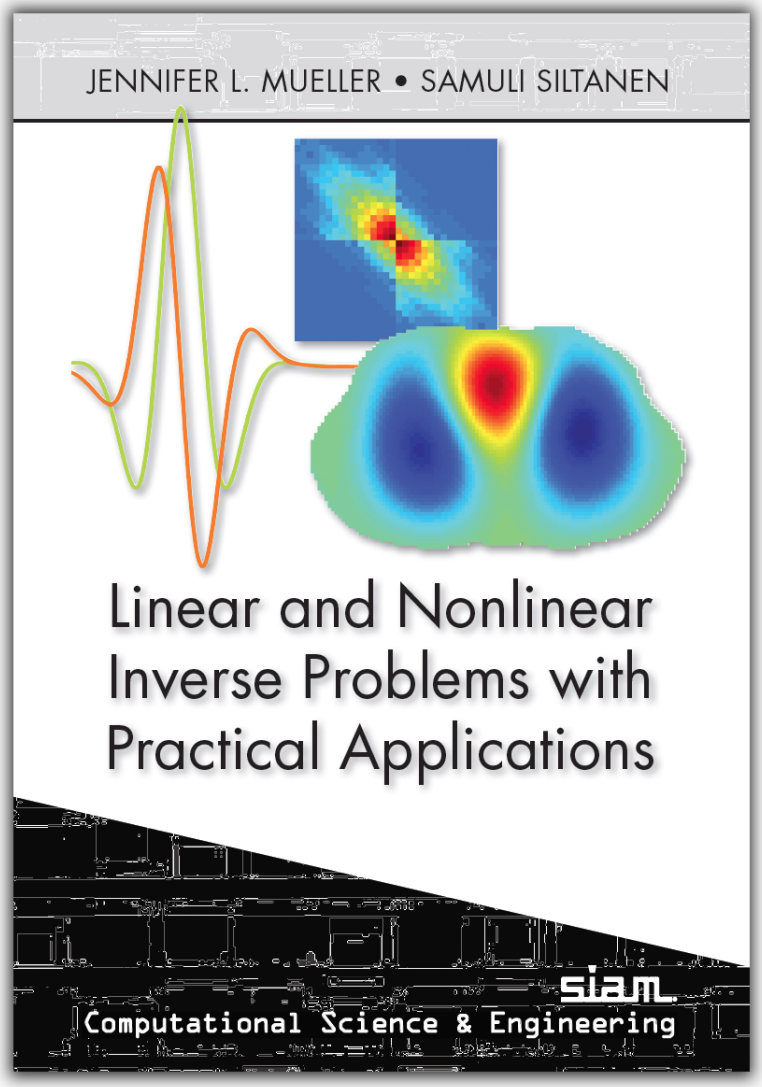

All Matlab codes freely available on a website!

Part I: Linear Inverse Problems

1 Introduction
2 Naïve reconstructions and inverse crimes
3 Ill-Posedness in Inverse Problems
4 Truncated singular value decomposition
5 Tikhonov regularization
6 Total variation regularization
7 Besov space regularization using wavelets
8 Discretization-invariance
9 Practical X-ray tomography with limited data
10 Projects

Part II: Nonlinear Inverse Problems

11 Nonlinear inversion
12 Electrical impedance tomography
13 Simulation of noisy EIT data
14 Complex geometrical optics solutions
15 A regularized D-bar method for direct EIT
16 Other direct solution methods for EIT
17 Projects