Computational Methods for Inverse Problems and Applications in Image Processing

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Timetable: 14 hrs (lectures and laboratories). First lecture on February 17, 2014, 09:00 (dates already fixed, see calendar), Torre Archimede, Laboratory LabTA on 2nd floor except on February 19, Room 2BC/30.

Course requirements: Background in numerical linear algebra and some experience using MATLAB.

Examination and grading: final project.

SSD: MAT/08

Aim: Students will learn computational techniques to solve ill-posed inverse problems that arise in scientific and engineering applications.

Course contents:

One of the most difficult challenges in scientific computing is the development of algorithms and software for large scale ill-posed inverse problems. Such problems are extremely sensitive to perturbations (e.g. noise) in the data. To compute a physically reliable approximation from given noisy data, it is necessary to incorporate appropriate regularization (i.e., stabilization) into the mathematical model. Numerical methods to solve the regularized problem require effective numerical optimization strategies and efficient large scale matrix computations.

In these lectures we describe how the challenges of solving linear inverse problems can be analyzed using the singular and spectral value decomposition (SVD), and how to efficiently implement the ideas with iterative methods on realistic large scale problems. We also discuss how the approaches can be adapted for use on nonlinear inverse problems. Examples from image processing will be used to illustrate the performance of various methods.