Numerical Linear Algebra for Ill-Posed Problems

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Timetable: 24 hours, First lecture on June 11, 2018, 09:30 (dates already fixed, see the calendar), Torre Archimede, Room 2AB/30.
There will be both lectures (about 16 hrs) and laboratory (about 8 hrs) for practical sessions.

Course requirements: No special requirement is needed for this course. Only some fundamental knowledge of numerical analysis and linear algebra. For the laboratory a basic knowledge of Matlab is required.

Examination and grading: Examination is based on a presentation given by each student.

SSD: MAT/08 Numerical Analysis

Aim: The aim of this course is to introduce Ph.D. students to numerical linear algebra required for the solution of linear discrete ill-posed problems. These problems arise for instance in image restoration and from the discretization of ill-posed problems, such as Fredholm integral equations of the first kind. The singular values of the matrix of linear discrete ill-posed problems ”cluster” at the origin. In particular, the matrices that arise are severely ill-conditioned and may be singular. The right-hand side represents available data that may be contaminated by measurement errors. Due to the ill-conditioning of the matrix and error in the data, straightforward solution does not give a meaningful result. Therefore regularization is employed before solution. Regularization replaces the given linear discrete ill-posed problem by a nearby problem that is less sensitive to errors in the data. Tikhonov regularization, truncated singular value decomposition, truncated generalized singular value decomposition, and truncated iteration are the most popular regularization methods. The course will discuss these method and techniques for determining a suitable value of the regularization parameter.

Course contents:

1. Linear discrete ill-posed problems Definition, properties, applications

2. Solution methods for small to moderately sized problems Regularization, Tikhonov regularization, the singular value decomposition, the generalized singular value decomposition, choice of regularization matrix


4. lp-lq minimization for image restoration.