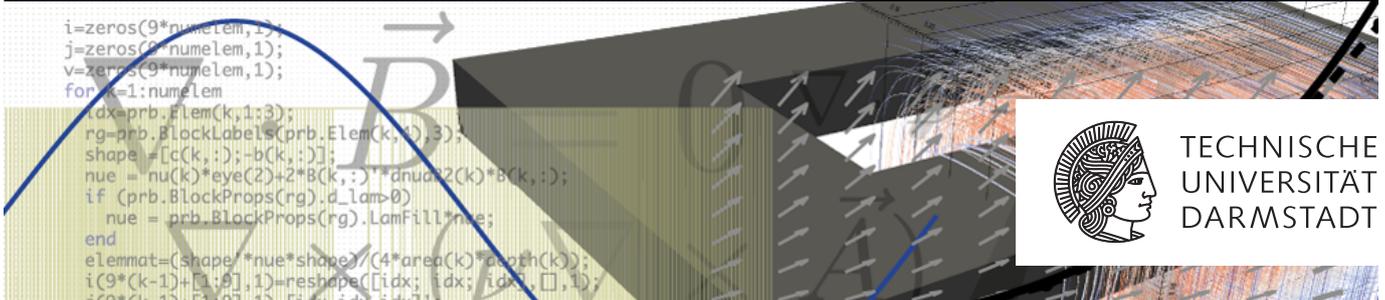# Iterative Solvers for Complex Linear Systems

Bachelor Thesis

Computational Engineering / Electrical Engineering

Start: Immediately

TECHNISCHE UNIVERSITÄT DARMSTADT

Graduate School of
Computational Engineering

Institut für Theorie
Elektromagnetischer Felder

Motivation

The solution of systems of linear equations with complex valued coefficients is an important task in engineering. Particular examples include systems arising from the numerical solution of the Helmholtz equation or Maxwell's equations. Since the number of unknowns can become quite large, a naive solution using Gaussian elimination cannot be used for most examples relevant for practical purposes.

An alternative widely used in practice are iterative solvers which are based on matrix-vector multiplications, for example the CG and the GMRES method. They exploit that in many cases the matrix-vector product can be performed efficiently. Since many textbooks and libraries describe and implement iterative solvers for systems of linear equations with real valued coefficients, the complex valued system is often transformed into an equivalent real valued system, which is then solved using a solver for real valued coefficients. However, in particular for ill-conditioned systems as they often occour in practice, it turns out that the solution of the real valued system is quite slow.

One can show that the complex valued system has much nicer properties for iterative solvers than the real one, and several suitable algorithms have been described in the literature. However, they are not widely available in modern software libraries.

Goals

- Implementation of a GMRES method for real and complex valued systems
- Literature survey on iterative methods for complex valued systems, in particular the QMR method
- Implementation of a suitable selection of the found methods
- Comparision of the methods, in particular to the real and complex valued GMRES method

Prerequisites

- Basic knowledge in linear algebra
- Basic knowledge of a programming language, e.g. MATLAB/Octave

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