LECTURES on Numerical Mathematics and Applications

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Basics of Multigrid Methods and Local Fourier Analysis

The efficient numerical solution of many real problems modeled by partial differential equations strongly depends on the resolution of the corresponding large linear systems resulting from their discretization. Since their development in the 70's, multigrid methods have been proved to be among the most efficient numerical algorithms for solving this kind of systems, achieving asymptotically optimal complexity at least for elliptic problems. However, their performance strongly depends on the choice of the so-called components of the algorithm, and this choice can be very challenging when new applications are investigated. Local Fourier analysis is a useful tool for an appropriate selection of the components. It is the main quantitative analysis for multigrid methods and provides very accurate predictions of the convergence factor of the algorithm. In this talk we will review the basic concepts and techniques of multigrid methods, concentrating on their role as fast solvers for elliptic boundary-value problems. Also we will do an introduction to the local Fourier analysis and we will show its practical usefulness.

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