



Lectures on Numerical Mathematics and Applications

Zaragoza, 3-4 June, 2013

The first courses of the series "Lectures on Numerical Mathematics and Applications" consist of five lectures of two hours each, given by renowned prestige professors of different Universities, related to theory and application of numerical mathematics.

The topics of the courses are the following:

- **ALFIO BORZI** - Multigrid methods for optimal control problems with PDE constraints

This lecture provides an introduction to advanced multigrid strategies for solving unconstrained and constrained PDE control problems. Development of multilevel algorithms for optimal control and optimization, and convergence analysis of some representative multigrid schemes are discussed. In particular, multigrid schemes for linear and nonlinear elliptic optimality systems and the MGOPT approach to unconstrained optimization problems are discussed in detail.

- **CORNELIS W. OOSTERLEE** - Numerical Mathematics Techniques in Computational Finance

The lectures on computational finance introduce the derivation of the famous Black-Scholes partial differential equation for the pricing of an option. We will explain aspects of financial markets and products. In particular, we explain what a financial option is, and how we can price it with applied mathematics techniques.

- **ULRICH RÜDE** - Introduction to Parallel Scientific Computing

With the advent of multicore technology, parallel computing has become ubiquitous and serial computers have virtually ceased to exist. We will present an overview of parallel systems and high performance computing paradigms for scientific applications. In particular, the lecture will discuss parallel iterative methods and parallel multigrid algorithms. This will include techniques of performance optimization and scalability studies on current supercomputer architectures.

- **VOLKER SCHULZ** - Introduction to shape optimization

This course first introduces basic aspects of the classical shape calculus leading to the famous Hadamard formulas for volume and boundary objectives. In a second part, the numerical treatment of shape optimization problems within a PDE context is discussed based on the shape calculus. It is demonstrated, how a proper approximation of the shape Hessian can be used to improve the convergence of shape gradient based optimization approaches. Furthermore, some discussion on a Riemannian framework for the optimization on shape spaces is provided.

- **IRAD YAVNEH** - Introduction to multiscale computational methods with applications to image processing

These lectures will provide an exposition of multiscale computational methods. We will introduce the basic concepts underlying these methods, and the difficulties encountered in the development of algorithms based on these ideas. We will then discuss several specific problems in the field of image processing and the multiscale algorithms that have been developed for their solution.

PROGRAMME

Monday 3rd June

8:50h - 9:00h	OPENING OF THE COURSES
9:00h - 9:30h	Alfio Borzi - Corso 0 - Multigrid Methods
9:30h - 10:20h	Alfio Borzi- Multigrid methods for optimal control problems with PDE constraints
10:30h - 11:00h	COFFEE BREAK
11:00h - 11:50h	Alfio Borzi- Multigrid methods for optimal control problems with PDE constraints
12:00h - 12: 50h	Ulrich Rde - Introduction to Parallel Scientific Computing
13:00h - 15:00h	LUNCH
15:00h - 15:50h	Ulrich Rde - Introduction to Parallel Scientific Computing
15:50h - 16:10h	BREAK
16:10h - 17:00h	Kees Oosterlee - Numerical Mathematics Techniques in Computational Finance
17:10h - 18:00h	Kees Oosterlee - Numerical Mathematics Techniques in Computational Finance

Tuesday 4th June

8:30h - 9:20h	Volker Schulz - Introduction to shape optimization
9:30h - 10:20h	Volker Schulz - Introduction to shape optimization
10:30h - 11:00h	COFFEE BREAK
11:00h - 11:50h	Irad Yavneh - Introduction to multiscale computational methods with applications to image processing
12:00h - 12:50h	Irad Yavneh - Introduction to multiscale computational methods with applications to image processing
12:50h	CLOSING OF THE COURSES
13:00h - 14:30h	LUNCH