



Mathematisches Forschungsinstitut Oberwolfach

Oberwolfach Seminar

Projection Based Model Reduction: Reduced Basis Methods, Proper Orthogonal Decomposition, and Low Rank Tensor Approximations

Date/ID:

23 November - 29 November 2014 (1448b)

Organizers:

Bernard Haasdonk, Stuttgart
Anthony Nouy, Nantes
Mario Ohlberger, Münster
Stefan Volkwein, Konstanz

Programme:

Many physical, chemical, biomedical, and technical processes can be described by means of partial differential equations or dynamical systems. In recent years, multi-physics and multi-scale problems have become a particular focus of applied mathematical research. A numerical treatment of such problems is usually very time consuming and thus requires the development of efficient discretization schemes that are often realized on large parallel computing environments.

In addition, these problems often need to be solved repeatedly for many varying parameters, introducing a curse of dimensionality when the solution is also viewed as a function of these parameters. Examples for such situations include design, control, optimization, inverse problems, uncertainty analysis and statistical sampling.

In recent years there has been a tremendous effort in developing efficient model reduction approaches to deal with such problems. Particular promising emerging fields to cope with such scenarios are Reduced Basis Methods, Proper Orthogonal Decomposition and Low Rank Tensor Approximation.

The seminar will introduce these approaches both from a theoretical and numerical perspective. In detail the seminar will be structured into 5 minicourses dedicated to the following areas:

M1 Reduced Basis Methods for stationary and instationary parameterized systems, including Empirical Operator Interpolation and non-linear model reduction.

M2 Proper Orthogonal Decomposition in PDE constrained optimization.

M3 Generalized Reduced Basis approach with application to localized model reduction for multi scale problems.

M4 Low-rank approximation methods, Proper Generalized Decompositions and applications in uncertainty quantification.

M5 Advanced topics and applications.

The program will consist of 2 lectures (1.5 hours each) in the morning, and hand on sessions in combinations with guided projects in teams in the afternoon.

Preparatory reading:

The intended audience consists of applied mathematicians with a background in numerical methods for PDEs/SDEs, optimal control, computational linear algebra, or related fields.

Textbooks:

[1] S. C. Brenner and L. R. Scott. *The mathematical theory of finite element methods*, volume 15 of Texts in Applied Mathematics. Springer, New York, third edition, 2008.

[2] F. Tröltzsch. *Optimal Control of Partial Differential Equations*, Graduate Studies in Mathematics, American Mathematical Society, 2010.

Further references to enter the field of projection based model reduction:

[3] M. Gubisch and S. Volkwein. *Proper orthogonal decomposition for linear-quadratic optimal control*, submitted 2013,
url: <http://kops.ub.unikonstanz.de/handle/urn:nbn:de:bsz:352-250378>.

[4] B. Haasdonk, and M. Ohlberger. *Reduced basis method for finite volume approximations of parametrized evolution equations*. M2AN Math. Model. Numer. Anal., 42(2):277-302, 2008.

[5] A. T. Patera and G. Rozza. *Reduced basis approximation and a posteriori error estimation for parametrized partial differential equations*, Version 1.0, Copyright MIT 2006, to appear in (tentative rubric) MIT Pappalardo Graduate Monographs in Mechanical Engineering, 2006.

Deadline for applications:

1 September 2014

The Oberwolfach Seminars are organized by leading experts in the field, and address postdocs and Ph.D. students from all over the world. The aim is to introduce the participants to a particular interesting development. The seminars take place at the Mathematisches Forschungsinstitut Oberwolfach. The Institute covers accommodation and food. By the support of the Carl Friedrich von Siemens Foundation, travel expenses can be reimbursed up to 150 EUR in average per person. Participants can ask for travel support during their stay in Oberwolfach at the guest office against copy of travel receipts. The number of participants of a seminar is restricted to 25.

Applications including:

- full name and address, including e-mail address
- short CV, present position, university
- name of supervisor of Ph.D. thesis
- a short summary of previous work and interest
- title, ID and date of the intended seminar

should be sent preferably by e-mail (pdf files) to:

Prof. Dr. Dietmar Kröner

Vice Director MFO

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