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UNIVERSITÀ DEL SALENTO

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Scientific Program - Timetable

Time	Sunday 22	Monday 23	Tuesday 24	Wednesday 25	Thursday 26	Friday 27
9:00			Contributed sessions (15 in parallel)	Plenary Lecture Moritz Diehl	Contributed sessions (15 in parallel)	Contributed sessions (14 in parallel)
10:00		Registration		von Mises prize lecture		
11:00			Coffee Break	Coffee Break	Coffee Break	Coffee Break
11:30			Plenary Lecture Thomas Böhlke	General Assembly	Plenary Lecture Ferdinando Auricchio	Contributed sessions (11 in parallel)
12:30			Lunch	Lunch	Lunch	
13:00		Opening				
13:30		Univ. Chorus Performance				Closing
14:00		Prandtl Lecture Keith Moffatt	Plenary Lecture Enrique Zuazua	Contributed sessions (15 in parallel)	Plenary Lecture Daniel Kressner	
15:00		Plenary Lecture Giovanni Galdi	Plenary Lecture Nikolaus Adams		Plenary Lecture Stanislaw Stupkiewicz	
16:00	Registration pre-opening	Coffee Break	Coffee Break Poster session	Coffee Break	Coffee Break Poster session	
16:30		Minisymposia & Young Reseachers' Minisymposia (10 in parallel)	Contributed sessions (14 in parallel)	Contributed sessions (15 in parallel)	Contributed sessions (15 in parallel)	
18:30			Public lecture Francesco D'Andria			
19:00		Opening reception at Castle of Charles V				
20:30				Conference dinner at Hotel Tiziano		

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YRMS3: Discretization Aspects in PDE Constrained Optimization

Optimization problems with partial differential equations (PDEs) as constraint have been of tremendous research interest over the past decades. Due to the PDE, these problems are of infinite dimension and can rarely be tackled directly. Instead, the PDE needs to be discretized.

This important step in the numerical consideration of PDE constrained optimization problems gives rise to a multitude of research questions, going from the choice of a suitable discretization for a given application, convergence analysis for the discrete approximations to the limit as the mesh is refined, to the design of appropriate (finite dimensional) solvers for the corresponding discrete problems.

Shape optimization by pursuing diffeomorphisms

Ralf Hiptmair, Alberto Paganini
Seminar for Applied Mathematics, ETHZ

We consider PDE constrained shape optimization in the framework of finite element discretization of the underlying boundary value problem. We present an algorithm tailored to preserve and exploit the approximation properties of the finite element method, and that allows for arbitrarily high resolution of shapes. It is based on the method of mappings and it employs (i) B-spline based representations of the deformation diffeomorphism, and (ii) superconvergent domain integral expressions for the shape gradient. We provide numerical evidence of the performance of this method both on prototypical well-posed and ill-posed shape optimization problems.

References

[1] R. Hiptmair, A. Paganini and S. Sargheini. Comparison of approximate shape gradients. BIT Numerical Mathematics (2014).

[2] R. Hiptmair, A. Paganini. Shape optimization by pursuing diffeomorphisms. SAM-Report 2014-27.

Fast Iterative Solvers for Discretizations of PDE-Constrained Optimization Problems

John W. Pearson
University of Edinburgh

A key consideration when discretizing PDE-constrained optimization problems is that of devising fast and effective methods for solving the resulting discretized systems. In this talk we focus on constructing preconditioned iterative methods for such problems, by exploiting the saddle point structure of the matrix systems that arise.

Using strategies that we have developed for more fundamental problems of time-independent [2] and time-dependent [4] form, we consider fast solvers for time-dependent PDE-constrained optimization problems. We focus on two specific such problems, from different application areas. Firstly we examine the time-dependent Stokes control problem [3], and build solvers for the sparse matrix systems involved using effective approximations of the $(1, 1)$-block and Schur complement. Secondly we examine dense matrix systems that arise from the optimal control of fractional differential equations [1], and discover whether our approaches may also be applied to such problems.

For each problem presented in this talk, we consider the likely theoretical convergence properties of our methods, the practical rate of convergence observed in numerical experiments, and whether our methods may lead to parallelizable solution strategies.

References

[1] S. Dolgov, J. W. Pearson, D. V. Savostyanov and M. Stoll, *Fast Tensor Product Solvers for Optimization Problems with Fractional Differential Equations as Constraints*, to be submitted.

[2] J. W. Pearson and A. J. Wathen, *A New Approximation of the Schur Complement in Preconditioners for PDE-Constrained Optimization*, Numerical Linear Algebra with Applications, 19(5), pp.294–310, 2012.

[3] J. W. Pearson, *Fast Iterative Solvers for Large Matrix Systems Arising from Time-Dependent Stokes Control Problems*, submitted, 2014.

[4] J. W. Pearson, M. Stoll and A. J. Wathen, *Regularization-Robust Preconditioners for Time-Dependent PDE-Constrained Optimization Problems*, SIAM Journal on Matrix Analysis and Applications, 33(4), pp.1126–1152, 2012.

Finite element error estimates for Dirichlet boundary control problems on polygonal domains

Th. Apel[1], M. Mateos[2], J. Pfefferer[1], and A. Rösch[3]
[1]Universität der Bundeswehr München
[2]Universidad de Oviedo
[3]Universtät Duisburg-Essen

In this talk we study the control constrained Dirichlet boundary control problem

$$\begin{aligned}
&\min J(u) = \frac{1}{2}\int_\Omega (Su(x) - y_\Omega(x))^2 dx + \frac{\nu}{2}\int_\Gamma u^2(x)\, d\sigma(x)\\
&\text{subject to } \ (Su, u) \in H^{1/2}(\Omega) \times L^2(\Gamma),\\
&u \in U_{ad} = \{u \in L^2(\Gamma) : \ a \le u(x) \le b \quad \text{for a.a.} \quad x \in \Gamma\},
\end{aligned}$$

where Su is the solution y of the state equation

$$-\Delta y = 0 \text{ in } \Omega, \ \ y = u \text{ on } \Gamma.$$

The underlying domain Ω is assumed to be polygonal but not necessarily convex. Since for $u \in U_{ad}$ the state equation does not possess a variational solution, the state equation is understood in the transposition sense.

In the first part of this talk, we investigate the regularity of the solution of the optimal control problem. It is well known that in polygonal domains the solution of an elliptic partial differential equation generally contains singular terms which depend on the size of the interior angles of the domain. By analyzing these terms in detail we are able to improve existing regularity results for the solution of the optimal control problem in convex domains. Moreover, completely new regularity results are presented for problems posed in non-convex domains. For example, we show that the optimal control is a continuous function although the normal derivative of the adjoint state may be unbounded.

In the second part, we discuss error estimates for the discretized optimal control problem where we apply a full discretization with piecewise linear and continuous functions for both the state and the control. The error estimates which we obtain mainly depend on the size of the interior angles but also on the presence of control constraints.

Finally, different numerical examples are presented in order to illustrate the theoretical results.

Scaling Limits in Computational Bayesian Inversion

Claudia Schillings, Christoph Schwab
University of Warwick
SAM - ETHZ

In this talk, preconditioning strategies for sparse, adaptive quadrature methods for computational Bayesian inversion of operator equations with distributed uncertain input parameters will be presented. Based on sparsity results of the posterior, error bounds and convergence rates of dimension-adaptive Smolyak quadratures can be shown to be independent of the parameter dimension, but the error bounds depend exponentially on the inverse of the covariance of the additive, Gaussian observation noise. We will discuss asymptotic expansions of the Bayesian estimates, which can be used to construct quadrature methods combined with a curvature-based reparametrization of the parametric Bayesian posterior density near the (assumed unique) global maximum of the posterior density leading to convergence with rates independent of the number of parameters as well as of the observation noise variance.

A Posteriori Error Estimation for State-Constrained Optimal Control Problems

K.G. Siebert[1], A. Roesch[2], S. Steinig[3]
[1]University of Stuttgart
[2]University Duisburg-Essen
[3]TU Dortmund

In this contribution we will examine a finite element discretisation of a state-constrained elliptic optimal control problem. We will present a reliable a posteriori error estimator giving an upper bound for the error between the true solution and the discrete one up to data-dependent constants which also takes into account the regularisation error naturally coming into play when tackling these kind of problems numerically. Together with a basic convergence result for a sequence of finite element discretisations we are thus able to build a convergent adaptive scheme for this type of problem mirroring the results derived for PDEs and control-constrained optimal control problems in [1] and [2] respectively.

References

[1] P. Morin, K.G. Siebert, A. Veeser. A basic convergence result for conforming adaptive finite elements. Mathematical Models and Methods in Applied Sciences. 18 (2008), 707–737.

[2] K. Kohls, A. Roesch, K.G. Siebert. A posteriori error analysis of optimal control problems with control constraints. SIAM Journal on Control and Optimization. 52 (2014), 1832–1861.

Optimal convergence order for control constrained optimal control problems

René Schneider, Gerd Wachsmuth

In this talk we consider the numerical solution of control constrained optimal control problems. We are interested in obtaining the optimal convergence rate for the L^2-error w.r.t. the number of degrees of freedom. Due to the control constraint, the optimal control possesses a kink at the interface between the active and inactive set w.r.t. the control constraint. This kink limits the convergence order of a uniform discretization to $h^{3/2}$.

We compare some approaches from the literature. Moreover, we provide a new, efficient and robust error estimator which is used for an adaptive refinement of the mesh.

We also present a new method for solving control constrained problems. In this method, we move the nodes of the mesh at the interface between the active and inactive set. This yields optimal order of convergence.