

MATHEMATISCHES KOLLOQUIUM

UNIVERSITÄT
DUISBURG
ESSEN

Offen im Denken

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ETH Zürich

"Shape Differentiation: New Perspectives"

The presentation examines the „derivative“ of solutions of second-order boundary value problems and of output functionals based on them with respect to the shape of the domain. A rigorous approach relies on encoding shape variation by means of deformation vector fields, which will supply the directions for taking shape derivatives. These derivatives and methods to compute them numerically are key tools for studying shape sensitivity, performing gradient based shape optimization, and small-variation shape uncertainty quantification.

A unifying view of second-order elliptic boundary recasts them in the language of differential forms (exterior calculus). Fittingly, the shape deformation through vector fields matches the concept of Lie derivative in exterior calculus. This paves the way for a unified treatment of shape differentiation in the framework of exterior calculus.

The obtained formulas can be employed in the so-called adjoint approach to derive shape gradients of concrete output functionals. The resulting expressions allow different reformulations. Though equivalent for exact solutions of the involved boundary value problems, they deliver vastly different accuracies in the context of finite element approximation, as confirmed by a rigorous asymptotic a priori convergence analysis for a number of important cases.

References

- [1] R. Hiptmair and J. Li, Shape derivatives in differential forms I: an intrinsic perspective, *Ann. Mat. Pura Appl.* (4), 192 (2013), pp. 1077-1098.
- [2] R. Hiptmair and A. Paganini, Shape optimization by pursuing diffeomorphisms, *Comput. Methods Appl. Math.*, 15 (2015), pp. 291-305.
- [3] R. Hiptmair, A. Paganini, and S. Sargheini, Comparison of approximate shape gradients, *BIT Numerical Mathematics*, 55 (2014), pp. 459-485.
- [4] A. Paganini, Numerical shape optimization with finite elements, eth dissertation 23212, ETH Zurich, 2016.

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Raum WSC-S-U-4.02

Zeit: Mittwoch, 9. November 2016 um 14:15 Uhr

Vor dem Vortrag gibt es ab 13:45 Uhr Gelegenheit zum Gespräch bei Kaffee und Tee in Raum WSC-S-4.05.