

Einladung

# Würzburger Mathematisches Kolloquium

Julius-Maximilians-Universität Würzburg • Institut für Mathematik

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Universität Trier

# Second-Order Riemannian Optimization: From Shape Spaces to Tensors to Positive Definite Matrices

Dienstag, 23. Juni 2026 • 14:15 Uhr

Seminarraum SE41 • Humboldt-Bau (Emil-Fischer-Straße 41, 97074 Würzburg)

Der Vortrag wird auch als Zoom-Meeting übertragen: [go.uni-wue.de/ifmcolloquium-zoom](https://go.uni-wue.de/ifmcolloquium-zoom)

**Abstract.** Riemannian optimization is increasingly used across computational mathematics, but often limited to first-order methods because explicit Riemannian Hessians are difficult to derive for specific objectives. This talk discusses second-order Riemannian Newton methods — often realized via Trust-Region globalization — on several manifolds arising in applications.

The starting point is shape optimization, where a Riemannian perspective yields geometrically consistent shape Hessians. While conceptually fruitful — ultimately leading to pre-shape calculus and linear second-order shape derivatives — the lack of geodesic completeness limits direct applicability of Newton methods on shape spaces. The situation changes on geodesically complete manifolds. On low-rank tensor manifolds, the Riemannian Hessian is derived via the Weingarten map, enabling Trust-Region methods for tensor completion. On the positive definite cone with the affine-invariant metric, explicit intrinsic Hessians are computed for Gaussian mixture models and REML estimation in linear mixed effects models. In each case, the exact Hessian enables superlinear local convergence and substantial improvements over first-order and derivative-free alternatives.



<https://www.mathematik.uni-wuerzburg.de/de/aktuelles/kolloquium>



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