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OBERSEMINAR IM INSTITUT FÜR ANGEWANDTE ANALYSIS Sommersemester 2026

Im Rahmen des Oberseminars spricht am Montag, den **8. Juni 2026**:

DUC HOANG

Humboldt University of Berlin

On the Information Complexity of Classes of Holomorphic Operators with Applications to Parametric PDEs

We study classes of nonlinear operators $G : \mathcal{X} \rightarrow \mathcal{Y}$ between separable Hilbert spaces under the assumption that G is analytic and admits a holomorphic extension and are uniformly bounded in a stronger output norm. Such classes have garnered interest because of their excellent numerical [1] and statistical [2] properties and arise naturally in the context of parametric PDEs. The geometry and complexity of these classes w.r.t. the $L^2(\mathcal{X}, \mathcal{Y}, \gamma)$ -topology will be a central focus of this talk; in particular, we prove upper and lower bounds for the metric entropy (i.e. the logarithm of the covering numbers) of these classes in terms of smoothness exponents (s, t) in the input and output space. Based on these results, upper and lower bounds on the statistical convergence rates for the recovery of G from n noisy input-output pairs can be shown to be dimension-independent and algebraic in n . This shows that for classes of holomorphic operators, one can circumvent the *curse of parametric/sample complexity* [3] of requiring an exponential amount of data for the recovery of non-linear operators of finite regularity. We conclude with applications to the learning theory for the elliptic Darcy flow equation, connections to scientific machine learning and possible further research directions.

joint work with: Sven Wang (École Polytechnique Fédérale de Lausanne, Lausanne [Switzerland]) Jakob Zech (Heidelberg University, Heidelberg [Germany])

References

1. L. Hermann, C. Schwab and J. Zech, *Neural and spectral operator surrogates: unified construction and expression rate bounds*, Adv. Comput. Math. **50**, 72 (2024).
2. N. Reinhardt, S. Wang, J. Zech, *Statistical Learning Theory for Neural Operators*, arXiv:2412.17582 (2024).
3. S. Lanthaler, A. M. Stuart, *The parametric complexity of operator learning*, IMA Journal of Numerical Analysis **45** (2025).

Der Vortrag findet in **Raum E60, Helmholtzstr. 18** statt.

Beginn: 16 Uhr (c.t.). Alle Interessierten sind herzlich eingeladen.

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