The blessing of smoothness and outlier-free spline spaces in isogeometric analysis

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Isogeometric analysis is a well-established paradigm to improve interoperability between geometric modeling and numerical simulation. It is based on smooth spline representations and shows important advantages over classical C^0 finite element analysis. In particular, the higher smoothness enables a higher accuracy per degree of freedom. This superior performance has been observed numerically since long time, and recently is supported theoretically by error estimates with constants that are explicit, not only in the mesh size, but also in the polynomial degree and the smoothness. Moreover, the isogeometric approach based on maximally smooth spline spaces over uniform grids turns out to be an excellent choice for addressing eigenvalue problems: it gives a very good approximation of the full spectrum, except for a very small portion of spurious outliers.

In this seminar we review some recent results on explicit error estimates for approximation with highly smooth splines. These estimates are sharp or close to sharp in several interesting cases and are actually good enough to cover convergence to eigenfunctions of classical differential operators under so-called k-refinement. We also discuss how subspaces of maximally smooth splines, which are optimal in the sense of Kolmogorov n-widths, can be selected to make outlier-free isogeometric discretizations. The seminar is based on joint work with Carla Manni and Espen Sande.