Local isogeometric mesh refinement in polar-type domains with corners

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Corner singularities play a significant role for the modeling of complex physical phenomena in non-smooth domains. Their presence renders simulations challenging as standard methods produce suboptimal results due to singular solutions. In isogeometric analysis, two-dimensional polar-type domains with corner singularities like circular sectors or L-shapes can be discretized conveniently with a single patch. However, the corresponding isogeometric parameterization is singular and standard approximation spaces are not appropriate.

Hence, two major challenges need to be tackled at once: the singularity of both the solution and the parameterization at the polar point. We introduce a graded mesh refinement algorithm, enabling locally refined meshes near the singular corner and combine it with modified approximation spaces that have been proposed for singularly parameterized domains in the literature. We prove optimal convergence of our method for solving boundary value and eigenvalue problems. To confirm the theory, we provide a series of numerical results.

References:

[1] T. Apel and P. Zilk. Isogeometric analysis of the Laplace eigenvalue problem on circular sectors: Regularity properties, graded meshes & variational crimes. arXiv preprint. 2024. arXiv: 2402.16589.

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