Machine Learning Approaches for Parametrization in T-Spline Surface Approximation

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Parametrization for curve and surface approximation is an important and yet open problem in geometric modeling. Computing parametrizations that yield tight approximations is a challenging task based largely on optimization techniques or user experience. In this work we propose two machine learning methods to determine parametric values and suitable knot vectors for T-spline surface approximation. Our first approach is to train Support Vector Machines (SVMs) to compute locations along a sequentially ordered point cloud where knot placement will improve the approximation quality. The trained SVMs assign a score to each position along the point cloud, based on geometric and differential geometric features of local point cloud neighborhoods. This score measures the quality of each location to be used as a knot in the subsequent approximation.
Since most existing methods consider the computation of parametric values and a knot vector as separate problems we propose a second approach where we train interdependent deep neural networks to predict parametric values and knots. We show that it is possible to include B-spline curve approximation directly into the neural network architecture. Finally, the T-spline surface is approximated by surface skinning. The resulting parametrizations yield tight approximations and are able to outperform state-of-the-art methods.

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