

Roughness regularization for functional data analysis with free knots spline estimation

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In this work, we introduced a novel approach for functional data estimation, employing roughness regularization with free knots spline. Our method integrates the free knots spline estimation technique by introducing two penalty terms. The investigation compares two penalty regularization schemes: a standard scheme with a single-parameter roughness term addressing function variability, and a two-penalty scheme managing monotonicity and smoothness.

Results, obtained from applying different clustering methods to both simulated and real datasets with curves of varying shapes, demonstrate the effectiveness of our approach. Our computational experiments suggest that the use of the double penalization could give significantly better results than the use of a single term in the approximation of functional data. In particular, when applied to simulated data, our method showcases enhanced capabilities in revealing a clearer clustering structure. A promising direction emerges from the non-linear effects linked to the selection of knots in the initial basis. The use of machine learning methods to enhance the analytical approach opens a different perspective for further advancements in the domain of functional data analysis.