

Adaptive Functional Data Analysis

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Functional Data Analysis (FDA) depends critically on the regularity of the observed curves or surfaces. Estimating this regularity is a difficult problem in nonparametric statistics. In FDA, however, it is much easier due to the replication nature of the data. After introducing the concept of local regularity for functional data, we provide user-friendly nonparametric methods for investigating it, for which we derive non-asymptotic concentration results. As an application of the local regularity estimation, the implications for functional PCA are shown. Flexible and computationally tractable estimators for the eigenelements of noisy, discretely observed functional data are proposed. These estimators adapt to the local smoothness of the sample paths, which may be non-differentiable and have time-varying regularity. In the course of constructing our estimator, we derive upper bounds on the quadratic risk and obtain the optimal smoothing bandwidth that minimizes these risk bounds. The optimal bandwidth can be different for each of the eigenelements. Simulation results justify our methodological contribution, which is available for use in the R package `FDAdapt`. Extensions of the adaptive FDA approach to functional time series and multivariate functional data are also mentioned.