

DIMENSION REDUCTION OF CONDITIONAL
QUANTILES FOR FUNCTIONAL DATA WITH ITS
EXTENSION

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Abstract

Functional data analysis (FDA) has become increasingly important in applications where observations are recorded as functions over a continuum, such as neuroimaging signals, electrocardiograms, and other biomedical measurements. However, most existing FDA methods focus on mean regression, with much less attention given to quantile regression. This dissertation develops a unified framework for dimension reduction in the conditional quantile analysis of functional data and its extensions. First, we develop dimension reduction techniques for the conditional quantiles of functional data by replacing infinite-dimensional functional predictors with a small number of finite-dimensional predictors while preserving the information relevant to the conditional quantiles and maintaining modeling flexibility. Second, we extend this framework to accommodate both functional and categorical predictors through a partial dimension reduction approach. Third, we relax the linear assumptions used in the first two settings and further generalize the framework to a nonlinear setting. For each proposed method, convergence rates are established, and performance is demonstrated through simulation studies and real-world applications, including studies of ADHD, Parkinson's disease, and NHANES dataset.