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MULTIVARIATE FUNCTIONAL PRINCIPAL COMPONENT ANALYSIS: A NORMALIZATION APPROACH

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Abstract: This study proposes a modified version of the classical Karhunen-Loève expansion for a vector-valued random process, called a normalized multivariate functional principal component (mFPC$_n$) approach, as a general stochastic representation for multivariate random functions. The mFPC$_n$ approach takes the varying extent of variations between the components of multivariate random functions into account and takes advantage of component dependency through the pairwise cross-covariance functions. The multivariate approach leads to a single set of multivariate functional principal component scores, which serves well as the proxy of multivariate functional data. We derive the consistency properties for the estimates of the mFPC$_n$ model components, and the asymptotic distributions for statistical inferences. We illustrate the finite sample performance of the mFPC$_n$ approach through the analysis of a traffic flow data set, including an application to clustering multivariate functional data derived from the mFPC$_n$ approach and a simulation study. The mFPC$_n$ approach serves as a basic and useful statistical tool for multivariate functional data analysis.

Key words and phrases: Karhunen-Loève expansion, Mercer's theorem, multivariate functional data, normalization, traffic flow.