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Covariance Networks for Functional Data on Multidimensional Domains

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Abstract

Covariance estimation is ubiquitous in functional data analysis. Yet, the case of functional observations over multidimensional domains introduces computational and statistical challenges, rendering the standard methods effectively inapplicable. We introduce Covariance Networks (CovNet) as a modeling and estimation tool to address this problem. The CovNet model is universal; it can be used to approximate any covariance up to desired precision. Moreover, the model can be fitted efficiently and its neural network architecture allows us to employ modern computational tools in the implementation. The CovNet model also admits a closed-form eigen-decomposition, which can be computed efficiently, without constructing the covariance itself. This facilitates easy storage and subsequent manipulation of the estimator. Moreover, the proposed estimator comes with theoretical guarantees in the form of consistency and rate of convergence. We demonstrate the usefulness of the proposed method on resting-state fMRI data. It is a joint work with Victor M. Panaretos.

Keywords:
Deep Learning; FDA; Neural Network; Non-Parametric Model; Random Field; Universal Approximation.