## Covariance Networks for Functional Data on Multidimensional Domains

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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. To address this problem, we introduce Covariance Networks (CovNet) as a modeling and estimation tool. The CovNet model is universal – it can be used to approximate any covariance up to desired precision. Moreover, the model can be fitted efficiently to the data and its neural network architecture allows us to employ modern computational tools in the implementation. The CovNet model also admits a closed-form eigendecomposition, which can be computed efficiently, without constructing the covariance itself. This facilitates easy storage and subsequent manipulation in the context of the CovNet. Moreover, we establish consistency of the proposed estimator and derive its rate of convergence. The usefulness of the proposed method is demonstrated using an extensive simulation study.

Keywords: deep learning, neural network, nonparametric model, universal approximation