PROCRUSTES METRICS ON COVARIANCE OPERATORS AND OPTIMAL COUPLING OF GAUSSIAN PROCESSES

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Covariance operators are fundamental in functional data analysis, providing the canonical means to analyse functional variation via the celebrated Karhunen–Loève expansion. These operators may themselves be subject to variation, for instance, in contexts where multiple functional populations are to be compared. Statistical techniques to analyse such variation are intimately linked with the choice of metric on covariance operators, and the intrinsic infinite-dimensionality of these operators. We will describe the manifold-like geometry of the space of trace-class infinite-dimensional covariance operators and associated key statistical properties, under the recently proposed infinite-dimensional version of the Procrustes metric [2]. In particular, we will identify this space with that of centred Gaussian processes equipped with the Wasserstein metric of optimal transportation. The identification allows us to provide a description of those aspects of the geometry that are important in terms of statistical inference, and establish key properties of the Fréchet mean of a random sample of covariances, tangent space PCA, as well as generative models that are canonical for such metrics. The latter will allow us to draw connections with the problem of registration of warped functional data.

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References


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