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Title: Fréchet Sufficient Dimension Reduction for Metric Space-Valued Data via Distance Covariance

Abstract: We propose a novel Fréchet sufficient dimension reduction (SDR) method based on kernel distance covariance, tailored for metric space-valued responses such as count data, probability densities, and other complex structures. The method leverages a kernel-based transformation to map metric space-valued responses into a feature space, enabling efficient dimension reduction. By incorporating kernel distance covariance, the proposed approach offers enhanced flexibility and adaptability for datasets with diverse and non-Euclidean characteristics. The effectiveness of the method is demonstrated through synthetic simulations and several real-world applications. In all cases, the proposed method runs faster and consistently outperforms the existing Fréchet SDR approaches, demonstrating its broad applicability and robustness in addressing complex data challenges.