DeepKriging on the Sphere: Basis Adaptation for Spherical Data

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Abstract

In this talk, we present a spherical extension of the DeepKriging framework designed for large-scale spatial prediction on global domains. Many existing deep spatial models rely on Euclidean distances, which can distort spatial relationships when applied to spherical data such as global climate or remote sensing measurements. In contrast, classical geostatistical approaches that correctly handle spherical geometry are often computationally infeasible for modern large datasets. To address these challenges, we develop a spherical multi-resolution DeepKriging model that integrates thin-plate spline basis functions defined directly on the sphere with a neural network architecture. The proposed approach captures both large-scale smooth variation and fine-scale spatial detail while maintaining geometric consistency on $\mathbb{S}^2$. We further incorporate Huber's loss into the training procedure to improve robustness against outliers. Simulation studies and real-world applications to global sea surface temperature and precipitation data demonstrate that the proposed framework achieves accurate, stable, and scalable prediction, offering a flexible and robust tool for modeling complex spatial processes on the sphere.

Keywords: DeepKriging, kriging, multi-resolution spline basis functions, thin-plate spline functions on the sphere, non-Gaussian spatial process