

Enhancing Spatial Interpolation: A Multi-Layer Inverse Distance Weighting Model for Complex Regression and Classification Tasks in Spatial Data Analysis

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Abstract : This study introduces the Multi-Layer Inverse Distance Weighting Model (ML-IDW), inspired by the mathematical formulation of both multi-layer neural networks (ML-NNs) and Inverse Distance Weighting model (IDW). ML-IDW leverages ML-NNs' processing capabilities, characterized by compositions of learnable non-linear functions applied to input features, and incorporates IDW's ability to learn anisotropic spatial dependencies, presenting a promising solution for nonlinear spatial interpolation and learning from complex spatial data. It employs gradient descent and backpropagation to train ML-IDW, comparing its performance against conventional spatial interpolation models such as Kriging and standard IDW on regression and classification tasks using simulated spatial datasets of varying complexity. The results highlight the efficacy of ML-IDW, particularly in handling complex spatial datasets, exhibiting lower mean square error in regression and higher F1 score in classification.

Keywords : deep learning, multi-layer neural networks, gradient descent, spatial interpolation, inverse distance weighting

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