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Approximation, shape preservation and image reconstruction by neural network operators

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Neural Network (NN) operators have emerged as a powerful bridge between classical approximation theory and modern data-driven methodologies. In this talk, we present several recent developments concerning NN operators generated by sigmoidal and B-spline activation functions. We discuss their approximation behavior, shape-preserving properties, and asymptotic analysis, including Korovkin-type results and Voronovskaja formulas that describe the local behavior of the approximation process. Special attention is devoted to neural network operators based on central B-splines, whose compact support and smoothness lead to localized and stable approximation schemes. Their multivariate extensions are also considered, together with preservation properties and convergence results in the bivariate setting. The theoretical developments are complemented by applications to image processing. In particular, we analyze the performance of Neural Network and Sampling Kantorovich operators in image reconstruction and denoising problems affected by Gaussian, Poisson, and Speckle noise. Numerical experiments, supported by standard image quality measures, show that operator-based approaches provide accurate and robust reconstructions, highlighting the potential of approximation-theoretic methods in modern imaging applications.

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