How Framelets Enhance Graph Neural Networks

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This talk presents a new approach for assembling graph neural networks based on framelet transforms. The latter provides a multi-scale representation for graph-structured data. With the framelet system, we can decompose the graph feature into low-pass and high-pass frequencies as extracted features for network training, which then defines a framelet-based graph convolution. The framelet decomposition naturally induces a graph pooling strategy by aggregating the graph feature into low-pass and high-pass spectra, which considers both the feature values and geometry of the graph data and conserves the total information. The graph neural networks with the proposed framelet convolution and pooling achieve state-of-the-art performance in many types of node and graph prediction tasks. Moreover, we propose shrinkage as a new activation for the framelet convolution, which thresholds the high-frequency information at different scales. Compared to ReLU, shrinkage in framelet convolution improves the graph neural network model in terms of denoising and signal compression: noises in both node and structure can be significantly reduced by accurately cutting off the high-pass coefficients from framelet decomposition, and the signal can be compressed to less than half its original size with the prediction performance well preserved.