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A graph-based fractality index to characterize complexity of urban form using deep graph convolutional neural networks

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Inspection of the complexity of urban morphology facilitates understanding of human behaviors in urban space, leading to better conditions for the sustainable design of future cities. Fractal indicators, such as fractal dimension, ht-index, and cumulative rate of growth (CRG) index, have been proposed as measures of such complexity. However, these major fractal indicators are statistical rather than spatial, which leads to failure of characterizing the spatial complexity of urban morphology, such as building footprints. To overcome this problem, in this paper a graph-based fractality index (GFI), based on a hybrid of fractal theories and deep learning techniques, is proposed. To quantify the spatial complexity, several fractal variants were synthesized to train a deep graph convolutional neural network. Building footprints of London were used to test the method and the results show that the proposed framework performs better than traditional indices. Moreover, the possibility of bridging fractal theories and deep learning techniques on complexity issues opens up new possibilities of data-driven GIScience.