“Decoding (urban) form and function using spatially explicit deep learning”

Abstract: This paper advances our understanding of the extent to which conventional deep learning methods can be applied to satellite imagery to capture the composition of primarily urbanized landscape. The building blocks that make up those -the activities and agents conceptualised as urban function and the structure that supports them conceptualised as urban form- can be spatially arranged in many ways. This paper relies on the concept of “spatial signatures”, a characterisation of space designed to understand urban environments, dependent on data sources released at a variable rate, limiting update frequency - an issue that could be resolved by remote sensing and satellite imagery. Using open data, we explore this pathway with the Sentinel-2 imagery within deep convolutional neural networks and predictive modelling trained to identify spatial signatures across Great Britain. While deep learning is established in the analysis of urban satellite imagery, its application has often ignored the geographical nature of the images. Our focus is not only to develop a performant model but also to learn about the effect of spatially explicit methods of doing so. The results indicate that classification of predominantly urban environments is more challenging than that dealing with non-urban areas. However, the accuracy is competitive with established land cover classification models, especially when applying spatially explicit methods. This suggests that satellite imagery presents a promising source and reflect form and function of urban environment in greater detail than is usually present in available remote sensing products.

Key words: spatial signatures, classification, remote sensing, artificial intelligence, open data