Explore Urban Spatial Density with Boltzmann Statistical Distribution

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Abstract : The underlying pattern in the modern city is agglomeration. To some degree, the distribution of urban spatial density can be used to describe the status of this assemblage. There are three intrinsic characteristics to measure urban spatial density, namely, Floor Area Ratio (FAR), Building Coverage Ratio (BCR), and Average Storeys (AS). But the underlying mechanism that contributes to these quantities is still vague in the statistical urban study. In this paper, we explore the corresponding extrinsic factors related to spatial density. These factors can further provide the potential influence on the intrinsic quantities. Here, we take Shanghai Inner Ring Area and Manhattan in New York as examples to analyse the potential impacts on urban spatial density with six selected extrinsic elements. Ebery single factor presents the correlation to the spatial distribution, but the overall global impact of all is still implicit. To handle this issue, we attempt to develop the Boltzmann statistical model to explicitly explain the mechanism behind that. We derive a corresponding novel quantity, called capacity, to measure the global effects of all other extrinsic factors to the three intrinsic characteristics. The distribution of capacity presents a similar pattern to real measurements. This reveals the nonlinear influence on the multi-factor relations to the urban spatial density in agglomeration.

Keywords : urban spatial density, Boltzmann statistics, multi-factor correlation, spatial distribution
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