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Research Article

Between morphology and function: How syntactic centers of the Beijing city are defined

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Abstract

The application of big data provides a new angle of view on investigating whether, and if so, how to define the urban center through analyzing urban spatial morphology intrinsically interacts with its functions. This article, using empirical research of the Beijing city, first seeking to explore spatial configuration-the complex relation between any pair of individual spaces regarding other contextual spaces – of urban network collected from Baidu. And then, focusing on conducting a statistical correlation between the configurational patterns of urban network and the aggregation patterns of functions. Based on the different patterns of aggregation or dispersion of those functions we discussed, as well as the multi-scale syntactic location choice underlying those patterns, it then can be identified four types of centers in the Beijing city, which may be called active center, ordinary center, brand centers and specified center, as well as the extent to which spatial layout influences functional distribution.

Keywords: Space syntax; Syntactically efficient center; Configuration; Function; POIs

1. Introduction

Urban centers have been usually defined in terms of population density, land use, social activity, movement intensity, telecommunication, and even block size. For example, a new functional method for identifying the limits of English town centercenters, combining GIS analysis of land use and demography with reviews of informed opinion, has been established by Professor Batty and his colleagues (Batty et al., 1998). However, what they had not elaborated was that the term of 'center' applied to settlements has both functional and morphological dimensions, which are inseparable. Theoretically, this can be arguably embodied as a distinctive concentration and mixture of activities in a certain area, spatially a certain position for that area in the settlement as a whole (Hillier, 1999).

From the perspective of space, the relation between morphology and function comprises two main aspects. One is dealing with spatial or geographic distribution patterns of socio-economic activities, as well as their functional relationships and the mechanisms of generating those relations and patterns, in spite of that the socio-economic activities can be measured by land uses, demographic features, creative industries, employment rates, informational

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intensities, or even traffic data (Burgess, 1925; Gordon, Richardson & Wong, 1986; Hoyt, 1933; Harris & Ullman, 1945; Hall, 2004; Hall & Pathy, 2006; Klootsterman & Lambregts, 2001; Porter, 1998; Long & Liu, 2015; Scheffler, Schirru & Lehmann, 2012). Another is seeking to investigate physical forms and the morphological mechanism underlying functional transformation, although the morphological features can be interpreted as block sizes, building densities, spatial forms, sight lines, frontage patterns, physical connections, or even topological relations (Duany & Emily, 2002; DPZ, 1999; Duany & Emily, 2002; Freeman, 1979; Hillier, 1973; Kier, 1977; Kostof, 1992; Katz, 1994; Lynch, 1961, 1984; Parolek, Parolek, & Crawford, 2008; Marshall, 2011; Rossi, 1984; Sabidussi, 1966). The first approach more focuses on the patterning of functions usually represented by land uses or traffic movements; the second approach gives more emphases on physical form and human behavior. However, both these two perspectives have no clear boundaries. To a large extent, spatial distribution mainly explored by the first approach relates to, or is involved in, spatial making primarily investigated by the second approach. Their relationship has not been fully elaborated.

In addition, in the community of GIS, numerous methods have been implemented for integrating spatial data sets aggregated from different mapping agencies or professional geodata providers (Yuan, Zheng, & Xie, 2012; Yang & Zhang, 2015 Yang, Zhang, & Lu, 2014). For example, Scheffler (2012) integrated the Points of Interest (POI)[1] from different VGI platforms to enrich OSM POIs based on a geo filter and string matching. As the public data of POI captured from the website of Baidu[2] 2012 offers a way of exploring urban functions at finer scale. this paper, by conducting a pilot study of the city of Beijing, seeks to investigate how urban functions (e.g. business, public service, parking and etc.) represented by the POIs are distributed across the Beijing city, and how far this relate to spatial morphology of Beijing. Further, to define the urban centers by clarifying configurational rules underlying the distribution phenomenon of the functions represented by the POIs of Beijing.

2. Methodology

Based on the intention, in this paper, space syntax was used to describe the urban spatial structure, and POIs were used to define the urban functions. The central idea of space syntax is spatial configuration, defined as the complex relation between any pair of individual spaces regarding other contextual spaces. It can be treated to play a key role in bridging physical form with function, in that space is not simply an inert background of human behaviors, but an intrinsic feature of functional arrangement (Hillier & Hanson, 1984; Hillier, 1996; Hillier & Iida, 2005). Therefore, investigating the mechanism of relating spatial configuration to urban functions will help us to give a better understanding of the optimization of urban structure.

Space syntax has developed several variables to measure spatial configuration of urban network. The most widely-used variables are choice calculating how often distance-minimizing routes between every pair of spaces pass through each space up to a certain radius, and total depth measuring how close each space is to all other spaces up to a certain radius (Hillier, Penn, Hanson, Grajewski, & Xu, 1993; Yang & Hillier, 2007; Hillier, 2009; Hillier, Turner, Yang & Park, 2010). The most recent variable is a ratio of choice and total depth – called syntactic efficiency in this article-with an aim of getting rid of the effect of system size (Hillier, Yang, & Turner, 2012).

As for POIs, taking Beijing as an example, the paper is based on a multivariate data comprising of 649,359 POIs in total, which is obtained mainly via data mining techniques. As maps are a basic way to describe urban form, which mainly consists of streets and buildings, and the POIs data can describe the basic information of each building's function. Thus, the POIs data may, to a certain extent, show the distribution pattern of urban functional zones.

Based on the space syntax and POIs, this paper firstly represents the syntactic feature of the Beijing city; And then, the configurational feature of each type of function is investigated; Finally, the paper focused on the normalized choice developed to get rid of the effect of system size.

In order to represent the syntactic feature of the Beijing city, a new method was proposed. First, a regular grid with 300 m by 300 m cells, which was defined by the block scale in Beijing, was applied to cover the Beijing city, and this provided a uniform spatial reference by which the syntactic and functional values can be assigned to each cell and then those two types of values can be compared with each other. Second, the road network of the Beijing city – downloaded from the website of

[1]A point of interest, or POI, is a specific point location that someone may find useful or interesting. The term is widely used in cartography, especially in electronic variants including GIS, and GPS navigation software.

[2]Baidu, incorporated on January 18, 2000, is a Chinese web services company headquartered in the Baidu Campus in Haidian District in Beijing.