Advances in Engineering, volume 126
5th International Conference on Machinery, Materials and Computing Technology (ICMMCT 2017)

Topological Analysis of Urban Spatial Structure

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Abstract

Based on the topological structure of the network, this paper calculates and analyzes the degree of the multi-center network of urban agglomeration based on the measurement of the regional integration of each urban agglomeration, from the aspects of density, intensity, symmetry, hierarchy and network development. It should be noted that most of the existing urban network analysis methods do not adapt to the data sparse matrix (for example, some cities are too low or even zero to logarithmic calculation, so they are not suitable for the rank analysis of Hall et al. It does not apply to the information entropy formula of Limtanakool et al.). In this paper, the method of measuring the difference between the two pairs of methods to effectively avoid the shortcomings of the traditional measurement measurement methods.

Keywords topological analysis, urban spatial structure

1 Introduction

Since the application of topology analysis technology to urban research, there have been two stages of development (Zhu Dongfeng, 2007): The first stage is based on the traditional topological analysis of pure spatial representation graphics, which starts from the objective urban space, The focus of the analysis is on the physical dimension of urban spatial form. The extraction of traditional topology analysis elements depends on the urban traffic network, with the road intersection as the node, the connection between any two adjacent nodes is the arc, and the enclosed area with multiple arcs is the domain. By analyzing the connection, the adjacency, the inclusion and the topological relation within the

whole network, the inherent composition law of space topology is analyzed. The second stage is the space snyax analysis based on the dual characteristics of the subject and object of urban space. Space syntax analysis is a new kind of topological analysis technology, its internal topological elements are the same as the former, but in order to characterize the social and functional characteristics of urban space system, it emphasizes the inner features of space. In the selection of topological space elements, the method chooses the street space in the visible range of social function to establish the axial lines, which corresponds to the arcs in the traditional topology analysis elements, and selects the least number of all the longest Axis to represent the topology of the entire urban space, the intersection of the axis includes both network junctions (Junctions), including the street space conversion point (Turning Points). This method takes the syntactic axis as the core element of the analysis. By analyzing the accessibility, integration and permeability of the axis itself, the inherent logic of the topological structure is studied, and the rules of its development and variation are summed up to judge the inherent variation of the urban spatial system. In this paper, the technical route and method of urban network topology analysis is based on spatial syntax analysis under GIS platform.

2 Network topology structure

First of all, the basic unit of the definition of urban agglomeration network between the two cities for the actual number of connections to Tij said i City headquarters in j City set up branches of the number of enterprises. At the same time, in order to characterize the average number of connections between nodes in the whole network, to facilitate the horizontal comparison between urban agglomerations.

In order to describe the degree of regional integration in urban agglomeration, Hall et al. (2006) measured the regional integration characterized by cross-city corporate headquarters-branches in the self-contained indicators used in eight mega-city regional summaries in Europe. In this paper, the prefecture-level city administrative boundaries as a self-contained measurement range.

In order to facilitate the horizontal comparison of the size of urban linkages between urban agglomerations, this paper proposes the connection strength Lij based on the actual number of connections, which indicates that the number of branch offices in city j accounts for all the cross- City business contact ratio.

For the network, the symmetry of nodes and connections is also an important indicator of network characteristics. For a node, the symmetry SNi of a node can indicate whether the node is a flow-in or a flow-out; for a connection, the symmetry SLij of the connection indicates to which node the connection between the two nodes i, j is more likely. For the node i in the network, its symmetry SNi and its connection symmetry SLIj with j-point.

The sample data of this paper belongs to the sparse matrix. In the related data analysis, if the node value of a city is 0, the rank-scale measure will be invalid, and the index can not reflect the point and connection of the relation research

well. Degree of dispersion. Therefore, the method of rank order - scale analysis is proposed, which is node level property βn and connection level property βL.

In the calculation of network density, Green (2007) and Limtana-kool (2007) are all in the form of a complete network, which is suitable for a large sample of urban intercommuni- cate flows, but when using a relatively small sample In the case of headquarters-branch offices, there may not be a link between a few cities. In this case, there is no full-grid matrix for a complete network, and a sparse matrix is used instead, which means that there is no direct link between the cities. If two networks are calculated by the network density formula, both have the same degree of multi-center; but in the incomplete network, six nodes are connected in turn.

Since the multicentric network is a relatively advanced regional spatial form, the urban agglomerations that have not yet been developed can not be fully integrated into the network analysis, and the focus of this paper is not the regional spatial identification of the urban agglomeration. Therefore, the screening of the object is mainly based on the existing Literature, rather than rigidly adhere to the geographical scope of the "absolute rationality." In the urban agglomeration of Wuhan, the study object includes some provincial-level cities directly under the provincial government. In addition, in the Chengdu-Chongqing urban agglomeration, Chongqing has the provincial spatial scale, which will be In 1997, three prefecture-level prefectures (ie, Wanzhou, Qianjiang and Fuling) prior to the establishment of the municipality directly under the Central Government were set up as statistical units.

3 The sub-features of network topology

The indicators of strength are divided into the average link strength index (AL value) and the total linkage strength index (L value). From these two indicators, the Yangtze River Delta urban agglomeration shows the strongest link strength, followed by the Pearl River Delta urban agglomeration, reflecting a higher degree of urban linkages between the two urban agglomerations. While the average intensity of urban agglomeration, urban agglomeration, urban agglomeration of Chengyu and Beibu Gulf cities are relatively small, which means that the connection between cities is weak.

Symmetry includes two indexes: contact value (SL value) and node (SN value). In all urban agglomerations, the asymmetry of big city outflow (head office) and small city inflow (branch) tends to appear. In general, the headquarters and sub-branches of Liao-Zhongnan and Beibu Gulf urban agglomeration are the most symmetrical, while Wuhan, Guanzhong and Beijing-Tianjin-Hebei cities are asymmetric, and Wuhan, Xi'an and Beijing are respectively formed. Surrounding cities.

In the 12 urban areas, the urban agglomeration of the Yangtze River Delta, Pearl River Delta, Jing-Jin-Ji and Liao-Zhongnan urban agglomeration occurred in all the cities in the study of the hierarchical nature of the urban network nodes by the relative value (βn value) The βn value in the hierarchy index is less than

0.4. It is noteworthy that this kind of agglomeration does not occur in a single central city, such as the Pearl River Delta, the Beijing-Tianjin-Tianjin-Beijing-Tianjin-Tianjin Delta and the Shanghai- The findings of the eight metropolitan areas are similar: the "mobile space" brought about by regional transport facilities and advances in communications technology will redefine geospatial space and still follow the principle of clustering according to service function levels, Level of urban aggregates.

The Yangtze River Delta urban agglomeration has the lowest self-capacity in the region, the Le value of 0.66, which means that 34% of the headquarters - branches are off-site distribution, enterprise cross-city links are closer, regional integration is strong; The Le values of the urban agglomerations of Beijing, Tianjin, Hebei, Liaoning, Central and South China, and the west coast of the Straits are 0.7-0.8. The self-contained Le values of the Central Plains, Beibu Bay, Wuhan, These urban agglomeration of the headquarters - a branch of the proportion of cross-city less than 10% of the regional integration process to be improved.

The density index is the index which reflects the close degree of network nodes in the urban agglomeration. It is not difficult to find that Beijing, Tianjin, Hebei and Yangtze River Delta cities are more closely linked, while the interior of the Beibu Gulf and Wuhan urban agglomeration is the most loose. Of course, the maximum network density of 1, we can see, including the Yangtze River Delta, including the three major urban agglomerations, the spatial relationship between the topology is still imperfect (network density Δ value of only 0.20), are showing (2007) proposed that "many urban agglomerations have not formed a regional entity with the overall competitive strength under the support of urban clusters", which is in line with the judgment of Zhao Manshi et al.

4 The type characteristics of space network

The network density, the link intensity and the network development degree of the urban agglomeration are all higher than the average of the 12 urban agglomerations, and the self-contained index is obviously lower than the average. This shows that the cities in the Yangtze River Delta are closely connected , Showing a clear integration of the network, and show the core of Shanghai, Suzhou, Hangzhou, Ningbo, Nanjing, Wuxi multi-center hierarchical network structure. It is worth mentioning that, although the balance of the nodes in the Yangtze River Delta is lower than the average level (βin, βout, βn values relative to other urban agglomerations reflect the negative cluster core exists), but the network level (BL) index is more prominent in 12 urban agglomerations, indicating that despite the existence of strong strong nuclear city of Shanghai in the Yangtze River Delta, the balance of network connection is the best.

The intensity of network connection and the degree of network development are obviously higher than the average level. Meanwhile, the cross-city enterprises are clustered in the urban agglomeration. Similar to the Yangtze River Delta, the level of this group of nodes is also more prominent indicators (βin, βout, βn value

of the negative also reflects the concentration of urban agglomerations exist), headquarters are more concentrated in Shenzhen and Beijing , And the formation of Shenzhen - Guangzhou, Beijing - Tianjin division of the dual-core division of labor pattern. Combined with the characteristics of group I cities, Shanghai, Beijing and Shenzhen are the headquarters of the three major urban agglomerations, and they are the top cities in the Chinese urban system participating in the global division of value chain. This phenomenon confirms to a certain extent Tang et al. (2010), Zhao et al. (2014a).

The level of AT is less than 0.74 times standard deviation of the mean value, and the linkage between non-core cities is not enough. The network efficiency, density and network development are lower than the average. At the same time, the symmetry index is more prominent, the reason is the lack of capacity to absorb the core cities, the performance of the outflow of enterprises in cities and inflow of considerable business. With the network connection and self-capacitive distribution, the Ⅳ-type urban agglomeration can be subdivided into 2 subtypes: one-way radiation type of dual-core cities (such as Chengdu-Chongqing and Liao-Zhongnan urban agglomerations), single-center and self-sufficient One-way radiation type (such as Wuhan, Changsha, Zhuzhou, Guanzhong city group). In addition, the urban agglomeration of Chengdu, Chongqing, Wuhan, Changsha, Zhengzhou and other cities in Chengdu, Chongqing, Wuhan, Changsha, Zhuzhou and Xiangtan are not lacking in the urban agglomeration. Center city, but in the dimension of the enterprise association network, it is a low-level multi-center decentralized spatial layout. The characteristics of the central city are not strong, which restricts the entry of cross-city enterprises.

5. Conclusion

Based on the existing research, this paper extends the measurement tools of the multi-center network of urban agglomeration, and the systematic network analysis method provides the foundation for the following related research. An empirical study on 12 urban agglomerations in China shows that the topological structure of China's urban agglomeration network is still imperfect, including the Yangtze River Delta, Pearl River Delta, and Beijing-Tianjin-Hebei three typical urban agglomerations. Sparse matrix and spatial combination are all tree-like structures. The hierarchical differences of headquarters location (out) are higher than the hierarchical differences of location (degree) of branches, indicating the asymmetry of "flow" within urban agglomeration.

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