Research on Spatial Pattern of Cultural and Creative Industries in Shanghai Based on POI Data

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Abstract: The combination of big data and cultural and creative industry provides reference for the smart layout of urban planning. Based on nuclear density estimation, location entropy analysis and Ripley's K function analysis, this paper uses ArcGIS10.2 to study the spatial pattern of cultural and creative industries in Shanghai based on the point of interest (POI) data of various cultural and creative industries in Shanghai. The results show that the spatial distribution of Shanghai's cultural and creative industries is characterized by agglomeration, presenting a "multi-core" spatial structure, and the industry space of various cultural and creative industries is distributed as "center - periphery", showing different distribution patterns. The results also show that the multi-scale spatial clustering of all kinds of cultural and creative industries shows different manifestations. They all converge on a larger spatial scale and have a larger range of spatial choices. Then, there are obvious regional differences in the professional functions of various cultural and creative industries. The mature blocks show multi-functional elements and multi-advantageous industries are featured by agglomeration. The functions of the developing blocks are relatively single.

1. Introduction
In recent years, with the rapid development of Internet technology, we are in the era of big data, and the various forms and patterns presented by data are the reflection of the real world. Big data holds the promise of massive amounts of data, including rich, detailed, interconnected, timely and low-cost data, giving us a deeper understanding of our society and the world we live in, and a more rational plan for our cities[1-3]. Point of interest (POI) data as a point of interest data, it is our common people used in the work life of geographical entities, such as hotels, schools, shopping malls, tourist attractions, compared with the traditional statistics with precise location information, the data of spatial attribute determines the possibility of the visualization on the map, through the further analysis and research, of point of interest (POI) data can more directly reflects the city all kinds of social and economic activities[4-6]. Since the beginning of the 21st century, the global economic structure has undergone fundamental changes. Cultural and creative industries have become an important economic driver. Knowledge-based industries play an important role in urban economy, and they also play a prestigious role in cities and regions, becoming a new driving force for national economic development[7-10].

Therefore, based on point of interest (POI) data and ArcGIS software, this paper studies the cultural and creative industry in Shanghai, overcomes the disadvantages of traditional statistical data, utilizes
the convenience of the era of big data to expand a new perspective in the study of the urban cultural and creative industry, and makes a reasonable planning of the cultural and creative industry in Shanghai based on the research results.

2. Research methods and data sources

2.1. Overview of the research area and data sources
As shown in Figure 1, Shanghai is taken as the research area, and the open source map is used to obtain the administrative district map, major traffic network, water system and green space. The point of interest (POI) data used in the study are mainly obtained from the open platforms of Baidu Map and Tencent Map, and the acquisition date is December 2019.

Fig. 1 The distribution map of point of interest (POI) data of cultural and creative industry in Shanghai

According to Shanghai Cultural and Creative Industries Classification Catalogue (2013 edition), Table 1 shows that there are 28 sub-class in 11 industries. After data correction, deduplication, and screening, 70530 valid point of interest (POI) data were finally obtained. According to the geographic location information provided by point of interest (POI) data, the real reliability of the data was confirmed by sampling survey of part of the data selected through field interview.

Tab. 1 The classification of cultural and creative industries in Shanghai

| Industry                  | Sub-class                                                                 | counting (pcs) | Proportion (%) |
|---------------------------|----------------------------------------------------------------------------|----------------|----------------|
| Media industry            | press and publication services, radio, television and film services        | 1781           | 2.53           |
| Art industry              | artistic production, performance and performance services, cultural protection and cultural facilities services, mass cultural services, cultural and artistic training services, cultural and artistic planning and agency services | 11838          | 16.78          |
| Industrial design industry| industrial product design, scientific and technical design                 | 1414           | 2.00           |
| Architectural design industry | planning and management, engineering survey and design and management services, greening management, building decoration industry | 5041           | 7.15           |
| Fashion creative industry | fashion services, fashion supplies, fashion beauty hair and supplies       | 2412           | 3.42           |
2.2. Research Methods

2.2.1. Kernel density estimation
Kernel density estimation is one of the commonly used methods in point element analysis, which is used to calculate the density of elements in the surrounding neighborhood. The result reflects the feature that the closer the distance is, the higher the correlation is.

The calculation formula of kernel density estimation can be expressed as:

\[
f(s) = \sum_{i=1}^{n} \frac{1}{h} k\left(\frac{s - c_i}{h}\right)
\]

\(f(s)\) represents the kernel density estimation function at space position \(s\); \(h\) is the threshold of distance attenuation; \(n\) is the element whose distance from \(s\) in space is less than or equal to \(h\); The \(k\) function represents the space weight function [11,12].

2.2.2. Location entropy analysis
Location entropy is also called specialization rate. The so-called entropy is the ratio of ratios, which is used to measure the spatial distribution of elements in a certain region [13-16].

The calculation formula of location entropy can be expressed as:

\[Q = e_{K-A}/e_{K}\]

\(Q\) is location entropy; \(e_{K-A}\) is the ratio of the number of category \(A\) industries in region \(K\) to the number of category \(A\) industry in the whole region; \(e_{K}\) is the ratio between the total number of industries in region \(K\) and the total number of industries in the whole region. The larger the value of \(Q\), the higher the degree of specialization.

2.2.3. Ripley’s K function
Ripley’s K function is an analysis method of point data pattern, which conducts clustering degree analysis of point data sets at different distances. It is used to reflect the degree of spatial aggregation or spatial diffusion.

The calculation formula of Ripley’s K function can be expressed as:

\[K(d) = A \sum_{i} \sum_{j} \frac{w_{ij}(d)}{n^2}\]

\(n\) is the number of industries; \(d\) is the distance scale; \(w_{ij}(d)\) is the distance between point \(i\) and point \(j\) within region \(d\); \(A\) is the area of the study area. Besag proposed to use \(L(d)\) instead of \(K(d)\) as the square root transformation to keep the variance stable.

The formula can be expressed as:

\[L(d) = \sqrt{K(d)}\]

\(L(d)\) is the linearized version of \(K(d)\) to make the variance more stable.
\[ L(d) = \sqrt{\frac{K(d)}{\pi}} - d \] (4)

The relationship between \( L(d) \) and \( d \) can test the spatial distribution pattern of cultural and creative industries within the range of \( d \). So under the random hypothesis, the expected value of \( L(d) \) is equal to 0: \( L(d) > 0 \) indicates that industries are clustered and distributed; \( L(d) < 0 \) indicates that industries are scattered and distributed. The maximum difference of the confidence interval represents the agglomeration intensity [17,18].

3. Spatial pattern analysis of Shanghai cultural and creative industry

3.1. Spatial distribution characteristics of cultural and creative industries

The results show that the nearest-neighbor ratio is 0.171 through the average nearest-neighbor analysis, which passes the test at the significance level of 0.01, indicating that the spatial distribution has obvious clustering characteristics. As shown in Figure 2:

- The cultural and creative industry in Shanghai has formed several gathering centers, with the central city as the main gathering center, and a small gathering center will be formed in the surrounding districts. The distribution density gradually decreases from the central city to the surrounding districts, forming a spatial structure of "one main multi-core".
- Wu jiao chang, Shanghai the Bund, Lu jia zui, Shanghai Railway and Zi ka wei are interconnected into clusters, forming the largest cluster center. Around this cluster center, many small clusters are scattered and distributed in the form of "constellation".

Fig. 2  The spatial density distribution diagram of cultural and creative industry in Shanghai

3.2. Spatial clustering characteristics of cultural and creative industries

The results show that according to spatial autocorrelation analysis, the Moran index value is 0.065. The significance level test of 0.01 indicates that its spatial distribution has obvious positive spatial correlation and agglomeration characteristics. As shown in Figure 3:

- Based on the units divided at township and street level, there are obvious cold and hot spots in the distribution of cultural and creative industries.
- Hot spots are mainly in the area of Wu jiao chang, Shanghai the Bund, Lu jia zui, Shanghai Railway and Zi ka wei. There are a large number of cultural and creative industries in this region, which are clustered and distributed, and have an obvious effect on their neighboring regions.
- The cold spots are mainly distributed in the urban fringe areas, and the cultural and creative industries are distributed in the regions with less quantity, indicating that the above regions have little influence on their neighboring regions.

![Fig. 3](image)

**Fig. 3** The spatial hot spots of cultural and creative industry in Shanghai

4. **Industry distribution of cultural and creative industry space in Shanghai**

4.1. **Spatial differentiation characteristics of "center – periphery**

The industrial space of Shanghai’s cultural and creative industries is distributed as "center - periphery". The results in Figure 4 show that:

- Various types of cultural and creative industries in Shanghai are mainly distributed within a 10 km circle of Huangpu District, and from the center to the periphery, various types of cultural and creative industries are relatively reduced and show a "wave" decline.
- Within 0 to 5 km, media industry accounts for the largest proportion of the distribution, and the distribution in each industry is concentrated, with a certain difference in the number of distribution.
- Within the range of 5 to 10 km, the distribution amount of network information industry takes up the largest proportion, and the distribution amount of media industry decreases sharply compared with that within the range of 0 to 5 km.
- Within the range of 10 to 20 km, the proportion of fashion creative industry, software and computer service industry in the distribution decreases slightly.
- Within the range of 20 to 30 km, the proportion of each industry distribution appeared a small peak, and the number of distribution increased.
- Within the range of 30 to 40 km, the number of industries decreased.
- Within the range of 40 to 60 km, except for two small peaks, the distribution of leisure and entertainment service industry shows a downward trend.
Fig. 4  The distribution of the number of industries in the cultural and creative industry in Shanghai

As shown in Figure 5, from the perspective of the density distribution of various industries, there are mainly the following characteristics:

- There are significant density distribution centers in all industries. The scale of the center of art industry and leisure and entertainment service industry is relatively large, and there are small density centers in several circles.

- Art industry and leisure and entertainment service industry belong to the distribution pattern of "great dispersion and great agglomeration".

- Industrial design industry, fashion and creative industry, network information industry, software and computer service industry, advertising and exhibition service industry, and cultural and creative related industries show the distribution pattern of "large dispersion and small aggregation". On the other hand, the media industry and consulting service industry show a distribution pattern of "small dispersion and large agglomeration".

- In the core circle, affected by the high-density population distribution and location advantage in the urban center, all industries have a concentrated center with high density.

Fig. 5  The density distribution diagram of cultural and creative industries in Shanghai
4.2. Multi-scale spatial clustering characteristics

As shown in Figure 6, the analysis results of Ripley's K function show that under 99% confidence, the L(D) values of various cultural and creative industries are far greater than the upper limit of the confidence interval, indicating that the space of various industries presents a characteristic distribution of agglomeration:

- The change characteristics of L(d) curve are similar, which first increases rapidly and then flattens out. The agglomeration degree of various industries is slightly different but not obvious. It gather on a large spatial scale, indicating that it have a large range of spatial choices.

- The art industry and leisure and entertainment service industry showed aggregation in a large range, with the peak value at 60 km. The peak values of media industry, fashion and creative industry, architectural design industry, advertising and exhibition service industry, and cultural and creative industries were 55 km, 57 km, 56 km, 57 km and 58 km respectively. The maximum clustering radius of industrial design industry and consulting service industry is relatively small, which is 50 km and 52 km respectively. The peak distance of network information industry, software industry and computer service industry is the smallest, which is 43 km and 46 km respectively, indicating a small range of space scale.

Fig. 6  The Ripley's K function analysis results of various industries of cultural and creative industries in Shanghai

4.3. Features of professional functional areas

As shown in Figure 7, the location entropy measurement of each industry at the township and street level is carried out, and the calculation results show that:

- Various kinds of cultural and creative industries have formed specialized functional agglomeration areas with obvious differences. Mature streets in the central urban area show the characteristics of complex functions, forming relatively few specialized functional areas, and towns
and streets in the periphery of the city are more likely to form specialized advantageous blocks due to the small number of industries.

- Industrial design industry, fashion and creative industry, advertising and exhibition service industry form a number of industrial function clusters, while the number of specialized functional zones in other industries is relatively small.

- The number of industry levels in the downtown area of Shanghai is relatively high, compared with that in the peripheral areas of the city. The number of industry levels of industries are relatively low, which is consistent with the spatial distribution characteristics of "center-periphery" of industries.

- Art industry, industrial design, architecture design industry, creative fashion industry, advertising and exhibition services in the peripheral villages and towns and cities of Shanghai street area form the industry advantage, the media, network information, software and computer services, consulting services, entertainment services, cultural creative industry in the city center of Shanghai city's streets form a relative advantage block.

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**5. Conclusion**

Based on point of interest (POI) data, this paper analyzes the spatial pattern of cultural and creative industries in Shanghai, and discusses the spatial distribution and clustering characteristics of various cultural and creative industries. The following conclusions are drawn:
- The spatial distribution of Shanghai’s cultural and creative industries is characterized by agglomeration and multi-center distribution, forming a spatial structure of "one main multi-core". On the whole, it presents a "constellation" distribution pattern with the central city of Shanghai as the center and several small agglomeration centers.

- The industry space of various cultural and creative industries is distributed as "center - periphery". According to the characteristics of the circle, various types of cultural and creative industries in Shanghai are mainly distributed in the 10 km circle of Huangpu district. Under the influence of high-density population distribution and location advantage in urban centers, all industries have a concentrated center with high density, and different types of cultural and creative industries show different distribution patterns.

- The multi-scale spatial clustering performance of various cultural and creative industries is different, and they all converge on a larger spatial scale with a larger range of spatial choices. There are obvious regional differences in the professional functions of various cultural and creative industries. There are great differences in the degree of industry specialization in towns and streets, and the well-developed towns and streets have the characteristics of multi-advantageous industry agglomeration. In the rapidly developing towns and streets, the characteristics of a single functional block appear; The development speed is slower, the low level development township and each street specialization degree is relatively low.

Research on Shanghai’s cultural and creative industry through point of interest (POI) data is conducive to improving the scientific nature of urban planning by relevant government departments, but there are still some deficiencies: As point of interest (POI) data a only have geographical attributes, other attribute information is insufficient, such as creation time, scale, and volume difference between "points" and "points", etc., which need to be obtained by other means, making it difficult to analyze and discuss the evolution and formation mechanism of its spatial pattern. In the future, big data and traditional data should be combined to make a more in-depth discussion on the cultural and creative industry in Shanghai.

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