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Analysis of the Distribution Characteristics and Influencing Factors of Advertising Billboards in Wuhan

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01 Background and Significance

1.Background and Significance

Billboard Placement → Surrounding Environment, Traffic Conditions, Target Audience, …… → Improved Advertising Impact and Business Value

The optimization of billboard placement is greatly facilitated by an understanding of the current spatial distribution of existing billboards.

Traditional Methods

Traditional methods relying on subjective memory and experience are prone to distortion over time, making them less reliable

Spatial Analysis

The spatial analysis method can yield more specific and comprehensive analysis results

02 Methods

2.Methods

Study Area and Data

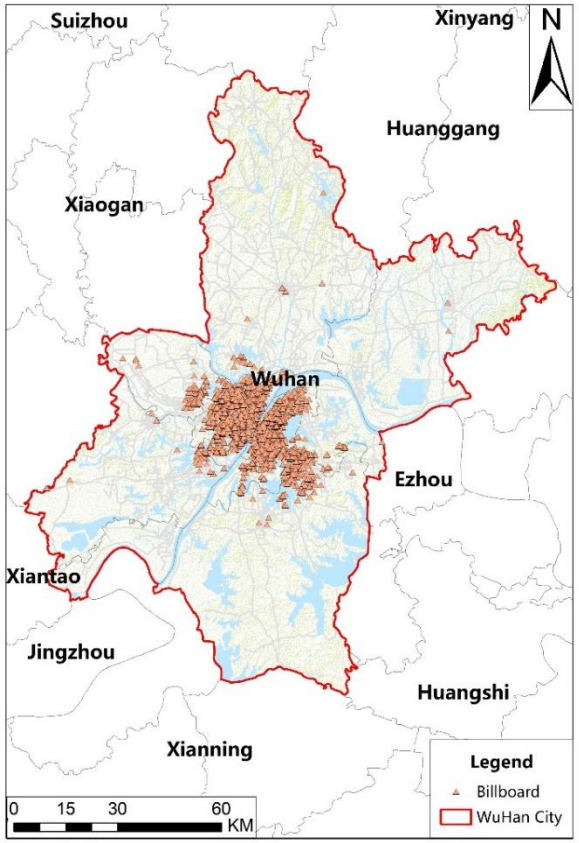

Figure 2: Spatial Distribution of Billboards in Wuhan City

Table 1. Classification of impact factors

Data Types	Influencing factors
Building Dataset	Geographic
Roadway Dataset	Geographic
Bicycle Sharing Service Points Dataset	Geographic
Charging Points Dataset	Geographic
Population Dataset	Anthropic
Billboard Spot Dataset	Audience
Public Transportation Route Dataset	Mobility

The comprehensive use of these data to select the location can improve the exposure rate of billboards so that the advertising effect can be as optimal as possible.

So, studying these influencing factors is crucial.

2.Methods

Workflow

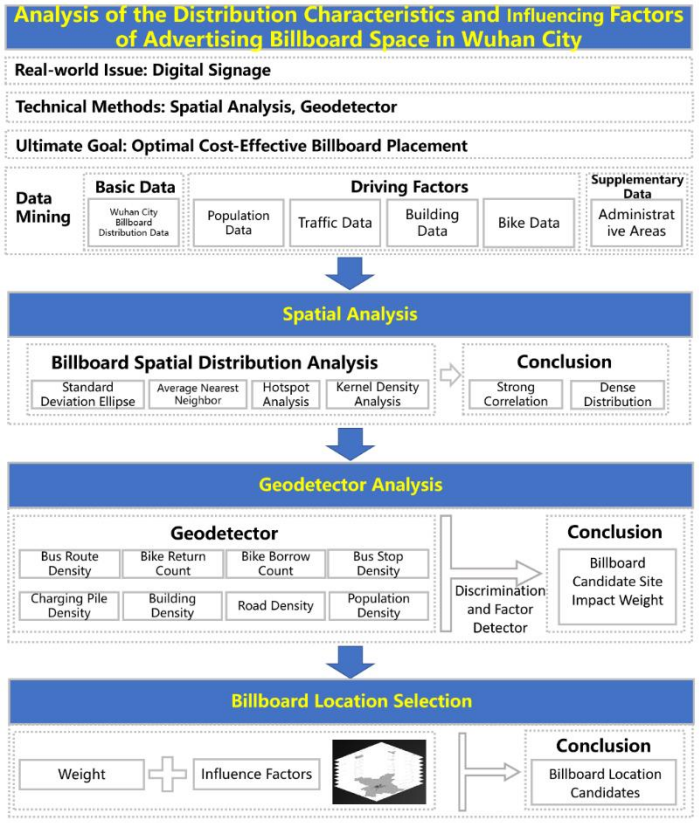

Figure 1: The Research Framework of This Article

- **Average Nearest Neighbor Method and Kernel Density Analysis** : investigate whether billboards exhibit clustered distribution and the extent of clustering
- **Standard Deviation Ellipse Analysis** : examine the directional distribution characteristics of billboards
- **Hotspot and Coldspot Analysis** : identify areas with high and low concentrations of billboards
- **Geodetector Analysis** : explore the factors influencing billboard distribution

2.Methods

Geodetector

In this study, the Geodetector model is used to quantify the individual and interactive effects of various influencing factors on the spatial distribution of billboards in Wuhan City. It aims to reveal the primary influencing factors of billboard spatial distribution in Wuhan and the ways in which these factors interact.

Table 2. Independent Variable Data Summary

Variable Name	Code Name
Population Density	X1
Bus Stop Density	X2
Bus Route Density	X3
Road Density	X4
Charging Station Density	X5
Building Density	X6
Number of Shared Bicycle Rentals per Kilometer Grid	X7
Number of Shared Bicycle Returns per Kilometer Grid	X8

$$q = 1 - \frac{\sum_{h=1}^{P} N_h \sigma_h^2}{N\sigma^2}$$

The q-value falls within the range of [0,1], indicating the magnitude of the impact of this influencing factor on the spatial distribution of billboards in Wuhan City. A larger value indicates a greater impact.

03 Results

3.Results

Spatial Analysis

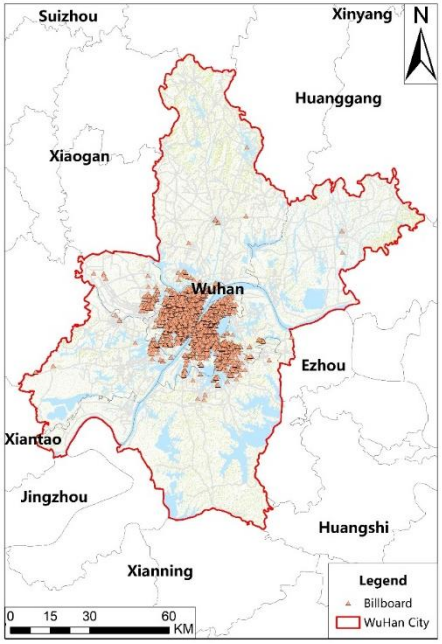

Figure 2: Spatial Distribution of Billboards in Wuhan City

Standard Deviational Ellipse

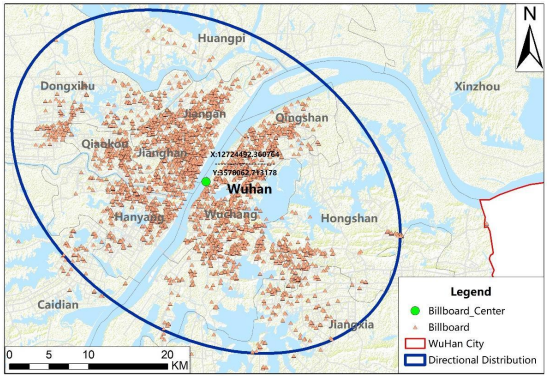

Figure 3: Directional Distribution Analysis (Standard Error Ellipses)

Table 3. Error Ellipse Parameters

CenterX	CenterY	XStdDist
12724492.3607	3578062.71313	26696.66039
YStdDist	Rotation	
19102.508687	123.809625	

Average Nearest Neighbor

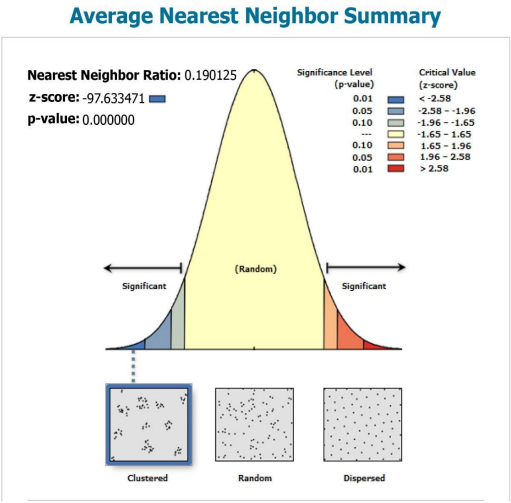

Figure 4: The report on the average nearest neighbor results

3.Results

Hot Spot Analysis and Kernel Density Analysis

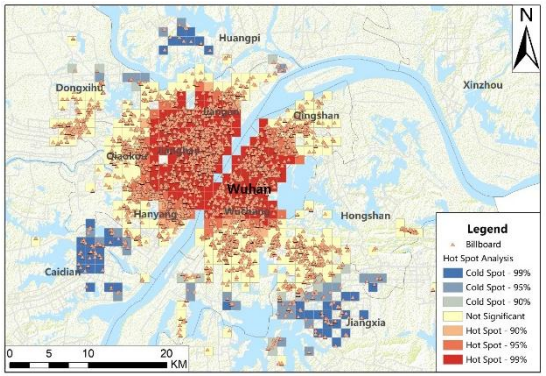

Figure 5: Hotspot analysis

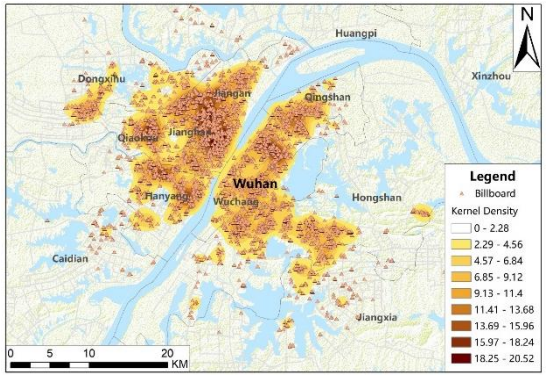

Figure 6: Kernel Density Analysis Chart

The hot spot analysis results show that the distribution of billboards in Wuhan presents an obvious hot spot aggregation pattern. In contrast, the cold spots are distributed in a ring pattern, mainly in the farther outer regions. The results of the kernel density analysis show a unique multi-modal pattern, indicating polarization.

3.Results

Geodetector

Table 4. Factor Detector Results

Variable	q-Value	Significance
X1	0.4329	yes
X2	0.5757	yes
X3	0.6245	yes
X4	0.4634	yes
X5	0.5618	yes
X6	0.5000	yes
X7	0.6128	yes
X8	0.6142	yes

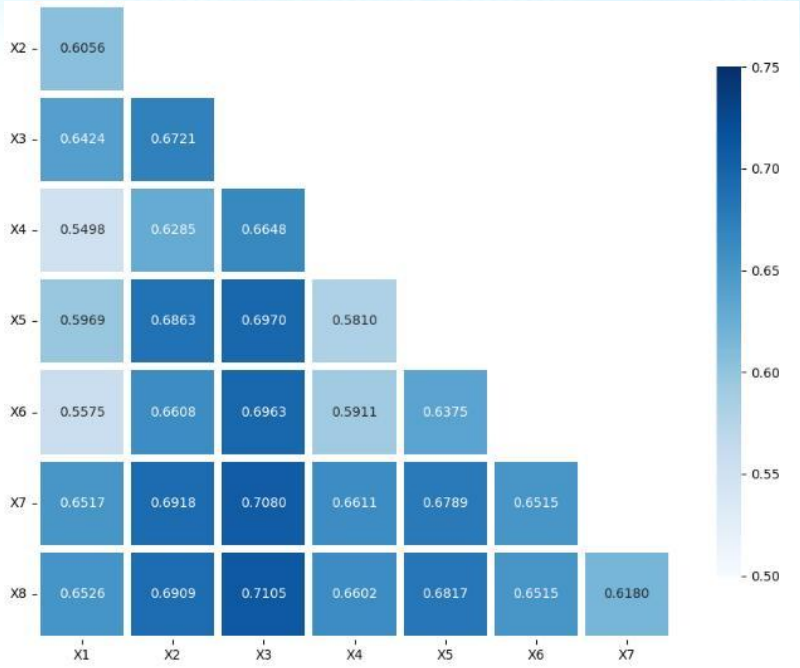

Figure 7: Interaction Detector Results

Bus Route Density (X3) > Number of Shared Bicycle Returns per Kilometer Grid (X8) > Number of Shared Bicycle Rentals per Kilometer Grid (X7) > Bus Stop Density (X2) > Charging Station Density (X5) > Building Density (X6) > Road Density (X4) > Population Density (X1)

- The spatial differentiation pattern of billboards in Wuhan City is not controlled by a single factor but is the result of the combined action of multiple factors.
- Largest : Bus Route Density (X3) and Charging Station Density (X5)
- Smallest : Road Density (X4) and Population Density (X1)

04 Conclusion

4.Conclusion

- By utilizing various spatial analysis methods, we explore the influence of different factors on the spatial distribution of billboards.
- From the aforementioned analysis, it is evident that the optimal placement of billboards should be closely associated with public transportation infrastructure and other relevant structures.
- The methods and tools employed in this paper can serve as a reference for spatial distribution analysis in other cities.
- This study has certain limitations, such as the failure to consider the impact of competition between different types of billboards on their placement. In the future, we will continue to improve and expand spatial analysis methods, focusing on delving deeper into the spatial distribution patterns of billboards in Wuhan.
- This will provide more valuable insights for optimizing the placement of billboards.

Thank you for your listening!