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Application of Gaode OPEN API in the Fire-Fighting Facility Planning Evaluation

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1 ABSTRACT

In recent years, big data has been extensively applied in urban planning and design area. However, its wider application is constrained by the data acquisition approach. Accordingly, many efforts have been made to accurately find and solve urban problems by mining legal open source internet data, which gradually becomes a hot topic among urban researchers. In this context, this study applies the Gaode OPEN API in the urban real-time traffic circle construction and fire-fighting facility planning evaluation taking Nanjing as example. First, a batch processing model is established on the basis of Gaode OPEN API, including automatic acquisition of real-time traffic data in the study area and extraction of average vehicle speed of all the roads during specified time period. It found that speed involves division of the whole Nanjing City into several characteristic zones. Then, a case study is conducted to construct the urban real-time traffic circle through python language and Arcgis software based on existing fire-fighting facilities. In the end, through a subsequent evaluation, it is found that the existing fire-fighting facility planning has a stark regional difference between urban central area and suburban area, which shows a low coverage rate of 22% and 39% for respond time of 6min and 8min respectively. This study provides an integrated approach for acquisition and processing of Gaode data, mining of its space-time features, and application in the planning evaluation practice. This approach demonstrates the advantages of streaming features and distributed processing of big data, effectively utilizes the real-time characteristics of big data in the emergency facility planning, and is expected to broaden ideas for data acquisition.

Keywords: Gaode OPEN API, fire-fighting facility planning evalation, Nanjing, China, real-time traffic circle

2 BACKGROUND

In recent years, the growing number of public emergency causes great losses to society. Especially for emergency events like fire disaster, require rescue workers get to the scene with least delay possible and take action immediately. Low treatment efficiency could turn general emergencies into serious public incidents or major catastrophic accidents. Additionally, the growth of urban traffic volume and vehicle out-driving ratio which results from the improvement of urbanization process and socioeconomic status, brings serious traffic congestion. Consequently, the commuting time of fire fighting trucks gets delayed, so that the emergency respond time is affected. Traditional emergency facility siting is static and determined, which is calculated on the basis of existing road network and specified vehicle speed. However, the traditional analogy method is considered to be unconvincing and imprecise since its neglects on the influence of the actual traffic capacity on commuting time. Therefore, it is believed that real-time big data could help making more accurate evaluation of fire station service quality and efficiency, which contributes to sophisticated emergency facility siting: making sure the emergency service could arrive at designated position within required time so as to ensure the safety of life, property and urban operation. Based on the above, this article tries to analyze the real-time traffic data of Gaode API, establish real-time traffic circle by Python and Arcgis. Taking fire station in Nanjing as example, following the logic of “intelligent extraction of real-time traffic data – establishment of real-time traffic circle – evaluation of fire station planning”, this article explores the flow characteristic of big data and the application of distributed processing in urban planning practice, in order to provide reference and basis for similar study and project. Moreover, this essay will help EU countries where the inspire regulations are responsible for obligatory generation of huge amounts of free open governmental datasets.

3 INTELLIGENT EXTRACTION AND PROCESSING OF TRAFFIC BIG DATA BASED ON OPEN API

3.1 Introduction of Gaode OPEN API

Big data has became growing important in urban study area during the past few years. Due to the restriction of data acquisition, the research value of OPEN API (application programmers interface, the interface code that makes internet connection between two websites or databases) on big data acquisition, technology broaden and urban ecosystem receives increasing attention. Gaode open platform is the leading LBS service provider in China, which possesses advanced data fusion technique and massive data handling capacity. In the meantime, it also provides development kits both on the web terminal and mobile terminal to the public. Developers achieve functions including map display, map labeling, position search through recall development kits or API interface. API open the gate of open resource data for data demanders in internet and big data ear. The existing web service includes geocoding & inverse geocoding, route planning, POI search, input tip, batch request interface, administrative region enquiry, static map, IP positioning, coordinate transformation, weather query, road extraction, traffic situation, etc. According to the ten billion level daily average location requests and related actions, it is convincing that the data acquired from Gaode open platform could reflect the population flow, regional heat, behavioral preference and traffic characteristic in real world effectively.

Traffic situation is one category of the HTTP interface, which responds traffic inquiry according to the input content. Massive original data with spatial position and time scale could be achieved from Gaode open platform through data acquisition from a database which is established on floating car data and travel data of over seven hundred million users, and covers 40 cities including Nanjing. Before using, it is essential to apply for a Gaode API account and key. Then, traffic situation data can be achieved for designated rectangle, roundness or roadway (it is confirmed by test that the maximum side length of rectangle is 0.6 longitude/latitude degree). Besides, there is daily restriction for total volume and utilization frequency. There are detailed technical specifications for data acquisition with spatial information through Open API wed interface both in China and other country. Some studies have introduced APIs of online map developers such as Google Map or Baidu Map to estimate travel time[1-3], recently Zhou et al. [4] and Xi et al. [5] use online map API to obtain data on the dynamic population distribution and variation in transit time due to different transportation modes. In this way, researchers can make use of the dynamically updated transport network data and the routing rules maintained by map developers to obtain a reliable estimation of travel time. In the previous prediction of travel distance, Euclidean distance is often used to represent the spatial connection between geographical entities[6-7], and some researches also calculate the transportation cost by dividing the grid[8-9]. The road network distance[10-11] can be used to build a complete network, but it often takes a lot of time to carry out topology analysis, integrity check and manual correction. Besides, the existing handling method are tedious in general. Moreover, there is few detailed description for acquiring traffic situation of designated area by merging units and automatic data collection in different time scale.

This study proposes to extract real-time traffic data using a Gaode Open API-based streaming processing method(Fig.1). Given the rectangular-shaped data extraction scope, this study first divides the urban area into several rectangular units according to their longitudes and latitudes, and then extracts the original traffic information of each unit through the traffic data acquisition program, which is subsequently archived in the database. After that, units are merged to form the actual regional road network, followed by pre-processing of the original data and linking them with the effective road condition information. Meanwhile, timers are set for multiple periods of multiple consecutive days to automatically acquire the road condition data, which are then intelligently processed in batch. In this case, urban traffic data within a specified time range are successfully acquired, and the processed information table can be automatically matched to the urban road network for related processing and time-space analysis. The presented approach fully considers flow characteristics of the Gaode data, which is a branch of open source big data, and achieves higher efficiency than the currently used more complicated manual traffic data crawling method.

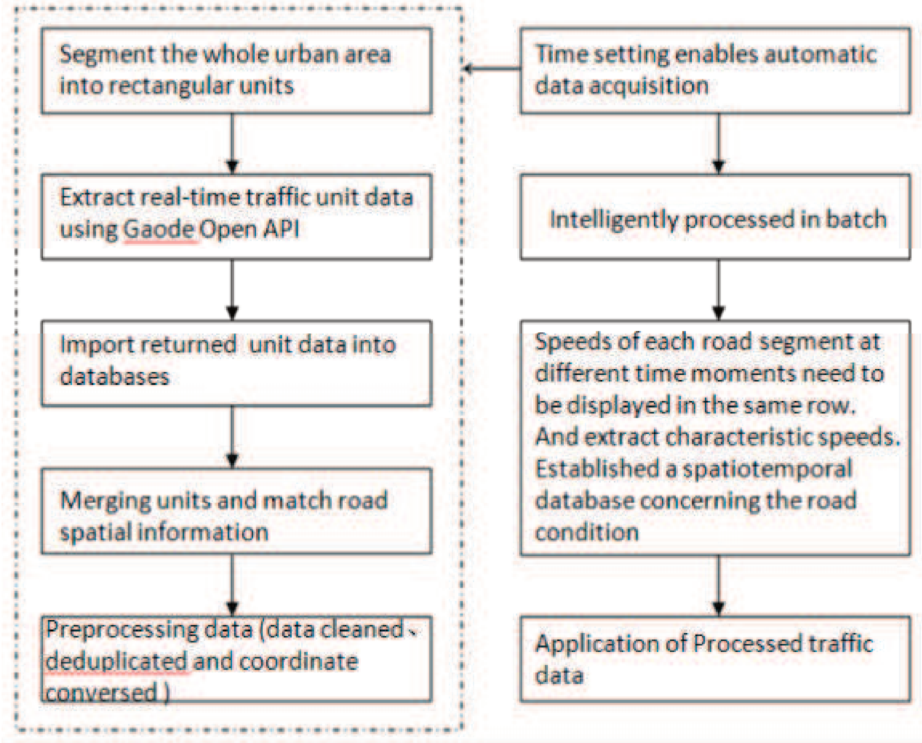

Fig. 1: Gaode Open API-based automatic processing method.

3.2 Intelligent traffic data extraction

3.2.1 Request diameter settings

Both data acquisition and processing are implemented using the Python language. The obtained data includes the real-time traffic speed and congestion status of the Nanjing City provided by Gaode Map, with a time range from May 28, 2019 to June 10, 2019 and a data acquisition spacing of 1 hour. Request parameters for traffic situation data acquisition in the rectangular units are input through the web service traffic situation API, including user permission identification, query road level, return data format, callback function, longitude and latitude coordinate pairs of top-left and top-right vertices of the rectangle unit to be queried (Table 1). The maximum distance in the rectangular unit to be queried should not exceed 10 km. Accordingly, the whole urban area of the Nanjing City is segmented into 230 rectangular units (0.06°by 0.06° for each unit). Before this, the latitude and longitude coordinates of top-left and top-right vertices of each unit need to be converted to Gaode coordinates from WGS84 counterparts(Fig.3 and Fig.4).

3.2.2 Data format analysis

Returned data objects include the result status value, the request status, the request status code, and the traffic situation information. Specifically, the traffic situation information includes road condition overview, road condition evaluation, and road information, and the road information includes road name, road condition, direction description, driving direction, speed, sign code for a certain road segment, and road coordinate set. Critical information such as road name, road segment code, road status, road speed and road point coordinate set is obtained and archived, accompanied by recording of the real-time acquisition time. Each rectangular unit contains several roads, and a certain road with its specific name consists of several road segments. In order to avoid repeated acquisition of road segments across units, this study assigns global codes (Row_ID) to road segments in a certain order during the data archiving. In this case, the overall road traffic situation is stored in the road condition information table, while the spatial point coordinate set is stored in the spatial point table. Data in both tables are linked to the corresponding Row_ID. In order to facilitate recognition of Chinese road names, input parameters and output data encoding of the interface are unified as UTF-8. The sracpying function is defined to loop through coordinates of top-left and top-right vertices of each rectangular unit, accompanied by data acquisition in order.

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Parameter	Meaning	The rule description
key	user permission identification	users applies for the Web service API type KEY on the Gaode Map website
level	road level	specify the meaning of the following values for the road class: 1：highway 2：expressway 3：auxiliary-road of the expressway 4：main road 5：other road 6：anonymous road
output	format type of returned data	optional type：JSON,XML
callback	callback function	The callback value is the name of the user-defined function, which is valid only if output=JSON
rectangle	a rectangular area is queried	top-left and top-right vertices of each rectangular unit; The diagonal of the rectangle shall not exceed 10 km

Table 1: Request parameters through the web service traffic situation API

Name		Meaning	The rule description
Rdstatus		result status value	0：request failed；1：request suceed
trafficinfo	Rdname	road name	
	RdOrgin	original of the road segment's name	
	RdDest	destination of the road segment's name	
	Rdstatus	road condition	0：unknown 1：clear 2：slowdown 3：congest
	Rdspeed	speed	
	RdPx;RdPy	road coordinate set	format：x1,y1;x2,y2

Table 2: Return parameters through the web service traffic situation API

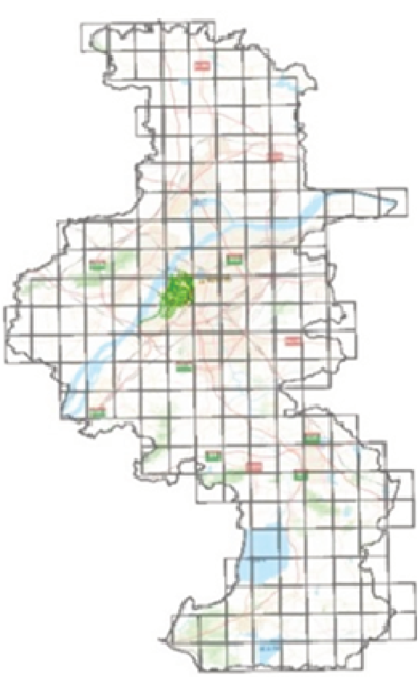


Fig. 3: Schematic diagram of the segmentation unit segmented units(left); Fig.4.Schematic diagram of the independent units(right)

3.2.3 Data cleaning and deduplication

In order to enhance accuracy and clarity of traffic information, data in the tables are processed using the Pandas library of Python, including merging of all units at the same time, deduplication of overlapping road segments after merging, and conversion of the coordinate system. All the merging processes are implemented while calling the sracpying function. After data of all units are obtained, the drop_duplicates function is called to delete the duplicate objects through filtering road names and road segment codes.

3.2.4 Batch data spatialization

Cleaned traffic data are implemented with coordinate conversion to the same coordinate system as the digital map. In this way, the information that is simply stored in the data table is spatialized. During data processing, the primary key pairs for regional traffic Shapefile files at different time moments, consisting of globally coded Row_ID, road name, and road segment code, are converted into hash values. In other words, the primary key pairs are converted into non-Chinese-character primary keys. These hash values are used as associated values to combine road condition characteristics of the same road at different time moments, resulting in spatial polyline objects with attributes such as hash values, road congestionstates, transit speeds, and time of data acquisition. Each Row_ID corresponds to a road polygon object and several latitude and longitude point pairs. In this context, the roads can have data concerning both spatial attributes and road conditions.

3.2.5 Timer setting

Above procedures are shown in the left part of Figure X. In order to obtain real-time traffic data for multiple days in Nanjing City, these procedures need to be repeated multiple times. Using automated means to ensure continuous operation can reduce a lot of manpower and improve data acquisition accuracy. Accordingly, a main_funtion function is defined to comprehensively package abovementioned procedures including user request sending, data acquisition, and data processing. Meanwhile, a timer is set using the threading library of Python. Specifically, the function is automatically run at intervals of 1 hour (3600 seconds) for 14 consecutive days, which enables automatic data acquisition, data pre-processing, and storage of the road condition data in readable shapefile format.

3.2.6 Establishment and use of spatiotemporal road condition database

Eventually, a spatiotemporal database concerning the road condition of Nanjing City is established, which consists of multiple shapfile files that document spatial road conditions at each hour (e.g. 7:00, 8:00, etc.) and one table that includes congestion and speed record of each road segment at all hours. In general, speeds of each road segmental different time moments need to be displayed in the same row. After transpositions of rows and columns, there should be theoretically a total of 336 (14 days * 24 hours) columns of speed features, which are excessively too many. It has been previously demonstrated that there are certain rules for residents' urban travel behavior, and thus there must be a lot of redundancy in road speed data for multiple periods of many days. Accordingly, the characteristic speeds related to the research purpose are extracted through principal component analysis to reduce speed data dimensionality of each road segment at all time moments. And characteristic speeds that are of interests are taken as the representative speeds of the road segment.

3.3 Modeling approaches of real-time traffic circle

On ArcGIS platform, running topology processes including intersection interruption, interface connection in the shapfile-format road network document, then a grid data set could be established as the real-time traffic circle model. Based on the real-time traffic circle model of Nanjing city, taking the location of emergency station as start point, and transit time as impedance, this study works out the coverage of emergency service within specified time. Thus, the real-time traffic circle could be evaluated by the road length and cover area with its scope. Through multi-plan trial and amendment, it could be suggested that stations with overlapped coverage area should be abolished or relocated, or new station should be built in the shadow area. Overall, this study helps optimizing the layout of emergency infrastructure. Specifically, it aims at reducing the overlapped coverage area of different stations, and improving the coverage rate especially in high risk regions.

The nature of real-time traffic model is to seek the service area of any position using Network Analyst which is a extended module of ArcGIS. As a matter of fact, it is a route solution program based on Dijkstra which is considered as a classical algorithm that solve the unisource shortest path finding in weighted graph. In order to find the shortest path from the initial position s to the target position d, this study originate a meeting point set S of which the shortest path to s is calculated by Dijkstra algorithm. Afterwards, meeting point with shortest estimated value would be searched repeatedly and be added to the set S. Meanwhile, the shortest estimated value of those adjacent points not included in the set S are being updated continuously. The algorithm will be executed until all expected meeting points get added to the set S. This study use the model as a refined stimulation that reflects the emergency response of related facilities in the research area, so as to lay the foundation of service area division. Basically, a traffic network model consists of road segment and road junction. Road segment is the edge feature of road network, which is expressed as segmental arc in ARC/INFO. Its attributes include normal average vehicle speed, average congestion speed, transit time, road length, etc. Road junctions is expressed as nodes in ARC/INFO, associated with the turn table, it could stimulate real-time road condition including waiting time during red light, no straight through, no left turn, elevated through, etc.

The steps are as follows: construct the road network framework with every road segment as an edge; set turn attribute, intersection attribute to establish connectivity; assign the value of length, vehicle speed and transit time to the road network according to the element attribute list. Finally, a feature dataset of all meeting points is generated. The existing road network is derived from Gaode open platform, and calculated with real-time average transit speed. Meanwhile, the planning road network is taken from “Overall urban planning of Nanjing” to the sub-arterial road level in principle, and partially access road if necessary. Vehicle speed using in the calculation is extracted from the real-time data considering different directions.

4 THE APPLICATION OF API BASED REAL-TIME TRAFFIC CIRCLE MODEL IN THE EVALUATION OF FIRE STATION LAYOUT

4.1 Gaode open API based real-time traffic status analysis in Nanjing

The vehicle speed extracted from Gaode API model is based on real-time traffic status, which is affected by holidays and festivals, fatal traffic accident and rush hour. Considering that emergency facility study more focus on the stable traffic connection and transit time between the facility and demand point, it is essential to evaluate the variability and stability of the transit time extracted from Gaode API model at different time. Therefore, this study acquires the two-week vehicle speed data from 28th, May, 2019 to 10th, June, 2019 as sample, and obtains the hourly average vehicle speed after data analysis. Compared the vehicle speed data of the two week, it can be seen from the covariance calculation result that the two average speed curves are highly matched, with a correlation coefficient of 0.973 (Figure.5). It confirms that the data is representative.

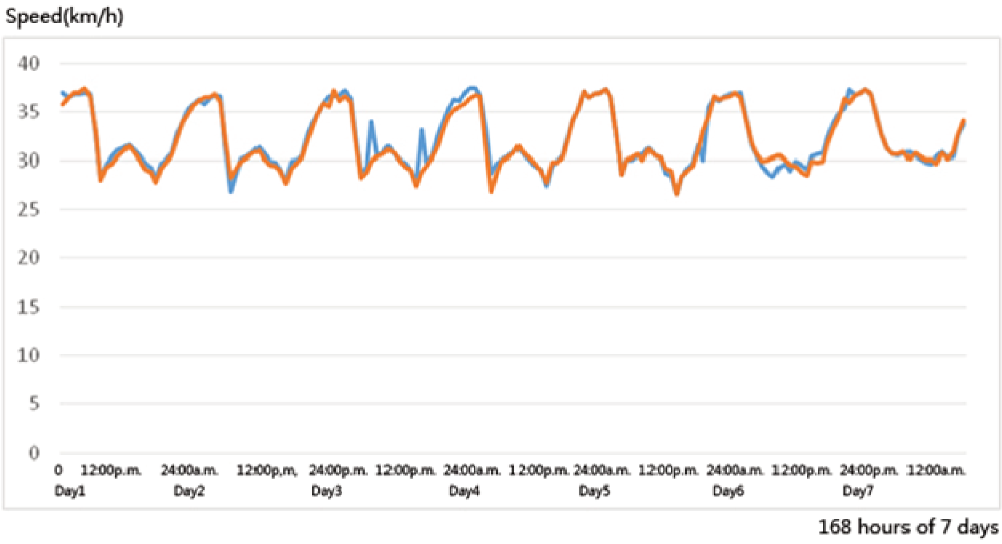

Figure 5: Comparison of average speeds (May 28 - June 10, 2019)

4.2 The space-time characteristics of road network during traffic congestion in Nanjing urban region

According to the Web API data, road condition spatial information has two characteristics: congested condition and driving speed. Taking the data from 28th, May, 2019 to 10th, June, 2019 as sample, the study carries on the statistics. The congested condition is divided into three level according to the congestion delay index1: clear (congestion delay index equal or less than 1.5), slowdown (congestion delay index between 1.5 and 1.8) and congested (congestion delay index equal or greater than 1.8). The statistics of all urban road data in Nanjing shows that the speed range of “clear” condition is [20, 120 km/h] with Eigen value of 35 km/h; the speed range of “slowdown” condition is [10, 50 km/h] with Eigen value of 20 km/h; the speed range of “congested” condition is [5, 25 km/h] with Eigen value of 10 km/h. It is calculated that the daily congestion delay index in Nanjing is 1.55 with the average vehicle speed of 28.29km/h. And for rush hours, the congestion delay index reaches 1.81 with the average vehicle speed drops to 24.21 km/h. The calculation result above can be corroborated with data from the official report of traffic management department. Thus it can be seen that traffic congestion has been a chronic disease of Nanjing city.

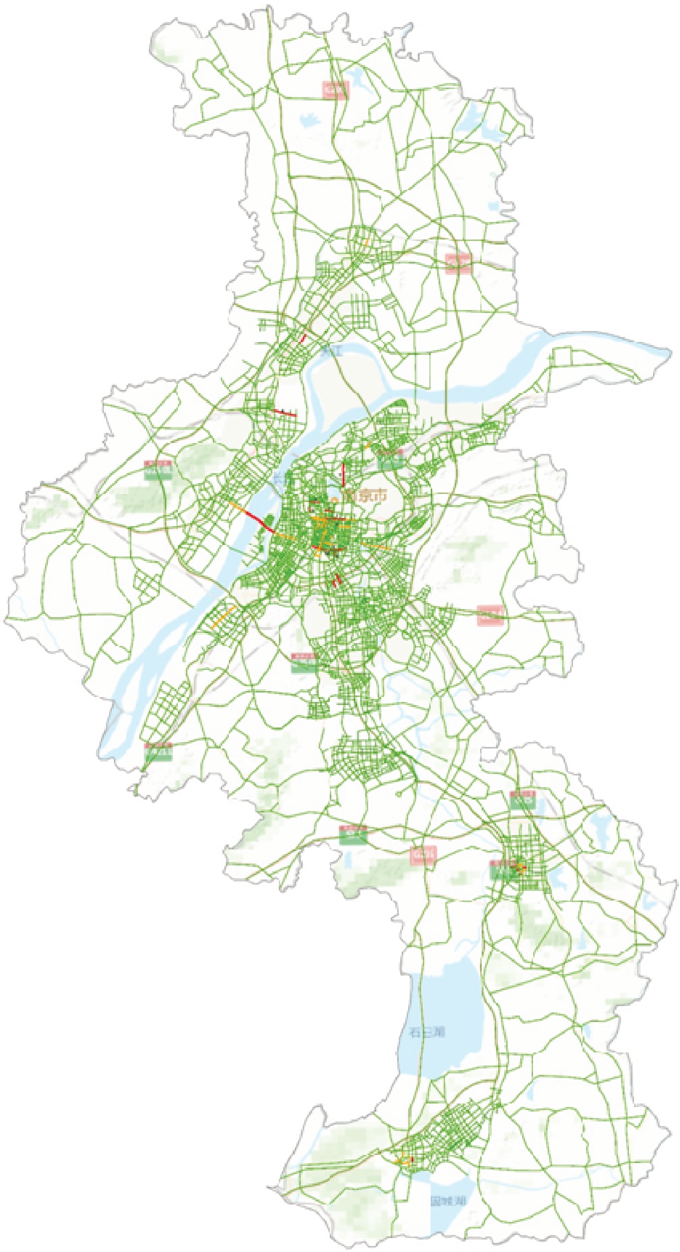

Figure 6: Road value of Nanjing City

The visualization result indicates that it is evidently more congested in Nanjing central urban area than in surrounding rural area. Specific to the district level, and focusing on the morning and evening rush hours. It suggests that Qinhuai District is the most congested area. Attributed to the traffic congestion, Qinhuai city

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dwellers spend twice as long travelling time compared with that in free flow condition. The congested condition is gradually improved from the center to the edge. According to the distribution characteristics of the two-week data, this study defines the road segment with average vehicle speed equal or less than 20 km/h as congested segment, the road segment with average vehicle speed between 21to 35 km/h as slowdown segment, and the road segment with average vehicle speed equal or over 36 km/h as clear segment. Taking a statistics of average vehicle speed on the 11 administrative districts of Nanjing respectively, it can be found that in the coral area of Nanjing central urban area including Qinhuai, Gulou, Xuanwu, Jianye district and their conterminous area, there is a continuous peaking traffic situation emerges in non-late-night hours while there are still a few road segments display slowdown situation during late night. In another word, within the coral area mentioned above and its 5 km extended scope, the traffic situation could be described as widespread “slowdown” with partially “clear”.

To be specific, the first circle with the core location facing outward: from Xuanwu District to Qixia district, Qinhuai district to Yuhuadai district, Qinhuai district to Jiangning district, and Jianye to Pukou district, all have major input and output roads bearing a large amount of transit traffic, causing time-division congestion. Similiarly, Hexi district is characterized with slow traffic as well, especially Hengshan Road, Fuchunjiang East Street and Yurun Street. Above all, Yuhuatai district has more prominent congestion. For transition area: The junction of Qixia and Xuanwu district starts from Hongshan Road, reaches Keyan Road in the north, and reaches Huadian East Road in the west, which is the characteristic congested area of the whole city. For surburb area: Lishui district, Liuhe district and Gaochun district shows that most of the road are unblocked with a small part of the central urban streets and main transit roads has more prominent congestion.

Through the two-week traffic data, 24 full-time data are automatically obtained every day. The average speed of the road is calculated and the congested road section is evaluated by the extreme value and average value of the road speed (Figure.6). In addition to the unknown state of the road, the original data is formatted to the effective road, and the average data availability reaches 89.8%. Considering that the traffic speed is limited by the road grade, the road with low traffic speed cannot be simply classified as congested state, so this paper retains two dimensions of average speed and congested state for comprehensive analysis. According to the analysis, the overall traffic situation shows the commuting characteristics of a single center in the city, spread to the transition area and many small centers in the suburb area; the characteristic congested sections in each jurisdiction are obvious; and the congested periods are also obvious (Figure 7).

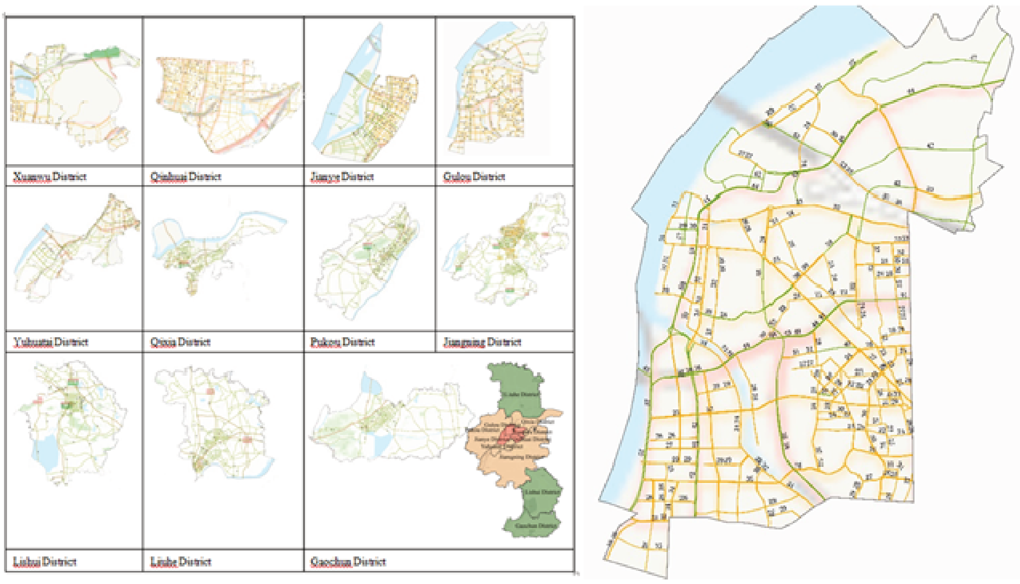

Figure 7: Average speed diagram of different districts (Top line for central area; the middle line for transition area; the end line for suburb area, the figure on the right is an example of a map of the Qinhuai region)

Urban real-time circles model integrate the two dimensions of time and space, which generally refer to the space range that can be reached within a certain time from the central location. In addition, it is a direct reflection of the ability of the transportation infrastructure to guide, support and secure urban and regional development [12]. The traffic circle can be used to assess the spatial scope of facilities and services.

Traditional traffic circle measurement methods are often carried out by simulating the speed of traffic [13-15]. However, it lacks the measurement of people's actual decision on behaviors and congestion in different parts of the city in real situation, thus it cannot mirror the influencing factors in real traffic congestion. Besides, there is no better way to quantify and extract those factors for explanation. In light of this, the article combines the real-time traffic conditions provided by the Gaode API, and applies Python and Arcgis software to extract and construct the real-time traffic circle. In other words, it divides the vehicle circle based on the speed of each road acquired from the Internet's open data to evaluate the coverage of the current service facilities.

4.2.1 Determination of evaluation index system

The traffic circle generated by the real-time traffic conditions can run through the entire process in the practice of emergency facilities planning. this study divides it into three stages: assessment of service scope of current facilities, mid-term location selection model to assist decision-making, and later facility optimization and verification. This article focuses on the application in the first stage. Namely, it divides the travel circle based on the speed of each road acquired from the Internet's open data to evaluate the coverage of the current service facilities. After extracting the current vehicle speed of each road in Nanjing, accurate real-time traffic circle analysis on the current facilities could be performed, corresponding to the arrival time of various emergency facilities, and choose different times to analyze the current traffic circle. In accordance with different levels in prevention, control and service requirements of fire stations, real-time circles including 2-4-6-8mins are set for comprehensive analysisc(Figure.8). Taking the linear coverage of fire stations as an example, the analysis of the current coverage of fire stations in the city of the actual road network speed reveals that, based on the area of the city, the overall service area coverage of fire stations is 16%. There are many blind areas in the Nanjing city, of which the core of the main urban area covers a continuous range, the surrounding jurisdictions mainly cover the central urban area. The lack of stations has become the main cause of large blind areas. Within 8 minutes, the maximum distance that can be visited by each fire station is 12435 meters, the minimum distance is 1085 meters, and the average service distance is 5125 meters. Besides, the service distance of the main urban area is smaller than the surrounding jurisdictions. The coverage of the 8-minute station almost coincides with the high-risk area, but there is still a large gap to meet the national regulatory requirements of "the fire brigade shall reach its descending edge within 5 minutes after receiving an active command". It shows a low coverage rate of 22% and 39% for respond time of 6min and 8min respectively.

4.2.2 Evaluation of current fire service coverage characteristics

The fire stations are rather independent and the 2-min fire service scale does not overlap. In the central urban area with high road density, service scope is distributed in plane shape, radiating from every fire station along the road network. While in the rural area with low road density, service scope is distributed in line with the shape of narrow belt, and the length-width ratio is pretty unbalanced. Vehicle traffic speed and road network density are the primary influencing factors, so that the 2-min fire service can cover 100% of the high fire risk area. The 4-min fire service scale are found partially overlapped. In the remote urban areas with high traffic speed, the patches become more diffuse, and the CONTAG rises. In the main urban area with high site density, the patches are even more diffuse, but connectivity increases which begins to show continuous characteristics. Thus in 4 minutes, the service scope is influenced by the road network density, the station density and the traffic speed, in which the impact of the traffic speed continues to increase. Compared with 4-min service scope, 6-min service scope is partially overlapped in remote urban area if more stations set and road network density offered. In the middle and north of Hexi, in the border area of Xuanwu, Gulou, Jianye and Qinhuai, and those 5km range, fire service is fully covered. The layout of road density is still narrow as a belt. Namely in 6 minutes, station density is the primary factor, while the influence of road density is reduced by traffic speed. In 8 minutes, except that Gaochun and Lishui are too far away from other fire stations and little stations in southern Jiangning, the service coverage shows connectivity between and inside jurisdictions, but far behind the demand of high fire risk area. The blindness would clearly reflect that high traffic speed cannot make up for the lack of fire station. In other words, unless the full travel time of fire fighting truck increases by a large span rather than 2-min staged rise (eg. 15 mins), the current fire service blind area cannot be effectively filled. In order to reduce the influence of traffic speed, the density of fire station plays a vital role (Fig.9.and Table 3).

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District	Service area (km²)	District area (km²)	Ratio (%)	average service distance (m)
Xuanwu	38.8457	74.44539408	52.18%	4028.082
Qinhuai	41.53912	48.43016978	85.77%	4044.878
Jianye	47.29169	81.10873799	58.31%	4981.331
Gulou	37.85746	53.04622712	71.37%	3032.16
Yuhuatai	63.94336	128.3607192	49.82%	5366.33
Qixia	87.12422	391.8374808	22.23%	4215.387
Pukou	161.1523	905.7031179	17.79%	5068.42
Jiangning	171.8731	1564.25834	10.99%	6482.437
Lishui	56.50106	1065.229347	5.30%	7176.875
Liuhe	361.5921	1472.001506	24.56%	6225.208
Gaochun	47.72451	788.9013365	6.05%	4266.789

Table 3 Service area and average service distance of each district

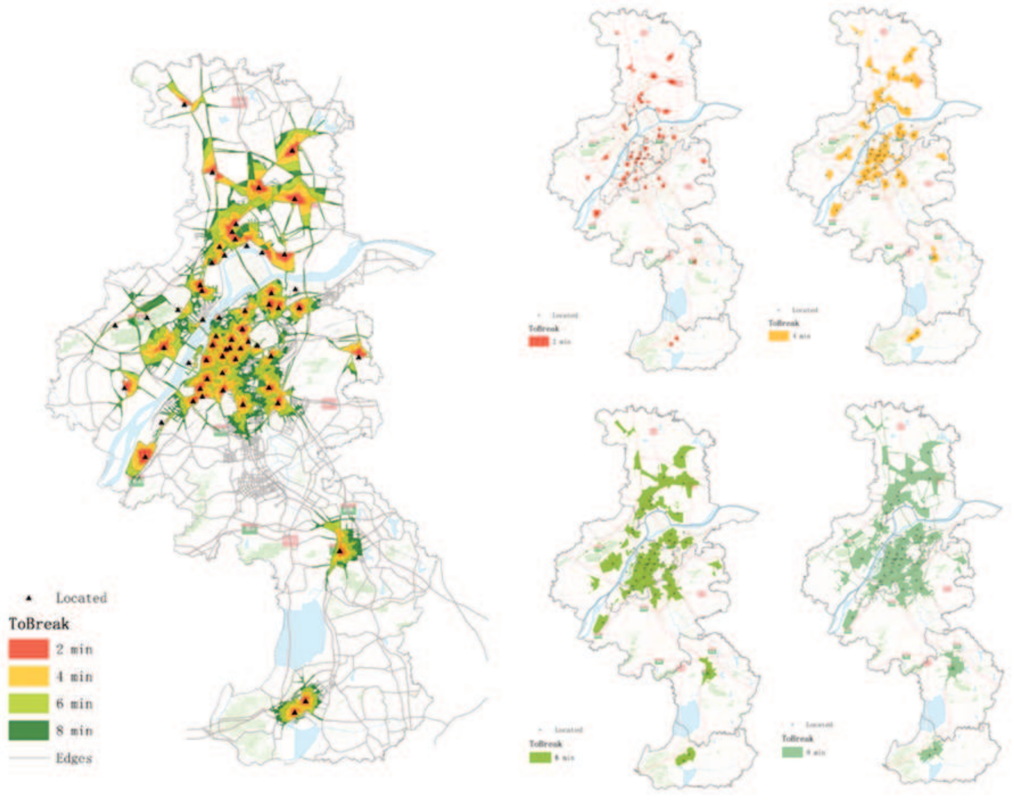

Figure 8: Service area diagram of Nanjing city

5 CONCLUSION

The purpose of this study is to provide a method of automatically acquiring and processing data using internet open data represented by Gaode open platform through the streaming and distributed processing features. This method restores the authenticity of data, and provides a practical method for the application of big data in urban planning discipline. Compared with traditional methods, it is perspective to establish a real-time traffic circle based on Gaode data. Besides, with the help of various government departments, it has been successful implemented into the emergency facility planning of Nanjing city, which helps proving its feasibility in practice. Speaking of the creativity, this study not only makes up the shortage of ignoring traffic condition in traditional emergency facility planning, but also expands thought for similar planning by reviewing the application of traffic circle. However, there are still some imperfections in this paper that need to be further supplemented in the future: firstly, the accuracy of data analysis is on hourly level which could be further divided in to minute level for more details.

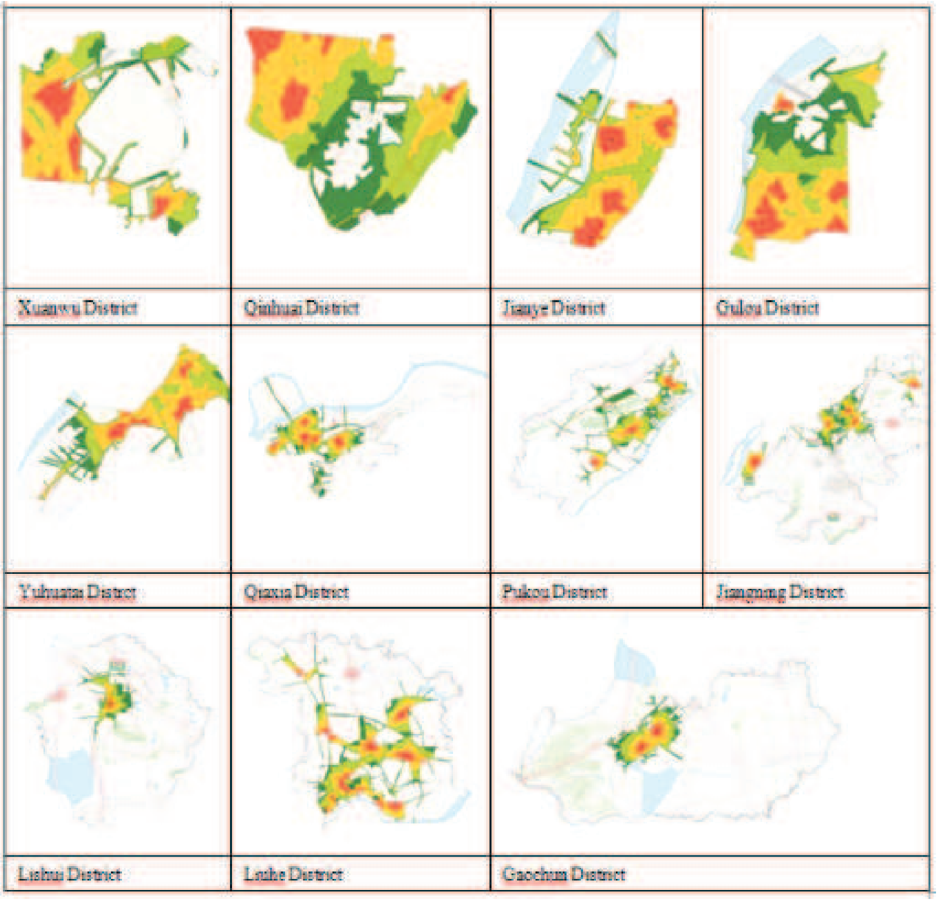

Figure 9: Service area diagram of different districts (Top line for central area; the middle line for transition area; the end line for suburb area)

6 REFERENCES

1. Cheng G, Zeng X, Duan L, Lu X, Sun H, Jiang T, Li Y. Spatial difference analysis for accessibility to high level hospitals based on travel time in Shenzhen, China. Habitat Int. 2016;53:485–94.
2. Wang F, Xu Y. Estimating O-D travel time matrix by Google maps API: implementation, advantages, and implications. Ann GIS. 2011;17(4):199–209.
3. Gu W, Wang X, Mcgregor SE. Optimization of preventive health care facility locations. Int J Health Geogr. 2010;9:17.
4. Tao Z, Yao Z, Kong H, et al. Spatial accessibility to healthcare services in Shenzhen, China: improving the multi-modal two-step floating catchment area method by estimating travel time via online map APIs[J]. BMC Health Services Research, 2018, 18(1):345.
5. Tianqi X, Xuan S, Haoran Zhang, et al. Measuring spatio-temporal accessibility to emergency medical services through big data Health and Place[J].Health and Place 56, 2019, 53-62.
6. Wu J, Kong Y, Li B, et al. Spatial accessibility analysis of rural medical facilities based on GIS -- a case study of donghai county, jiangsu province[J]. Human Geography, 2008; 23(5): 37-42.
7. Ye M, Wang J, Liu Y, et al. Research on the accessibility of refuge in parks in downtown Shanghai based on GIS[J]. Geography and Geo-information Science, 2008; 24(2): 96-98.
8. Ding S, Chen B. Evaluation of rationality of spatial distribution of urban medical facilities[J]. Journal of Geo-information Science, 2017; 19(2): 185-196.
9. Han Y, Lu Y. Evaluation and planning of accessibility of educational public service facilities -- a case study of Yizheng senior center in Jiangsu province, Earth Science, 2012; 32(7): 822-827.
10. Tao Z, Cheng Y, Dai T. Evaluation on the space accessibility of pension facilities in Beijing[J]. Progress in Geography, 2014;33(5): 616-624.
11. Song Z, Chen W. Evaluation method of medical facility space accessibility based on potential model[J]. Progress in Geography, 2009;28(6): 848-854.
12. Huang Y, Liu X, Liu Y, et al. Spatial and temporal accessibility analysis of urban parks based on Gaode Map API -- a case study of Haizhu district, Guangzhou[J]. Geography and Geo-information Science, 2018, 34(06):3+56-63.
13. Chen Z, Jin F. The scope, form and structure of Beijing isochronous traffic circle[J]. Progress in Geography, 2016,35（3）: 389-398.
14. Huang Y, Li C, Ou X, et al. A quantitative study on geosciences of "1-hour traffic circle" between cities -- a case study of Shanghai's main urban area [J]. SCIENTIA GEOGRAPHICA SINICA, 2013.
15. Wang D, Liu K. A study on spatial characteristics and dynamic changes of daily communication circles in Shanghai [J]. Urban Planning Forum, 2003(3)：3-10, 95.

Index1 Congestion delay index = travel time/free flow travel time

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