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Research on AI Technology Empowering the Intelligent Application of Smart Cities

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Abstract: Since the 20th National Congress, Chinese urban intelligence has entered a new era of technological empowerment, with strong momentum in intelligent development, particularly reflected in the deep integration of digital technologies such as artificial intelligence and government management services. These technologies not only reshape the process and mode of government governance but also significantly enhance the scientificity of decision-making and service efficiency. In response to the challenges of insufficient data support capabilities and the need to improve the level of intelligence in smart city governance, this study focuses on the effective utilization of unstructured data, the construction and practice of urban knowledge graphs, and the scenario-based application of large-scale language models technology, and deeply analyze the solutions and impacts of artificial intelligence empowerment. Research has found that natural language processing of unstructured information in the field of government affairs can greatly enhance data value conversion and grasp public opinion and sentiment. At the same time, the urban economic knowledge graph serves as a comprehensive information framework, promoting the integration and insight of information in the urban economic field, and strengthening the management and forecasting capabilities of economic scenarios. In addition, large-scale language models will increasingly replace human operations in urban intelligent management, demonstrating their enormous potential in optimizing resource allocation.

Keywords: Smart city; Unstructured data; Knowledge graph; Large-scale language models

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1. Background and research review

On the eve of the 20th National Congress, the State Council issued the "14th Five Year Plan for the Development of Digital Economy", which put forward overall requirements for the construction of digital economy, and the development of digital economy has been elevated to a national strategy. The plan proposes that by 2025, the added value of core industries in the digital economy will account for 10% of the gross domestic product. Yao Qianyu, Wu Dan, and Li Nanshu mentioned in their research that the 20th National Congress report proposes that research on smart cities and urban intelligence will become the focus of

future research [1–3]. It can be said that empowering the intelligence of smart city construction with artificial intelligence technology is the key to accelerating high-quality development during the 14th Five-Year Plan period.

At present, various provinces and cities across the country have proposed implementation plans for smart city intelligence. According to Liu Tong's research, in the process of urban "digitalization" construction, digital technologies such as big data, artificial intelligence, Internet of Things, and 5G communication technology provide technical support and innovative solutions for urban planning, construction, management, and services [4]. This article focuses on exploring the innovative applications of artificial intelligence technologies such as natural language, knowledge graphs, and large-scale models in assisting urban governance, livelihood services, industrial economy, and other fields.

2. Application of urban unstructured data

Mingxin proposed the challenges faced by urban data governance, a large part of which is the governance and application of unstructured data. Unstructured data has the characteristics of large capacity, fast generation speed, and diverse data sources, making it difficult to apply [5].

In the field of government affairs, the public opinion analysis of the 12345 hotline has always been an important issue in urban governance. Du Tianxiang and Bao Xiaoyuan found that there were problems with insufficient response quality and insufficient data resource mining during the operation of hotline data [6–7].

12345 hotline text analysis mainly involves the classification, identification, and handling of livelihood issues. Citizens often reflect the same issue through multiple channels, or the same issue may be reported separately by different citizens. Identifying these recurring issues can improve the efficiency of the government's handling of incidents and reduce resource waste from repetitive processing. On the other hand, obtaining feedback on a large number of common incidents can also provide more targeted solutions to problems. Processing 12345 hotline data requires a comprehensive application of techniques ranging from basic text preprocessing to complex machine learning and natural language processing. Through these methods, the efficiency and accuracy of data processing can be effectively improved, better serving the needs of the public and the government. The specific solution is as follows.

Text preprocessing and cleaning: Collect text data from the 12345 hotline system. Including the content, time, duration, and so on of the incoming call, removing irrelevant information such as blank characters and punctuation marks, and correcting spelling errors in the text. Manually annotate the text. The annotation content includes the type of problem, urgency level, and others.

Application of natural language processing technology: The word network analysis methods are used to extract text features, including keywords, word frequency, syntactic structure, and so on. The goal is to identify hot issues reflected by citizens, respond promptly, such as municipal management and environmental protection, and conduct a correlation analysis of events.

Continuous optimization and feedback: Based on the large-scale language models, design prompt templates, use the large-scale language models to obtain corresponding categories, and extract information from similar events. Similar events refer to events that occur at similar times, in a certain region, and address similar issues.

Extract and write prompt statements based on the large model of time and place, input text directly into the large model, and have it extracted directly by the large model.

To calculate the similarity of events, keywords are extracted from the text, and the similarity between two

events is explained by comparing the overlap of their keywords. Embedding event descriptions into vectors using a pre-trained language model. By comparing the similarity of two event description vectors, the similarity of events can be demonstrated.

By extracting keywords from unstructured complaint events, constructing a network relationship graph, and performing fine classification, it helps to quickly identify the essence of common problems. Through similarity calculation, similar events can be found and merged, which can effectively solve a large number of problems reported by the public and improve processing efficiency.

3. Research on the application of knowledge graph

The management of cities covers a wide range of indicators, and there is little research on the interrelationships between indicators, making it difficult to discover patterns. Therefore, building a set of indicator systems is particularly important. Wang Yanqing and Yang Chunlei believe that knowledge graphs can play an important role in urban governance [8–9]. Feng Jing proposed using knowledge graphs to fuse multi-source data to build a large-scale knowledge base and achieve smart city governance [10]. Taking urban economic management as an example, the economic indicator system generally has problems of poor hierarchy and weak problem orientation.

The economic knowledge graph, formed through the economic indicator system, is a knowledge network that helps break down information barriers between departments, assists the government in overall planning, and improves work efficiency. Secondly, it can visually display economic development data and indicators, helping the government predict the future economic trend of the city and to some extent control risks. The comparison of economic indicators between industries and the development trends within the industry helps the government better formulate industrial policies.

Taking a certain city as an example, this article elaborates on the construction plan of the urban economic knowledge graph.

Firstly, the source of the data. Extract reliable data sources such as the city's existing statistical yearbook, economic census database, and Chinese industrial enterprise database. The data corresponding to each indicator item should be as detailed as possible in terms of time (year/quarter/month data), and the geographic space of the indicator data (city, district, county, and township) should be as accurate as possible.

Secondly, the classification of indicators. In different databases, the same indicator item may have different names, so it is necessary to classify different names that clearly point to the same indicator. The search results achieved through the use of knowledge graphs are not only indicators and their corresponding data, but also more reflected in the network associations formed by the relationships between indicators, as well as the problems that the indicators can solve. Therefore, it is necessary to classify various economic indicators, form logical relationships according to the accounting rules in economics, and connect them to ultimately obtain a complete knowledge network, which is also the basis for artificial intelligence to make inferences.

Moreover, the division of indicators. The classification of economic indicators can be broadly divided into macro indicators and micro indicators, with macro indicators being explained by three aspects: the city's Gross Domestic Product (GDP), price index, and employment level. The city's gross domestic product is composed of consumption, investment, government purchases, and net exports. The price index includes the Consumer Price Index and the Retail Price Index. The employment level can be measured by the number of employees in the society and the average salary of on-the-job workers.

Urban microeconomic indicators, based on the distribution of industrial structure, summarize the main

economic indicators of industries and enterprises. Firstly, at the industry level, according to the national economic industry classification standard (GBT four-digit code), summarize the economic indicators of the development of each sub-industry under the primary industry, secondary industry, and tertiary industry, including but not limited to industrial output value, industry structure, number of industry employees, and geographical distribution of the industry. Secondly, at the enterprise level, based on micro-enterprise databases such as the "Chinese Industrial Enterprise Database" and "Customs Database", as well as the "Statistical Yearbook", collect various economic indicators related to enterprise development, including but not limited to enterprise size, financial status, investment amount, number and skill structure of employees, import and export volume, and composition of import and export products.

Finally, the system of indicators is sorted out. Firstly, based on the standards for dividing urban administrative regions, a data structure is formed in the spatial dimension from cities to districts, counties, and townships. At the same time, according to the national economic industry classification standard (GBT four-digit code), the indicators for measuring the overall economic development status of the city are gradually expanded to compare relevant economic indicators between and within different industries, and then to enterprise level economic indicators, ultimately forming a city industry enterprise, macro to micro level indicator hierarchy relationship of urban economic knowledge graph.

The economic knowledge graph can provide a comprehensive view to help understand the complex relationships between different economic factors. By effectively constructing and applying an economic knowledge graph, the efficiency of economic activities can be greatly improved, promoting better economic decision-making and management.

4. Scenario-based application of large-scale language models technology

The release of ChatGPT 3.5 in November 2022 marks the official entry of the large model into the public eye. Chen Minjun and Yuan Ye both mentioned the need to widely apply cutting-edge methods such as AI large-scale language models, explore the creation of large-scale language models for the urban governance industry, and empower the upgrading of application scenarios in the urban governance industry [11–12].

The ecological prosperity and rich scenarios of artificial intelligence large-scale models can be fully applied in smart cities. By utilizing the common support capabilities of large-scale language models, such as computing power, algorithm training and evaluation, and enhanced retrieval and generation capabilities, this study aims to create functions such as knowledge question answering, intelligent classification tags, intelligent summarization, intelligent question counting, and document assisted editing.

4.1. Knowledge question and answer

Based on the user-provided underlying database, intelligent question-answering services are provided through large-scale language models to help users quickly obtain key information from the knowledge base in a question-and-answer manner. The function supports managing knowledge through guidelines, policy documents, and Q&A and can provide knowledge mining, question generalization, and other functions based on large-scale language models. Based on user questioning intentions, contextual information, and colloquial expression, it can perform question retrieval, citation, and effective response. The function is suitable for various Q&A and search scenarios such as government and public Q&A, internal Q&A, and so on.

4.2. Intelligent classification tags

Based on the user-provided label system, high-accuracy label classification can be performed using a large

model without prior training. This feature is particularly suitable for scenarios with limited raw training data and small label quantities. It can quickly provide basic judgments under temporary government business needs, and with a small amount of manual review and prompt word adjustment, accurate results can be obtained. The function is suitable for classification scenarios such as temporary document analysis

4.3. Intelligent summary

Based on a large section of user input, summarize it into a concise text that covers key information and reduces the reading cost for users according to their interests and requirements. Intelligent summarization is suitable for scenarios such as policy interpretation writing and search result extraction.

4.4. Document assisted writing

By utilizing the processing capability of large-scale language models for text, text writing can be carried out based on understanding the user's intention, including outline writing, content filling, expansion, and continuation functions. It can be applied in internal office software to create reports based on leadership requirements and data knowledge, improving office processing efficiency for government workers.

Based on the above scenarios, the large model utilizes its knowledge question-answering ability, comprehension ability, and continuous dialogue ability to fully support the voice backend of urban management, achieving data queries and system function calls. In the application of urban governance, utilizing its intelligent classification tags, intelligent summaries, and document auxiliary editing capabilities, combined with urban scenarios, differentiated smart applications are produced.

5. Summary and prospect

This article demonstrates the intelligent application of artificial intelligence in empowering smart cities from the perspectives of unstructured data analysis based on natural language, knowledge graph technology application, and large-scale language models technology application.

Huang Xiaobin proposed that the use of artificial intelligence has profound significance in improving the level of urban governance, promoting the transformation of governance models, and advancing the digital transformation of urban governance [13]. Huang Qifan also discussed that the universal logic induction and reasoning ability of general artificial intelligence supported by large-scale language models, big data, and big computing power is changing the content and methods of various human work, and also bringing new opportunities and challenges to urban development and governance [14].

Gao Fengya's article elaborates on the importance of embedding artificial intelligence in urban governance and analyzes the challenges faced by AI embedding in urban governance [15]. For example, data privacy and security issues: AI requires a large amount of data to operate, which may lead to data privacy breaches. Limitations of technology and infrastructure: The implementation of artificial intelligence requires advanced technology and infrastructure support, which may result in the wastage of urban resources. Uncertainty in regulations and policies: The use of artificial intelligence may involve new laws, policies, and even ethical issues. These issues require further research and exploration.

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