Research on Multi-scenario Application of Power Data Mining for Digital Government

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Abstract. The construction of digital government is a new trend to comply with the digital transformation of the economy and society, and is also a new way and a new way to promote the modernization of the nation governance system and governance capacity. As a production factor, the data information of the electric power system contains a large amount of transformation value, this paper starts from the theoretical perspective of electric power data, analyzes the demand of the main body of the construction of digital government and the status quo of electric power data application capacity, summarizes the overall demand of digital government for electric power data mining, elaborates on the five application scenarios of electric power datamining to support the digital government, and demonstrates that electric power data mining can support the role of the digital government from the industrial chain balance and aggregation application cases. data mining to support the digital government. Through the case study, it can be seen that electric power data mining can provide decision-making basis for many fields of digital government construction.

Keywords: electricity data; digital government; datamining; multi-scenario applications

1 Introduction

At present, China is at a major critical point in promoting the modernization of the national governance system and governance capacity, and the popularization and promotion of digital technology has triggered major changes in the way of production, life and governance. Digital government as the core area of digital transformation, leading the digital economy, digital society to build out a digital governance ecosystem, but also become an important driver to promote Chinese-style modernization [5]. As the production infrastructure with the widest coverage and the most complete ser-

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vice system, electric power is closely related to social and economic life: the deep integration of information and communication technology and electric power production, operation and management, and the comprehensive development of smart grid and energy Internet, electric power data has become an indispensable and key production factor for the construction of digital government [8].

With the advancement of electric power informatization, it covers all aspects of generation, transmission, distribution, and use of electric power enterprises and power carriers, and accumulates massive, unstructured data, which can be widely used in various fields such as grid operation, equipment management, marketing services, and enterprise management. In terms of safety and reliability of grid operation, Mei Mingyang et al. designed a secure multi-intelligence deep reinforcement learning (SMS-MADRL) algorithm based on sensitivity matrix, and proposed a new method of voltage optimization and control based on this algorithm [7]. Hao Xulong et al. proposed a multi-dimensional data aggregation scheme based on privacy protection in smart grid data aggregation to address the current issues of data security and user identity privacy in smart grid data aggregation, which can achieve accurate analysis of fine-grained data [6]. Peng Hanmei et al. expounded a security correction control decision method based on deep deterministic policy gradient (DDPG) deep reinforcement learning [9]. In marketing quality services and customer management, Zhao Hongshan et al. designed a load forecasting model based on spatial-temporal attention mechanism (STformer) and proposed a new method of accurate short-run load forecasting for multi-users in the platform area [12]. Yu Hong et al. used the K-means clustering algorithm to classify users' electricity consumption lines and evaluate the characteristics of electricity consumption, which helps to find the most suitable fitting method for users with different behavior characteristics [11]. Tian Yingjie et al. proposed to use Functional Data Analysis (FDA) to correct and complete errors and missing data, which can accurately extract the user's electricity consumption characteristic curve, and accurately repair the wrong data and missing data [10]. By analyzing all kinds of smart meter data, the classification of power users is carried out and the characteristics of power consumption behavior and sensitive factors (such as price, reliability, etc.) are evaluated, which is conducive to the development of differentiated services [1].

Comprehensive research literature at home and abroad can be seen that mining the potential value of electric power data in the power system can help to improve the planning of grid facility construction, dynamic security assessment, power load forecasting, empowering the improvement of operation and management, customer service quality, and effectively guarantee the safe supply of electric power to the digital government. However, the supporting role of electric power data mining on digital government is not limited to guaranteeing the supply of electric power, but has been extended to various fields such as environment (e.g., environmental protection testing, etc.), public services (e.g., electric vehicle operation, etc.), and residents' life (e.g., smart pension, etc.).which provides the possibility of serving the main body of the construction of the digital government in multiple fields, but the degree of support is relatively weak at the present time.

Starting from the concept of digital government, this paper, on the basis of fully analyzing the demand of the main body of digital government construction and the status quo of electric power data application capability, clarifies the overall demand of digital government for electric power data mining, emphasizes the potential value of mining electric power data oriented to the digital government, describes the multiple application scenarios of electric power data mining in support of the digital government, and carries out an in-depth analysis of the industrial chain balance and aggregation application cases to explore and promote the application of electric power data mining in digital government.

2 Overview of Digital Government and Electricity Data Mining

2.1 Digital Government

At present, there is no unified definition of digital government in the academic world. Falk believes that digital government opens up a digital era and is an effective method of innovation in government governance [2]. Garcia believes that the process in which information technology helps the public sector to improve the quality of service and helps citizens to participate in political affairs is called digital government [3]. He Shengdong et al. regard the digital government as a state of operation in the modern social species, which uses big data and other technologies to digitize and store government activities and network the whole process [4]. To sum up, digital government starts from improving people's happiness, driven by data productivity, using informatization and digital technology to reconstruct the government organization and shape a new type of service-oriented government, and ultimately achieve the all-round enhancement of the competitiveness of the government.

2.2 Electricity data characteristics

With the development of the smart grid, 3 types of power data are generated for production, marketing and management, and external data originating from relevant government departments, third-party platforms, and internal systems of power customers involving economy, population, area, environment, meteorology, and internal users are also accumulated. Some data resources of the provincial power grid are shown in Table 1.

Table 1. Provincial power grid part of data resources

Data Type	Categorization	Content of Data	
Produc-tion data	Production monitoring category	Dispatch automation data	Current, voltage, active. reactive. phase angle, frequency, etc.
		TWR gateway data	Gateway power for all 220kV substations in the urban area
		Condition monitoring data	Transmission line micro-weather, ice cover, pollution flash, danc-

		for transmission and substation equipment	ing, tilt, video, etc.; Substation equipment oil chromatography, SF6, cable connection temperature, etc.
	GIS class	GIS	Geographically relevant information
		Network topology	Transmission and distribution lines and equipment topology and power supply range data
	Distribution network repair category	Medium and low voltage distribution network fault repair, emergency repair, etc.	
Market-ing data	Marketing fundamental data	Customer file. OEI. electricity consumption of customers, receivable/payable tariffs. etc.	
	Electricity consumption information collection data	Active reactive power factor, current and voltage data	
	Customer service information collection	Telephone voice. customer service reception data customer profile information and other data	
Manage-ment data	Equipment ledger data	Information on equipment shipments commissioning, and production program management data	
	Equipment operation and maintenance information	Defect records, fault records, maintenance data inspection management data, safety inspection management and condition evaluation data of transmission substation and distribution equipment, etc.	
	Eneineering and construction data	Grid equipment technical transformation, overhaul project plan progress control and other data	

The massive power data presents distinctive features such as wide coverage, strong timeliness, and outstanding objectivity, and fits extremely well with social governance, as follows: (1) Large quantity: the rapid development of electric power informatization and the full completion of the smart grid have generated massive data from multiple business systems.(2) High value: electric power data throughout the electric power system generation, transmission, transformation, distribution and use of each link, the use of big data technology to extract effective information, can provide value-added services to the residents, enterprises, the government and other subjects, all-round support for the construction of digital government.(3) High authenticity: power applications require high authenticity of data, however, non-technical errors and environmental noise interference can reduce the authenticity of data.(4) Fast speed: power data acquisition, processing, analysis of highspeed requirements, the power system should have a fast response time and strong data processing and analysis capabilities.(5) Strong relevance: Electricity data comprehensively and truly reflect the operating status of the power grid, and are associated with upstream producers, suppliers, and providers, and at the same time, downstream distributors, consumers, and appliance producers.

2.3 Power Data Mining

Data mining (DM) is a process of using various analytical tools (such as correlation analysis, cluster analysis, etc.) to discover models and relationships between data in massive data, using which predictions can be made, potential correlations between data can be searched for, and neglected factors can be found, In the face of high val-

ue-added electric power data, combining electric power with information from other fields through multi-source data mining can be used to assist decision-making in the five major areas of digital government. For example: using meteorological information and transmission and substation state detection information fusion mining, establishing emergency warning models to support urban disaster prevention and mitigation and emergency management; using electric vehicle charging and switching information to optimize the planning and distribution of urban electric vehicle charging stations (piles): through the enterprises and residents of the refine power consumption analysis, assessing the level of energy consumption and high energy-consuming links, to reduce the level of carbon emissions in the city: through the countryside of all types of categories of electricity data, to build the Through the electricity consumption data of various categories in the countryside, we will construct an all-round electricity consumption index for rural revitalization, which will provide decision-making assistance for the implementation of regional macro policy regulation and industrial support.

3 Analysis of the current status of and needs for application capacity

3.1 Analysis of the current status of application capacity

To consolidate big data application capabilities, inventory data resources, build a unified data model (SG-CIM), and introduce a mature data middleware.

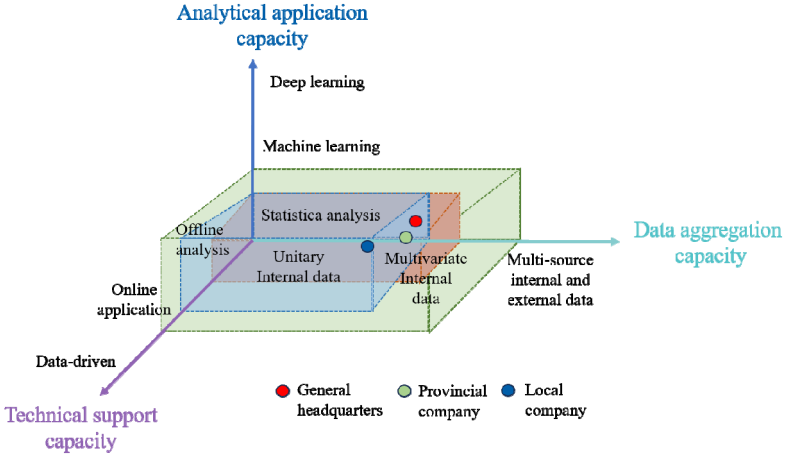

Fig. 1. Power Data Application Capability Assessment.

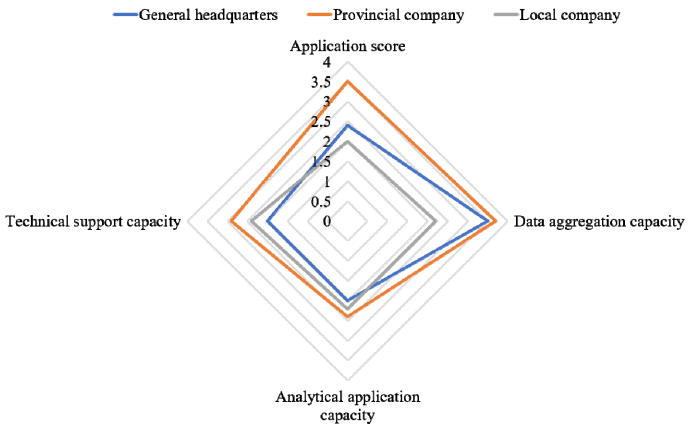

Fig. 2. Application Capability Status Evaluation Radar Chart.

As can be seen from Figures 1 and 2, overall, the current development of big data application capacity is uneven, with headquarters, provincial and municipal companies, as well as different regions having greater capacity for big data application development.

(1) Status of big data application capacity at Headquarters

The big data application capability of the corporate headquarters scored 2. 4 out of 5 As can be seen from the distribution of the assessment quadrant, the overall is still in the primary stage of quantization, and the insight and prediction ability is obviously insufficient. The data aggregation ability is strong, scoring 3.5 points; the analysis and application ability is generally at the primary level, scoring 2.0 points; the technical support ability is obviously insufficient, scoring 2.0points.

(2) Status of provincial companies' big data application capabilities

The average score of big data application of provincial companies is3.5. 0verall, quantitative analysis was basically realized, and insight and display functions were initially available, while the prediction capability was seriously lacking. The average score for data aggregation capability is 3.7, the average score for analysis and application capability is 2.4, and the average score for technical support capability is 2.9.

(3) Current status of big data application capabilities of local municipal companies

The overall score of big data application of local municipal companies is 2.0, which has initially formed a favorable atmosphere for big data application, with less deep-level analysis and application, and there is still a lot of room for improvement in the future. The average score for data aggregation capability is 2.2, the average score for analysis and application capability is 2.2, and the average score for technical support is 2.4.

3.2 Overall application requirements

Electric power data mining applications for digital government include five major aspects of economic regulation, market supervision. Social management, public ser-

vice, ecological protection, and the demand for electric power data mining in each service area is shown in Table 2and to meet the above demand requires the synthesis of multiple sources of data inside and outside the power system.

Table 2. Electricity data mining application requirements for digital government

Service Areas	Demand	Supporting digital government goals
Economic regulation	Macroeconomic analysis	Urban management refinement
	Analysis of industrial energy efficiency level	Urban management refinement
Market supervision	Emergency management monitoring	Urban management refinement
Social management	Electricity price and other policies to assist decision-making	Urban management refinement
	Fine urban operation and manageent	Urban management refinement
	Urban and rural integrated development	Urban management refinement
Public service	Energy saving services	Livable living environment
	Intelligent Life	Public services have been made easier
Ecological and environmental protection	reduce emissions through energy conservation	Livable living environment
	Dual carbon monitoring	Livable living environment

4 Typical application scenarios

4.1 Application Scenarios

Value-added power data in the service of the government includes five major areas: economic regulation, market supervision, social management, public services, and ecological and environmental protection.

(1) In the field of economic regulation, give full play to the characteristics of electricity as an important "barometer" of the macro economy, rely on the power demand side management platform, combined with industry, regional electricity data, GDP, etc., develop smart eye index, industry momentum index, urban and rural coordinated development index and other products to analyze the regional economic development trend and industry prosperity.

(2) In the field of market supervision, relying on the smart grid and smart electricity platform, integrating all kinds of business data and industrial and commercial data, helping the government to timely grasp the production and operation conditions and energy consumption of enterprises, researching and developing applications such as financial credit of electricity and government credit of electricity, and providing a reference basis for the government to formulate policies.

(3) In the field of social management, based on power big data, comprehensively understand the production and development status of all sectors of society and residents' living conditions through data analysis of society, residents, villages and industries, and develop applications such as electric tourism development index, rural revitalization Power Index and Common Prosperity Power Index.

(4) In the field of public services, according to the characteristics of tight coupling between electricity consumption and residents' lives, through different time distribution of electricity, electricity growth rate and other factors, to achieve smart elderly care, smart community, smart city and other fine management.

(5) In the field of ecological environment, integrating the data of various industries including power data, based on the collection and analysis of the total electricity consumption of enterprises, production equipment and environmental treatment equipment, research is conducted on "power big data + environmental protection" products such as carbon emission detection, enterprise electricity consumption monitoring in the Yellow River and Yangtze River basin, industrial air pollution emission electric power detection, and sewage electricity detection.

4.2 Analysis of Industry Chain Balance and Aggregation Degree

Focusing on the leading enterprises in the industry chain, the development of the industry chain is reflected in three aspects: development trend, development balance and regional concentration. The average annual growth rate of enterprises in the industry chain is used to reflect the development trend of the industry chain, and an increase rate of >=40% is a high growth rate, and vice versa is a low growth rate; the average annual growth rate of electricity consumption of enterprises in the industry chain is used to reflect the degree of balance of the industry chain's development, and a standard deviation of less than 1 is a high degree of balance, and vice versa is a low degree of balance; and the degree of concentration of the regional distribution of electricity consumption of the enterprises in the industry chain is used to reflect the degree of regional agglomeration of the industry chain. The degree of concentration of regional distribution of electricity of enterprises within the industry chain is used to reflect the regional concentration of the industry chain.

A city's economic data and electricity data are analyzed:

(1) As can be seen from Figure 3, from the perspective of balanced development of the industry chain, in recent years, the development of enterprises within a city's integrated circuit and biomedical industry chain has been growing at a faster rate and the development among enterprises is more balanced, the development of enterprises within the energy-saving and environmental protection and artificial intelligence industry chain has been growing at a faster rate, but the degree of balance is relatively low; the industry chain of creative culture and green food and the modern seed industry has a larger space for development.

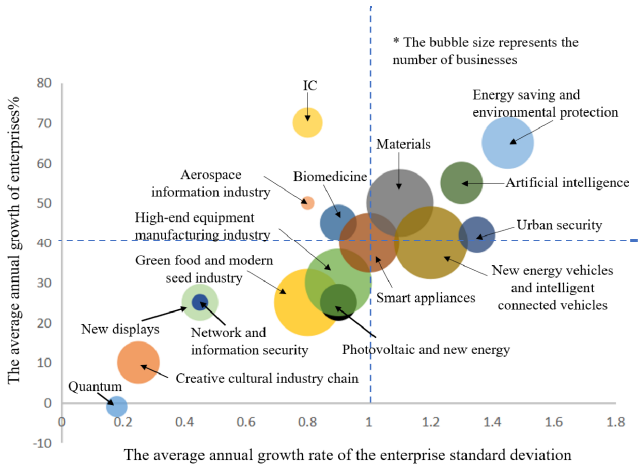

Fig. 3. Average annual growth rate of electricity consumption of 16 industrial chains in a city,2016-2021

(2) As can be seen from Figure 4, from the industrial chain regional aggregation, in the first half of the year, in the industrial chain with a large volume of electricity consumption, the new display, integrated circuit industrial chain regional distribution of higher aggregation.

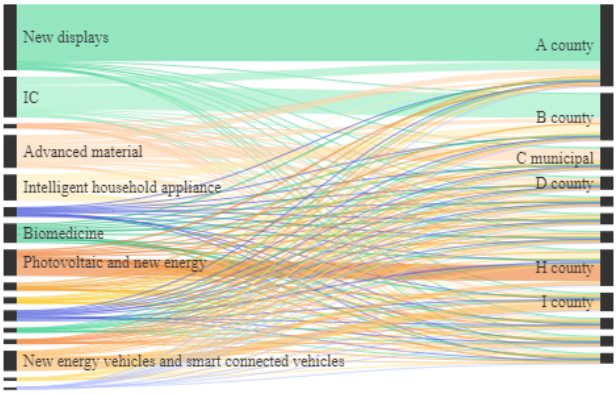

Fig. 4. Regional Distribution of Electricity Consumption of 16 Industrial Chains in a City in the First Half of 2022.

5 Conclusions

Electricity is the foundation and guarantee of digital government construction, mining the potential value of electric power data can provide decision-making basis for digi-

tal government in many fields such as economic regulation, emergency management, etc., and the application prospect is broad. This paper summarizes the application requirements and typical scenarios of electric power data mining, and discusses the application cases of industry chain balance and aggregation analysis from economic demand side management, to clarify that the use of multi-source, massive, heterogeneous, and high-value-added electric power data can effectively support the construction of digital government in the areas of macro-economic forecasting, public services, and so on. Meanwhile, in order to maximize the benefits of data mining for digital government, it still faces problems such as data silos and lack of application, which need to be further explored in depth.

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