Knowledge Organization and Relational Analysis of Qing Dynasty Official Positions: A Case Study of the "Annotated Table of Changchun Official Positions" from the Changchun County Gazetteer (Postprint)

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Abstract

[Purpose/Significance] By leveraging the concepts and methods of digital humanities to deeply develop resources related to China's officialdom domain from a knowledge perspective, this study assists scholars in conducting in-depth humanities research while simultaneously enriching officialdom research within the digital humanities domain. [Method/Process] Based on systematically organizing the knowledge system structure of Qing Dynasty officialdom and collecting relevant digital resources, we construct an ontology model for the Qing Dynasty officialdom domain, using the "Changchun County Annals: Annotated Table of Changchun Officials" as a case study for instance population and visualization. [Results/Conclusion] This achieves fine-grained semantic description and organization of officialdom knowledge units, revealing multi-level, multi-dimensional, multi-type, and complex interwoven dynamic relationships among knowledge units.

Full Text

Knowledge Organization and Relational Analysis of Qing Dynasty Officials: A Case Study of the *Changchun County Annals · Changchun Official Examination and Interpretation Table*

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Abstract:
[Purpose/Significance] By applying digital humanities concepts and methods to deeply develop official position resources from a knowledge perspective, this study assists scholars in conducting in-depth humanities research while enriching digital humanities scholarship on Chinese officialdom. *[Method/Process]* After systematically organizing the knowledge structure of the Qing official system and collecting relevant digital resources, we constructed a domain ontology model for Qing Dynasty officials, using the *Changchun County Annals · Changchun Official Examination and Interpretation Table* as a case study for instantiation and visualization. *[Result/Conclusion]* This approach achieves fine-grained semantic description and organization of official knowledge units, revealing multi-level, multi-dimensional, multi-type, and complex dynamic relationships among knowledge units.

Keywords: digital humanities; officials; domain ontology; knowledge organization
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Digital humanities is an emerging interdisciplinary research field that originated from humanities computing. It introduces technologies such as text mining, big data, GIS, and semantic networks into humanities research to deeply excavate implicit logical relationships among knowledge within digital resources, providing intelligent and precise knowledge-level services while enabling the creative discovery of new knowledge. Compared with traditional humanities research, digital humanities is characterized by digital research objects, diversified research subjects, intelligent research technologies, and smart research outcomes, which add technological wings to the organization and development of traditional humanities resources while offering new research perspectives and paradigms.

Traditional knowledge organization centers on controlled vocabularies, with classification, subject indexing, and metadata methods playing crucial roles in resource description and representation. However, knowledge organization oriented toward digital humanities represents a new generation of knowledge organization. Through theories and technical methods such as ontologies, linked data, and concept maps, the focus shifts from describing resource information to describing knowledge units, and the organization objects transform from static and absolute knowledge to dynamic and relative knowledge.

Officials refer to individuals holding positions in state institutions who participate in national governance and operations, with different ranks, authorities, and status levels. This study specifically focuses on Qing Dynasty officials. In China's ancient feudal society under imperial rule, officials assisted the emperor in managing political, economic, military, and cultural affairs. Therefore, developing humanities resources in this domain not only facilitates research on the official system itself but also enables broader investigations into political institutions, economic development levels, social productivity, and ethnic cul-

tural characteristics of that historical period through information such as official appointments and removals. From a digital humanities perspective, leveraging information technology to study the vast and diverse official resources allows for more efficient fine-grained organization and management of fragmented knowledge units, thereby achieving deep development and utilization of resources and enriching the research framework for Chinese officialdom knowledge.

This paper takes Qing Dynasty officials as its entry point, combining ontology theory with technical methods to systematically represent knowledge and relationships within this domain through a domain ontology conceptual framework model. Using the *Changchun County Annals · Changchun Official Examination and Interpretation Table* as an example, we construct ontology instances to achieve visualization of domain knowledge representation and association, providing theoretical and practical support for the deep development and efficient utilization of digital resources on Qing official themes in the digital humanities context.

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2 Literature Review

The history of digital humanities research can be traced back to 1949, when the Busa team collaborated with IBM to combine text and computation, successfully indexing over 10 million Latin words in the works of the famous Italian philosopher and theologian Aquinas. In the past two decades, digital humanities has emerged as an active discipline, with research topics primarily concentrated in four areas: digital humanities infrastructure and key technologies, basic theories and practical applications, integration of library, information, and archival science with digital humanities, and education and services for digital humanities. Scholars have produced numerous studies on knowledge organization from a digital humanities perspective.

Domestic research on knowledge organization using ontologies has primarily focused on literature, history, education, medicine, and culture. For instance, Zhou Lina et al. designed a Tang poetry ontology model, using multi-source heterogeneous data crawled from the Web to automatically construct a Tang poetry

knowledge graph through knowledge extraction, fusion, and reasoning, and built an intelligent knowledge service platform called Know-Poetry. Liu Ningjing et al. investigated and analyzed four types of person-centered knowledge models, including FOAF, CBDB, the Shanghai Library's celebrity manuscript archive resource knowledge model, and the CERIF model for academic research information resources, to construct an academic celebrity description framework model and a relationship model between academic celebrities and other entities. Teng Chun'e and Wang Ping established a metadata standard based on relevant resource types in the intangible cultural heritage domain, combined with DC metadata to determine the core element set for each conceptual attribute in the ontology, and constructed a Hezhen ethnic intangible cultural heritage resource system. Hou Xilong et al. built an intangible cultural heritage knowledge ontology model, performed RDF-based attribute descriptions of entities according to the ontology model, established entity links, and selected appropriate data storage and publishing platforms to provide access and data interfaces for both humans and machines. He Chao and Zhang Yufeng constructed an ontology-based semantic aggregation and visualization model for collection resources, discussing the main functions of each module and key processes and methods in model implementation.

Currently, domestic research combining digital humanities with local gazetteers (such as county and prefecture annals) remains scarce, primarily focusing on metadata strategy discussions, knowledge base construction, and toponym automatic recognition model building. Research on the official domain tends to focus on local official systems across different periods, such as the relationship between imperial examination education and the purchased official title system, and the digital integration of the recommendation and secret memorial inspection systems. Moreover, few studies utilize ontologies for official knowledge organization, with Guo Jianwei's research on ontology construction for the official category in the *Siku Quanshu* being a notable exception.

International literature reveals that although foreign research rarely incorporates the concept of officials, ontologies have been gradually extended to engineering, biology, medicine, libraries, government affairs, education, agriculture, and other fields. J. A. Hassan explored Nigerian indigenous cultural heritage ontology models and knowledge structures. D. Marilena et al. proposed a Political Roles (PRoles) ontology, constructing a new ontology model for political roles and related event relationships based on existing models such as the Publishing Roles Ontology (PRO), PROV-O, and the Pluralistic Participation Ontology. J. Plisson et al. proposed a large collaborative network organization (CNOs), namely VBE (virtual organization breeding environment), to identify participants and relationships in specific types of networks. G. Prokopiadou et al. analyzed the advantages of ontologies in e-government information resource development and application, and implemented ontology-based knowledge organization of government information resources. D. Riano et al. introduced an ontology for chronic patient care that can automatically provide medical professionals with relevant clinical information, serving as a knowledge base for

decision support tools to help detect anomalies such as misdiagnosis.

Thus, ontology serves as an important research method widely applied domestically and internationally for classifying, expressing, integrating, sharing, and reusing domain knowledge. Although scholars have moved beyond traditional single-dimensional linear knowledge organization models and gradually shifted toward semantic-based fine-grained representation and multi-dimensional association through ontology construction, achieving humanities domain knowledge services-driven resource development that meets increasingly sophisticated information needs, exploration of the interoperability and integration between digital humanities and official research remains lacking. The scarcity of research in the official domain has left vast amounts of exploitable official knowledge hidden in massive, scattered, and disorganized digital resources. This field remains underexplored yet holds strong development potential.

Therefore, firmly grasping the transformative opportunity of digital humanities and providing domain-specific concept vocabularies that can be widely recognized, accepted, and easily shared represents an effective means to achieve structured organization and semantic association of knowledge units in the official domain. This study employs ontology as a research tool to construct a Qing Dynasty official domain ontology model, supplemented by instance visualization to achieve efficient organization and integration of resources, demonstrating high-quality, multi-angle, and in-depth services from data to information to knowledge. This approach helps scholars conduct deep humanities research while enriching digital humanities knowledge studies on official resources.

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3 Construction of the Qing Dynasty Official Domain Ontology Model

Ontology-based knowledge organization centers on constructing an ontology model that formally and structurally expresses concepts and relationships related to a particular topic, thereby proposing a machine-readable conceptual model that is universally recognized, facilitates sharing and reuse, and avoids unnecessary duplication. Ontology construction should follow five principles: clarity, coherence, extensibility, minimal encoding bias, and minimal ontological commitment. The specific process of Qing official knowledge organization driven by digital humanities is as follows:

3.1 Determining the Ontology Domain, Scope, and Reusable Ontologies

Before formally constructing the ontology, we must first clarify its domain and scope—the knowledge of Qing Dynasty officials—and establish a targeted and extensible domain ontology model. Considering the need to fully utilize existing mature ontologies for knowledge sharing and reuse while avoiding unnec-

essary duplication, this study partially reuses four existing ontologies: FOAF ontology (prefixed as foaf, e.g., foaf:name); the CBDB ontology and Genealogy ontology from the Shanghai Library Ontology Service Center (prefixed as shl, e.g., shl:nativePlace); and the Relationship ontology (prefixed as rel, e.g., rel:brotherOf). Additionally, combining the characteristics of Qing officials, we defined custom ontologies prefixed as jlu, such as jlu:hasEvent. To clearly distinguish between classes and properties, superscript c denotes classes and superscript op denotes object properties in the following text.

3.2 Qing Official Data Collection and Preprocessing

Comprehensive collection of relevant digital resources on Qing officials provides the foundation for constructing a sound and reasonable domain ontology and instance addition. This study uses the *Changchun County Annals* · *Changchun Official Examination and Interpretation Table* as the data source. Although stored in digital format, this resource has not been databased. Therefore, unlike machine automatic extraction methods, this study manually extracted 164 pieces of Qing official appointment information, including official names, courtesy names, origins, appointment ages, native places, memorial submission (imperial endorsement) times, tenure periods, and appointment methods.

Concurrently, we consulted archival documents such as CBDB, *Selected Compilation of Jilin Archival Materials from the Qing Dynasty*, and *Draft History of Qing* to supplement information including official ranks, departure times, and other details to enrich and complete official profiles. After data collection, we preprocessed the data according to Qing official characteristics, removing duplicate and useless information. After repeated verification, we organized information describing the same official position around the rank itself, selecting, classifying, and sorting relevant data. Partial processed information is shown in Table 1 . Due to space limitations, other collected information describing Qing officials, such as official aliases, ranks, categories, courtesy names, art names, posthumous titles, ethnicity, banner registration, native place, birth year, death year, appointment age, memorial submission (imperial endorsement) time, tenure period, and departure time, are not listed individually in Table 1 .

3.3 Model Construction

3.3.1 Class Construction Concepts are the core and foundation of domain ontologies. The fundamental purpose of an ontology model is to provide a widely accepted, recognized, and easily shared conceptual system for a specific domain. Based on collected data, combined with Qing official characteristics and knowledge service needs in the digital humanities environment, we identified and enumerated relevant concepts and important terms, selecting comprehensive and generalized core concepts as ontology classes. Therefore, information about officials themselves, appointment events, and positions constitutes the most essential and indispensable independent classes. Other closely related and uniquely rich core concepts were also established as independent classes, includ-

ing origin and native place (represented as Place class) related to individuals; official rank and category related to positions; and appointment methods and tenure/departure times related to specific appointment events. Additionally, the Eight Banners system was a fundamental institution with era-specific characteristics and a pillar of the Qing dynasty's political management system. Banner registration thus represents an important unique attribute of Qing officials and a bond connecting different individuals. Therefore, it was also established as a separate class, along with ethnicity closely related to banner registration. Finally, 11 major classes were formed, as shown in Figure 1 [Figure 1: see original paper] and Table 2 .

3.3.2 Property Construction Starting from core concepts, other identified concepts were analyzed, classified, and organized according to their connotations and functional requirements, converting them into properties of existing classes. Property construction is a complex and critical component, divided into object properties, data properties, and annotation properties.

Class relationships in the ontology are defined and described by object properties, whose domain and range are both classes in this ontology. Constructed object properties are shown in Table 3 . These properties connect independent knowledge units, revealing rich, complex, and multi-dimensional dynamic relationships among them, and transforming knowledge organization and management models from single-dimensional linear to network-based structures.

Data properties supplement and perfect class information, further describing class characteristics from the attribute dimension and enriching class connotations. The domain is a class defined in the ontology model, while the range is a string (string) to be filled in. Property establishment clarifies and determines the conceptual system structure and semantic relationships between concepts, laying the foundation for reasoning and semantic-based information retrieval.

Additionally, annotation properties can add information to classes, objects, or data properties, functioning similarly to metadata as "data about data." For each class, object, and data property in the constructed Qing official domain ontology, we used protégé's built-in comment property for explanation to facilitate ontology understanding, sharing, and reuse.

Based on the above architecture, we used protégé, an open-source ontology modeling software with a plugin library supporting multiple file formats, to model the Qing official domain ontology. The model is stored in OWL file format, which offers more expressive means for meaning and semantics than XML, RDF, and RDFS, and has stronger capabilities for expressing machine-understandable content on the Web. Partial ontology models are shown in Figure 4 [Figure 4: see original paper], and partial code in Figure 5 [Figure 5: see original paper].

3.4 Instance Addition and Visualization

3.4.1 Instance Addition Knowledge organization and management oriented toward the Qing official domain ontology model involves not only designing and establishing a structured, extensible framework for knowledge aggregation and storage but, more importantly, describing the rich knowledge contained in Qing official-related digital resources and revealing complex dynamic relationships among knowledge units. Using the *Changchun County Annals* · *Changchun Official Examination and Interpretation Table* as an example, we selected representative figures from collected digital resources for instance addition. Instance addition is a crucial step in ontology construction and a concrete application of knowledge organization that must meet users' actual retrieval needs.

For clear and intuitive instance visualization and retrieval, and to avoid duplicate instance names, this study uses name symbols that reflect individual meaning and existence as instance names—for example, using specific personal names like "Sun Kan" for Person class instances and "Acting Appointment" for Appointment Method class instances. Considering that the same person may have multiple appointment experiences, Appointment Event class instances are named "Name + Number," and corresponding Temporal class instances are named "Name + Time + Number." Specific instances and their classes are shown in Figure 6 [Figure 6: see original paper].

3.4.2 Instance Visualization Visualization processing of constructed instances graphically presents multi-dimensionally associated knowledge units in an intuitive, 图谱化 manner, facilitating knowledge understanding and utilization (see Figure 7 [Figure 7: see original paper] and Figure 8 [Figure 8: see original paper]). Taking official "Sun Kan" as an example, his appointment experiences were relatively rich, having served as both Changchun Department Civil Administration Judge and Changchun Prefecture Governor. Specific visualization results are shown in Figure 7, where solid lines represent connections via object properties and dashed lines represent connections via data properties. Based on the established domain ontology model and collected information resources on Sun Kan, we created instances under each class and assigned property values—the content within the boxes.

Through structured, formalized, and fine-grained knowledge aggregation, this approach clearly depicts a piece of unstructured semantic information at a glance: Sun Kan, a Han Chinese from Zhili Qingyuan, who entered officialdom as a Jinshi in the Bingchen year of the Xianfeng reign, served as a sixth-rank civil external official—Changchun Department Civil Administration Judge—at age 52 through acting appointment, with memorial submission on the first day of the eighth month and appointment on the seventeenth day of the sixth month, both in the 16th year of Guangxu (1890). Sun Kan's second appointment event follows the same pattern. Evidently, ontology-based knowledge organization and management better facilitate machine and human understanding and manipulation of Qing official domain knowledge, reducing retrieval difficulty while

enhancing result relevance and effectiveness.

Moreover, the superiority of ontology-based Qing official knowledge organization lies not only in achieving structured representation and semantic association of resources but, more importantly, in gradually establishing a domain knowledge base by creating numerous interrelated and mutually complementary instances. Figure 8 shows instance visualizations for three individuals—Sun Kan, Shan Qing, and Nalingtai—with specific personal instance expansions as previously described. Information resources describing different figures can point to identical instances, thereby associating Qing Changchun official-related digital resources from different sources and content themes, and integrating dispersed, heterogeneous, and complex domain knowledge under a unified framework. As shown in Figure 8, Sun Kan and Shan Qing both served as Changchun Department Civil Administration Judges and both served in Changchun through acting appointments; Shan Qing and Nalingtai were both Manchu Plain White Banner members and both served as Changchun County Administrative Judges; Sun Kan and Nalingtai are both connected to Shan Qing, thus forming an indirect association path between them.

Any two instances constructed in this study can be directly or indirectly connected through different paths, forming a Qing Changchun official knowledge network. This achieves deep semantic-level association and knowledge aggregation, improves knowledge retrieval efficiency, helps users find potentially interesting related resources, and enables deep mining and development of resources.

The ultimate goal of knowledge organization is to enable users to obtain needed information and knowledge most conveniently through retrieval. However, with rapid information technology development and increasing demand levels, traditional metadata-based keyword retrieval can no longer satisfy users' increasingly complex and diverse information needs, bringing semantic-level knowledge management and service models into mainstream view. Ancient Chinese official-related digital resources contain rich knowledge and represent important humanities resources and historical memory, yet knowledge reuse in this domain remains low, lacking deep-level, systematic organization and development of domain knowledge.

Based on 梳理 Qing official knowledge characteristics and frameworks, this study constructed an ontology model achieving fine-grained, structured, and semantic expression and description of domain knowledge, revealing multi-level, multi-dimensional, rich, and complex dynamic relationships among knowledge units. This enables accurate and efficient identification and location of interrelated knowledge, better meeting scholars' and the public's needs for researching and utilizing such resources. Using the *Changchun County Annals* · *Changchun Official Examination and Interpretation Table* as an example, we performed instance population and visualization. Starting from any object, users can progressively associate with other instances through different paths, presenting a dynamically changing knowledge network. This effectively promotes paradigm transformation in official-themed resource research from a digital humanities perspective,

facilitates deep development and comprehensive utilization of digital resources in this domain, and drives innovation in domain knowledge management and service models. Simultaneously, it provides practical experience and references for interested scholars and institutions developing official knowledge-embedded digital resources, helping institutions improve knowledge service quality and innovation capabilities while enhancing social visibility and influence.

The constructed official ontology model can reveal knowledge unit relationships and help users retrieve hidden knowledge information, demonstrating the feasibility and effectiveness of digital humanities technical methods for official research and revealing associations among people, places, events, and times. Future digital humanities applications in the official domain could deepen in four directions: First, continuously enrich and optimize ontology classes and properties while ensuring scientific rationality and accuracy, expanding new concepts to enable real-time and effective coverage of domain knowledge. Second, combine with database technology to establish domain knowledge bases and enable sharing and reuse of heterogeneous database knowledge. Third, apply machine learning technology to intelligently extract and mine from massive official information, forming semantic chains of knowledge units and saving manual organization and screening time to achieve large-scale corpus content identification and verification. Fourth, construct official knowledge graphs and build knowledge cluster networks using knowledge measurement, graphics, databases, and data mining technologies to map-style panorama-reveal official group development trajectories, discover potential new phenomena or knowledge relationships, and introduce GIS technology to present official appointment migration paths and construct spatial network structures of official group changes.

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Author Contributions

Deng Jun: Proposed the overall research framework and revised the paper;
Zhong Chuyi: Wrote the paper and performed data analysis;
Wang Ruan: Collected and analyzed data;
Song Xueyan: Collected data;
Liu Qinchun: Collected data.

English Abstract

Knowledge Organization and Relational Analysis of Officials in Qing Dynasty—Taking *Changchun County Annals· Changchun Official Examination and Interpretation Form* as an Example

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Abstract: *[Purpose/significance]* With the help of the concept and method of digital humanities, the in-depth development of relevant resources in the field of professional officers in China from the perspective of knowledge will help scholars in the field to carry out in-depth humanities research and enrich the study of officials in the field of digital humanities. *[Method/process]* Based on sorting out the knowledge system structure of Qing Dynasty officials and collecting related digital resources, this paper built the ontology model of Qing Dynasty officials' domains, and took *Changchun County Annals · Changchun Official Examination and Interpretation Form* as an example to add and visualize. *[Result/conclusion]* This paper has achieved fine-grained description and organization on the semantic level of official knowledge units, and has revealed multi-level, multi-dimensional, multi-class, and complex interlaced dynamic relationships among knowledge units.

Keywords: digital humanities; official; domain ontology; knowledge organization

Note: Figure translations are in progress. See original paper for figures.