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From "Data Stacking" to "Meaning Generation": Knowledge Graph Reconstruction and Digital Narrative of Urban Red Cultural Resources from the Perspective of Digital Intelligence

-- A Case Study of Guangzhou

Zekai Chen [1], Feng Zhong [2], Yingmei Li [3,*]

[1] School of Computer Science, Guangdong University of Finance, Guangzhou, China

[2] School of Credit Management, Guangdong University of Finance, Guangzhou, China

[3] Qingyuan Campus, Guangdong University of Finance, Guangzhou, China

ABSTRACT

Against the backdrop of the in-depth implementation of the national cultural digitization strategy, the protection and inheritance of urban red cultural resources face a critical challenge of transforming from "digital preservation" to "digital-intelligence activation." Currently, red resource-rich areas represented by Guangzhou generally exhibit a phenomenon of "data stacking" in their digital construction. This is characterized by an emphasis on physical digital scanning and archival listing, coupled with a lack of deep development based on semantic associations. This results in fractured narrative logic of the red gene and a loss of historical context. Introducing the Knowledge Graph theory from the perspective of digital humanities, this paper proposes a path for knowledge reconstruction ranging from the ontology layer and association layer to the application layer. By constructing a red culture domain ontology adapted to Guangzhou's specific characteristic as a "Source of the Revolution," this study achieves semantic interconnection and knowledge reasoning of multi-source heterogeneous data. Furthermore, it establishes a digital narrative mechanism with multi-dimensional coupling of "Time-Space-Event-Person," transforming fragmented information into an embodied and perceptible space of meaning. The research aims to explore the theoretical logic and practical path of value generation for red cultural resources empowered by digital intelligence, providing theoretical support and methodological reference for the living inheritance of urban red memory in the new era.

KEYWORDS

Digital Intelligence Empowerment; Red Cultural Resources; Knowledge Graph; Digital Narrative; Meaning Generation; Guangzhou

1. INTRODUCTION

Red cultural resources are valuable spiritual wealth left by the Chinese people under the leadership of the Communist Party of China during the processes of revolution, construction, and reform. They serve as vivid teaching materials for strengthening cultural confidence and inheriting the red gene. With the deep integration of digital technology and humanities, the digital protection of red cultural resources has become an important component of "implementing the national cultural digitization strategy." General Secretary Xi Jinping emphasized: "Make good use of red resources, inherit the red gene well, and pass on the red country from generation to generation" [1]. This instruction requires

us not only to preserve the material carriers of red resources but also to excavate their spiritual connotations, realizing a transformation from static display to dynamic dissemination.

As the source of the modern Chinese democratic revolution and a pioneer of reform and opening up, Guangzhou possesses extremely rich red cultural relics, such as the Site of the Third National Congress of the CPC, the Guangzhou Peasant Movement Institute, and the Guangzhou Uprising Memorial Hall. In recent years, Guangzhou has made active explorations in the digitization of red resources, establishing multiple thematic databases and virtual exhibition halls. However, examining the current status of construction, it is not difficult to discover a typical dilemma of "data stacking": massive amounts of archives, images, and videos are "moved" onto the internet, but the data lacks logical association, existing in an atomized and discrete state. This mode of "having data without knowledge, having display without narrative" fails to restore deep historical logic through superficial digital forms, leading audiences to often stop at "viewing" rather than "understanding" during browsing, making it difficult to generate deep value resonance.

The advent of the era of digital intelligence, especially the application of Knowledge Graph, Semantic Web, and Artificial Intelligence technologies, provides new epistemological tools and methodological paths to solve this dilemma. Moving from "data stacking" to "meaning generation" means we must transcend the simple replication of the physical attributes of cultural heritage and turn towards the structural reconstruction of its underlying historical context, social relationships, and spiritual connotations. Taking Guangzhou's red cultural resources as an example, this paper attempts to explore how to use knowledge graph technology to construct a semantic network of red memory. Through digital narrative strategies, structured knowledge is transformed into infectious cultural experiences, thereby achieving the value reshaping of red cultural resources in the digital-intelligence space.

2. DILEMMA EXAMINATION: THE "SUPERFICIALITY" SYMPTOMS OF URBAN RED CULTURAL RESOURCE DIGITIZATION

In the process of promoting the digitization of red cultural resources, the excessive assertion of technological rationality often leads to the concealment of humanistic values. Currently, in the construction of red resource databases in many cities, including Guangzhou, there are widespread dual bottlenecks of "resource fragmentation" and "narrative flattening."

2.1. Physical Scanning vs. Semantic Absence: The Formation of "Data Islands"

Current red culture database construction mostly follows the mapping logic of "Entity-Digitization," transforming cultural relic entities into digital documents through high-precision scanning and 3D modeling. While this method effectively solves the problem of physical preservation of cultural relics, information organization still follows traditional archival classification methods (e.g., classification by time, location, or material). This linear, hierarchical classification system severs the intricate horizontal connections inherent in historical events.

Taking Guangzhou as an example, there is a close causal logic and personnel intersection between the convening of the Third National Congress of the CPC, the subsequent KMT-CPC cooperation, the establishment of the Whampoa Military Academy, and the founding of the Peasant Movement Institute. However, in existing independent databases or cloud exhibitions, these resources are often fragmented into different entries or subsystems. A user searching for "Mao Zedong" might receive a series of independent documents about his activities in Guangzhou but would struggle to intuitively see his residence during the "Third National Congress," his teaching content at the "Peasant Movement Institute," and his social relationship network with other revolutionaries of the same period (such as Zhou Enlai and Chen Yannian). This collection of data lacking semantic association

essentially constitutes countless "data islands," making red resources rich in quantity but impoverished in the knowledge dimension.

2.2. Static Display vs. Context Stripping: The Disappearance of Historical Presence

The unique charm of red cultural resources lies in their "sense of presence" and "sense of history," that is, the interaction between people and events in a specific space-time environment. However, current digital displays often fall into the trap of "decontextualization." On many digital platforms, revolutionary cultural relics are extracted from their original historical scenes and presented merely as high-definition images accompanied by brief textual descriptions. This "cabinet-style" digital display makes cultural relics "accessible" but also strips them of their vitality as historical witnesses.

For a city like Guangzhou, a "museum of revolution without walls," the distribution of its red resources possesses strong spatial narrative characteristics. From the Academy under Yuexiu Hill to the wharves by the Pearl River, every site is part of the urban fabric. Existing digital means often ignore the deep interaction between these geographical features and historical events, failing to connect scattered sites into lines and planes. Audiences face isolated "points" and cannot perceive the overall historical atmosphere of Guangzhou as the revolutionary center a hundred years ago—a time of "surging winds and clouds." As scholar Wang Jianjun pointed out, the governance of red resources in the new era requires the construction of a full-process ecological model, rather than a single display window [2].

2.3. One-way Instillation vs. Interaction Deficiency: Obstruction of Meaning Generation

"Meaning" is not inherent in the object but is generated in the interaction between the subject and the object. Current digital platforms for red education mostly adopt a "one-way instillation" transmission mode ("I speak, you listen"). Although new technologies like VR panoramas and AI explanations have been introduced, their essence remains the unidirectional feeding of information. Users cannot conduct exploratory learning based on their interest paths, nor can they participate in the reorganization and reinterpretation of historical knowledge.

This "hard digitization" lacking interactivity fails to stimulate the cognitive interest of contemporary youth groups. In the perspective of digital intelligence, true "meaning generation" should allow users to wander (Serendipity) within the knowledge network, discovering the hidden threads in historical details, thereby completing the internalization of the revolutionary spirit through autonomous inquiry. If we merely stop at data stacking and ignore the user's subjective cognitive structure, the digital dissemination of red culture will inevitably fall into the trap of formalism.

3. THEORETICAL TURN: THE LOGIC OF RED MEMORY RECONSTRUCTION BASED ON KNOWLEDGE GRAPHS

To break through the aforementioned dilemmas, a shift from the "archival perspective" to the "digital humanities perspective" must be completed at the theoretical level. As a semantic network revealing relationships between entities, the Knowledge Graph (KG) can transform unstructured text data into structured knowledge, providing epistemological tools for the deep excavation of red cultural resources.

3.1. Ontological Basis of Knowledge Graph: From "Document" to "Entity"

In the architecture of a knowledge graph, the world is abstracted into a triple structure of "Entity—Relation—Entity." For red cultural resources, this means we no longer view them as individual Word documents or JPEG images but deconstruct them into "entities" with specific attributes and behaviors.

For Guangzhou's red cultural resources, we need to construct a Domain Ontology with local characteristics. This ontology layer is the "grammar rule" of the knowledge graph, defining concepts within the domain and the relationships between them.

Definition of Core Classes: Should include "Person" (e.g., revolutionary martyrs, historical witnesses), "Organization" (e.g., CPC Guangdong Regional Committee, All-China Federation of Trade Unions), "Event" (e.g., Canton-Hong Kong Strike, Guangzhou Uprising), "Location" (e.g., East Garden, Guanyin Mountain), "Artifact" (e.g., relics from Wedding on the Execution Ground), "Literature" (e.g., The Guide Weekly), etc.

Description of Properties: Define detailed attributes for each class, such as birth and death years, native place, and political affiliation for "Person"; start and end time, background, results, and impact for "Event."

Construction of Relations: This is the soul of the knowledge graph. We need to define complex semantic relationships, such as "Participated_in" (a person participated in an event), "Affiliated_with" (an institution belongs to a superior organization), "Located_at" (an event occurred at a location), "Mentored_by" (educational relationship between people), "Comrade_of" (social relationship between people), etc.

Through this ontological reconstruction, Guangzhou's red resources are no longer static archives but a dynamic network interwoven with countless entities and relationships. Scholar Qi Yongliang and others pointed out that the key to digital integration lies in breaking resource barriers and achieving multi-dimensional data interoperability [3], and the construction of the ontology layer is the cornerstone for achieving this interoperability.

3.2. Semantic Association and Implicit Knowledge Discovery: From "Search" to "Reasoning"

Traditional databases only support keyword matching searches, while knowledge graphs support semantic retrieval and knowledge reasoning. This makes it possible to excavate implicit relationships in history.

In the perspective of "Digital Intelligence Empowerment," algorithms can traverse paths in the graph to discover associations not explicitly recorded. For example, by constructing a knowledge graph of students from the "Guangzhou Peasant Movement Institute," we can track the flow of alumni after graduation. The system might automatically infer: several students returned to a certain county in a certain province after graduation and jointly initiated an armed uprising. This implicit association of "Institute—Student—Local Uprising" is difficult to clarify quickly through traditional reading of historical materials but is clearly visible in the knowledge graph.

Furthermore, based on spatio-temporal reasoning, the "Guangzhou Revolutionary Ecosystem" under a specific time slice can be reconstructed. For example, setting the time to "1925," the graph can instantly retrieve all key personnel of the Kuomintang and the Communist Party active in Guangzhou at that time, major events occurring (Canton-Hong Kong Strike), active social groups, and their geographical locations. This panoramic knowledge presentation provides researchers and audiences with a "God's eye view," greatly enriching the cognition of historical complexity.

3.3. Fusion and Disambiguation of Heterogeneous Data: From "Chaotic" to "Ordered"

Guangzhou's red cultural resources come from a wide range of sources, including official party history documents, folk oral history materials, and museum collection information, with widely varying data formats (structured, semi-structured, unstructured). Knowledge graph technology can

achieve the fusion of multi-source heterogeneous data through Natural Language Processing (NLP) and entity alignment technology.

For example, the same historical figure might be referred to as "Comrade So-and-so," "Secretary So-and-so," or by a former name in different documents. The entity disambiguation mechanism of the knowledge graph can map these different references to the same unique entity ID, thereby aggregating information scattered across different historical materials to form a complete portrait of the figure. This process realizes a qualitative leap from chaotic data stacking to ordered knowledge organization, laying a solid data foundation for subsequent digital narratives.

4. SYSTEM CONSTRUCTION: IMPLEMENTATION PATH OF GUANGZHOU RED CULTURAL RESOURCE KNOWLEDGE GRAPH

Translating theoretical logic into practical results requires establishing a scientific process for knowledge graph construction. Combined with the actual situation of Guangzhou's red resources, this paper proposes an implementation path of "Data Acquisition and Cleaning—Ontology Construction and Mapping—Knowledge Extraction and Fusion—Graph Storage and Update."

4.1. Data Layer: Multi-source Aggregation and Quality Control

First, a comprehensive census and digital collection of Guangzhou's existing red resources must be conducted. This includes not only basic information collection for 136 red sites but also relevant historical archives, memoirs, academic research results, and audio-video materials.

In this stage, special attention should be paid to the standardization of "Metadata." Referencing international standards such as CDWA (Categories for the Description of Works of Art) and Dublin Core, combined with the Specification for Description of Revolutionary Cultural Relics, a metadata collection standard adapted to Guangzhou's characteristics should be formulated. For example, for the "Guangzhou Uprising" event, not only the time and place should be recorded, but also fine-grained information such as the designation of participating troops, marching routes, and lists of sacrificed personnel.

Simultaneously, OCR (Optical Character Recognition) technology should be used to digitize paper documents, and data cleaning algorithms should be applied to remove redundant and erroneous information, ensuring the accuracy and authority of the data entering the library. Scholar Song Xiuhui emphasized that in digital transformation, content accuracy is the prerequisite for education [4], so a strict data review mechanism must be established.

4.2. Logic Layer: Spatio-temporal Coupled Ontology Design

In the logic layer, the core task is to design an ontology model that covers the full picture of Guangzhou's red culture. Given the strong spatio-temporal characteristics of red history, an "Event-centric Model" is recommended.

With "Event" as the core node, people, organizations, and artifacts are connected through the two dimensions of "Time" and "Space."

Time Dimension: Introduce a timeline logic to support precise positioning of time points and fuzzy queries of time periods. For example, the "Great Revolution Period" can be defined as a time interval entity associated with all specific events occurring during that period.

Space Dimension: Combine with GIS (Geographic Information System) technology to assign latitude and longitude coordinates to each location entity. Establish a mapping table of "Historical Place Names—Modern Place Names" (e.g., "East Parade Ground" corresponds to a specific modern location) to solve cognitive obstacles caused by historical geographical changes.

Event Hierarchy: Establish a hierarchical structure of events (sub-event relationships). For example, the "Guangzhou Uprising" can be subdivided into sub-events like "Uprising of the Training Regiment," "Workers' Red Guards Attacking the Police Station," and "Defense of Guanyin Mountain," forming a detailed narrative granularity.

4.3. Algorithm Layer: Automated Extraction and Semantic Web Construction

Facing massive text data, purely manual graph construction is inefficient. Deep learning technology should be utilized to train Named Entity Recognition (NER) and Relation Extraction (RE) models oriented towards the red culture domain.

Through a "Human-in-the-loop" mode of "Manual Annotation of Small Samples + Machine Large-scale Learning," the algorithm's recognition rate for specific historical vocabulary can be improved. For instance, training the model to automatically recognize verb phrases like "launched," "established," and "sacrificed at" allows for the automatic extraction of triple knowledge from documents.

In addition, the construction of multi-modal knowledge graphs should be explored, semantically associating multimedia data such as images, audio, and video with text entities. For example, a photo of the "Guangzhou Uprising Martyrs Cemetery" can be associated with the "Guangzhou Uprising" event entity and related martyr person entities through image recognition technology, achieving "Image-Text Mutual Evidence."

5. DIGITAL NARRATIVE: TRANSFORMATION FROM "KNOWLEDGE GRAPH" TO "MEANING SPACE"

The knowledge graph constructs a rational knowledge skeleton, while the digital narrative is responsible for fleshing it out with emotional substance. Based on the structured knowledge base, we can use digital intelligence technology to reconstruct narrative methods, creating an immersive study and education system, realizing the value transformation from "cold data" to "warm faith."

5.1. Dialectical Unity of Linear Narrative and Non-linear Exploration

Traditional historical narratives are mostly linear, told in chronological order. The network structure of the knowledge graph naturally supports non-linear narratives. On the digital platform, we can provide two narrative modes:

Guide-style Narrative (Linear): For beginners, the system automatically generates standardized narrative paths such as "Storms of the Great Revolution in Guangzhou" or "The Third National Congress and the United Front" based on the "Time" main line in the graph, narrating like a documentary.

Explorer-style Narrative (Non-linear): For deep researchers, any node in the graph is open as an entry point. Users can click on "Zhou Enlai," jump to "Whampoa Military Academy," then to "Eastern Expedition," and then to "Canton-Hong Kong Strike." This "hyperlink-style" jumping simulates the process of human associative thinking, allowing users to piece together personalized historical pictures during free exploration. Zhu Ming's research indicates that AI-empowered personalized learning is an important direction for innovation in university red education [5], and non-linear narrative is an effective means to achieve this goal.

5.2. Spatial Narrative: Urban Red Map Redrawing Based on LBS

Utilizing the spatial attributes in the knowledge graph, combined with mobile internet technology, reconstruct the city's "Red Spatial Narrative."

Develop an "AR Guangzhou Red Map" application. When users are in historical districts like Beijing Road or Wende Road, the mobile terminal uses LBS (Location-Based Services) positioning to automatically trigger push notifications of surrounding red history.

Furthermore, utilizing AR (Augmented Reality) technology, historical scenes can be superimposed onto real street views. For example, in front of the current "Guangzhou Uprising Memorial Hall," one can see the virtual image of the uprising army gathering wearing red scarves in 1927 through the mobile screen. This virtual-real symbiotic spatial narrative breaks down the walls of the museum, turning the entire city of Guangzhou into a red university without walls. This is not only the revitalization of sites but also the activation of urban memory, allowing citizens to encounter red history unexpectedly in their daily lives.

5.3. Embodied Narrative: Role-playing and Immersive Experience

Based on the rich character relationships and event details in the knowledge graph, high-fidelity "Script Kill" (Role-playing mystery games) or immersive study courses can be designed.

The system can generate several typical roles (such as workers' picket members, Whampoa Military Academy students, progressive newspaper editors, etc.) based on historical figure profiles in the graph. Participants play these roles during the study tour, and the system pushes task clues based on historical facts (i.e., the relationship logic in the graph).

For instance, a student playing a "Canton-Hong Kong Strike Worker" needs to follow system prompts to find the former site of the "All-China Federation of Trade Unions" and simulate the strike organization process of that year. In this process, students are no longer bystanders but "witnesses" of history. Every decision they make can find corresponding historical feedback in the knowledge graph. This Embodied Cognition experience greatly enhances the emotional penetration of red education. Cao Lu also pointed out in research that ideological and political courses in the digital age need to explore integration paths, and this embodied narrative is a powerful weapon to break boring preaching [6].

6. VALUE GENERATION AND APPLICATION PROSPECTS

The leap from "data stacking" to "meaning generation" is not only a technological upgrade but also a profound transformation in the paradigm of red cultural resource protection and utilization. Constructing a digital-intelligence platform for Guangzhou's red cultural resources based on knowledge graphs has multi-dimensional application values.

6.1. Academic Research: Providing Refined Digital Humanities Tools

For party history experts and historians, the knowledge graph provides powerful quantitative analysis and visualization tools. Scholars can use the graph to analyze the group characteristics (Prosopography) of figures in specific historical periods, study the evolution laws of revolutionary networks, and even discover contradictions in historical materials (such as the same person appearing in two places at the same time). This Data-driven Research paradigm will promote the development of Guangzhou's red history research towards refinement and empiricism, producing high-quality academic results.

6.2. Education Inheritance: Building a Stratified and Classified Study System

Based on the flexibility of the knowledge graph, knowledge subsets of different complexities can be easily extracted to serve the educational needs of different school segments.

For elementary school students, the system outputs simple graphs focused on "character stories," accompanied by animation demonstrations; for middle school students, it outputs logic graphs focused on "event causality" to guide inquiry-based learning; for university students and party members/cadres, the full graph is opened to support complex thematic research and party spirit analysis. This stratified teaching mode precisely aligns with the cognitive laws of different audiences, solving the pain point of "one size fits all" in traditional red education [7].

6.3. Cultural Industry: Empowering New Formats of Cultural Tourism Integration

The structured red knowledge graph is a "rich mine" for the cultural creative industry. After authorization, data can be opened to game companies, film and television companies, or cultural creative enterprises.

For example, utilizing data on character costumes and artifact patterns in the graph to develop cultural creative products; utilizing event script data to develop red-themed games or micro-films. Especially against the backdrop of the "Double Reduction" policy and the rise of study travel, red study route planning and content services based on digital-intelligence platforms will become a new growth point for Guangzhou's cultural tourism industry, achieving the unified effect of social benefits and economic benefits [8].

7. CONCLUSION

In the wave of digital intelligence, the protection and inheritance of urban red cultural resources is no longer a simple "rescue project" but a systemic change involving knowledge reconstruction, narrative innovation, and value re-creation. As a heroic city with a profound red heritage, Guangzhou has the responsibility and conditions to pilot in this field.

The transformation path from "data stacking" to "meaning generation" proposed in this paper lies centrally in using knowledge graph technology to penetrate the deep semantic structure of red resources, weaving fragmented historical information into a web of meaning. Through ontology construction, association mining, and digital narrative, we not only make the heritage displayed on the vast land "come alive" but also make the spirit flowing in the long river of history "stand up."

Of course, this transformation process also faces multiple challenges such as data standard unification, cross-departmental coordination mechanisms, algorithmic ethics, and ideological security. Future research and practice require the synergistic efforts of the government, academia, enterprises, and the public. By exploring a path of digital-intelligence survival for red cultural resources with Guangzhou characteristics within the dialectical unity of technological rationality and humanistic spirit, we can build a strong dam of red memory in the digital space, allowing the red gene to shine with more brilliant brilliance in the era of digital intelligence.

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