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# *Research on the Historical Remain of the Bombard of Chongqing Ontological Model from the Perspective of Digital Humanities*

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***Abstract:*** Based on the perspective of digital humanities, taking the example of the historical remain of the bombard of Chongqing, this research explores the possibilities of digital communication of the historical remain of the bombard of Chongqing through specific methods，such as multi-source clustering, resource indexing, knowledge reorganization, and interactive operations. The semantic ontology model can achieve a multidimensional stereoscopic description of the historical remain of the bombard of Chongqing with heterogeneous data from multiple sources. This facilitates the in-depth integration of related resources of relic objects, designing an ontology model that aligns with the unique characteristics of Chongqing's red culture. The study also discusses the technical and expansion paths of the ontology model for war relics, aiming to provide insights and references for the integration of digital resources and the digital preservation and dissemination of the historical remain of the bombard. To achieve the preservation of Chinese historical and cultural heritage.

***Keywords:*** Digital Humanities, the Historical Remain of the Bombard of Chongqing, Ontology Model

## 1. Introduction

The red cultural relics are a precious spiritual wealth of the Chinese nation. It is an indispensable part of traditional culture, which possess significant historical significance and heritage value. In July 2018, the Central Committee of the Communist Party of China and the State Council issued the *Opinions on Implementing the Revolutionary Cultural Relics Protection and Utilization Project (2018-2022),* proposing to establish a large database for revolutionary cultural relics [1]. The presentation and dissemination of red resources use a new perspective to elevate the vitality of red culture, bring the research to a new height.

The historical remain of the bombard of Chongqing have physical immovability and distinctive red cultural characteristics, closely related to the environment and history. These relics represent material cultural heritage, and they are the carriers of red culture. The protection and management of the cultural relics of the War involve tremendous amount of information about history, status, regulations, and events related to individuals. These information contents touch on various highly

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specialized fields such as history, cultural heritage protection, structures, resource management, and material chemistry.

Due to the differences in methodologies and knowledge systems between different subject, the digitized resources of red cultural relics exhibit characteristics of being heterogeneous from multiple sources. Therefore, interoperability at the information management level becomes particularly important. In the process of protecting heterogeneous cultural relic information, the correlation and integration of information are crucial technical aspects. Efficiently integrating digital resources from different sources, and presenting them interactively and multidimensional becomes the key to the integration and dissemination of digitized resources related to red cultural relics.

## 2. Construction of the Historical Remain Ontology Model

Currently, there has been a wealth of digital research achievements in various aspects such as the red historical relics, events, figures, spirit, and literature. The related databases, resource repositories, and digital platforms exhibit characteristics of wide content coverage and diverse information carriers. Due to the temporal and geographical factors in the development of the War, red cultural resources are regionally and temporally concentrated, presenting a localized and phased distribution. Moreover, there are multiple connections among these resources, making it impractical to integrate all resource data through a single linear relationship. Therefore, conducting targeted analyses of the relationships between local and local resources, as well as local and overall resources, not only enriches regional red cultural resources but also allows for an accurate understanding of the dialectical development relationship between local resistance processes and the nationwide War, and even the global anti-fascist war. This approach holds significant research value.

### 2.1. Organizing Cultural Heritage Resources: Methods and Ontology Technology

The organization and management of red cultural heritage resources require processing, organizing, formatting, indexing, and other methods to transform unstructured data into structured data. Common methods for organizing resources related to data indexing are based on vocabulary, metadata, or ontology. Metadata provides standardized descriptions of data, improving interoperability between different systems. However, metadata records lack a semantic hierarchical structure, making it difficult to describe complex relationships between records. Vocabulary can structure information resources using classification structures and synonym relationships but lacks the capability for large-scale data integration. Ontology focuses on the interconnection of information, providing semantic relationships through classification hierarchy and conceptual relationships, and is not limited to hierarchical classification organization in vocabularies [2].

Ontology serves as a model for representing conceptual hierarchies and semantics. In the construction of ontology, knowledge is organized, summarized, and refined to extract recognized concepts in the field. The ontology structural model consists of five elements, including classes, relationships, functions, axioms, and instances. Classes represent domain concepts, relationships and functions, and they are connections between concepts, axioms specify constraints between concepts, and instances correspond to specific objects that belong to one or more concepts or relationships [2]. Due to the reasoning and semantic expression capabilities of ontology and semantic networks, as well as the ease of achieving data standardization, ontology can be expressed through language based on semantic networks.

Ontology technology, using "functions" and "axioms," can enrich the conceptual model of cultural heritage. Because of these characteristics, ontology technology plays an important role in cultural heritage data management. Ontology technology meets the requirements for expressing multi-source

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heterogeneous cultural heritage data in the same model, achieving structured transformation of information at the levels of data, information, and semantics.

## 2.2. Ontology Model Design Method

The historical remain of the bombard of Chongqing possess both material and spiritual value. On the material level, these remains not only document the great achievements of the Chinese nation revolting against the invasion, but also serve as important evidence of the atrocities committed by the Japanese. It is necessary to finely explore their unique characteristics, fully integrate related information resources of the remain, and comprehensively reflect their material value. From a spiritual perspective, the remains reflect numerous outstanding spirits born out of the anti-invasion war. Taking the example of the bombard of Chongqing, it vividly embodies the spirit of resistance and the spirit of revolutionary martyrs in red crag with the motto "the more bombed, the stronger." Integrating resources with a focus on the spirit greatly enriches the diversity of resources, presenting a more lively and vivid representation of the non-material value of the remains.

The design of the ontology model for the anti-invasion war remains is based on the overall course of the Chinese resistance against invader. It considers the remains themselves, related information, and the overall information of the war. Chongqing's war remains are established as the central description, radiating to all digitized resources directly or indirectly related to the description center, collectively constructing a three-dimensional network of resource description for Chongqing's war remains. Due to the unique characteristics of the eight years' war of resistance, the complexity of the relationship between digital cultural resources and relic features, the extensive coverage of resources, and the diverse forms of carriers, human intervention is necessary during information extraction.

For accurate information extraction, the accurate extraction of semantic relationships is a prerequisite for precise expression. This study uses human intervention to ensure the accuracy of semantic relationship understanding. Currently, scholars are also researching the intelligent application of natural language processing technology, machine learning technology, and other information processing technologies in semantic extraction. Subsequent research will build on this foundation to achieve the application of cutting-edge technologies such as machine learning, enabling the automatic extraction and organization of entity information [3].

## 2.3. Entities in the Model

Through the analysis of resource data related to the bombard of Chongqing remains, it was found that instance information is associated with four entities: Period, Place, Actor, and Event. Based on an investigation and research, this article adopts the CIDOC-CRM ontology model as the main framework, reusing parts of the model for applicable entities, and customizing three entities: War Remain, Digital Resource, and Situation Background, defined as follows:

1. Cultural Heritage: Categories of the eight years' war of resistance remains, including buildings, war sites, mass graves, fortifications, arsenal factories, party and government offices, memorial parks, etc.
2. Digital Resource: Images, documents, audio, and other digital media files that display or describe information related to war remains.
3. Situation Background: Specific periods and events related to war remains, involving the political, economic, cultural, and other aspects of relevant countries domestically or internationally.
4. Event (crm: Event): Important activities related to the eight years' war of resistance remains, serving as a crucial way to connect remains with other entities.
5. Actor (crm: Actor): Individuals involved, mainly referring to the roles related to war remains.

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6. Period (crm: Period): Defines the time range related to war remains, including points in time, time spans, and timelines.
7. Persistent Item (crm: Persistent Item): Relevant persistent projects or plans associated with war remains.
8. Move (crm: Move): Events related to the migration of war remains.
9. Place (crm: Place): The geographical scope related to war remains, including the surrounding areas of the remains and other regions related to historical events.

## 2.4. Relationships in the Model

Extract specific relationship instances from relevant data, establish entity relationships based on the CIDOC-CRM model. Although the CIDOC-CRM model is widely used in the cultural heritage field, it still has certain limitations in expressing specific contextual needs. When establishing an ontology model for war remains with special expressive requirements, considering the similarity between the expression structure of Dublin Core and the research context, and its characteristics of good operability and high universality, some terms can be reused to improve the model.

Taking the example of the bombard of Chongqing Remains, the relationships between war remains and various entities are described as follows:

1. Relationship between War Remains and Events: There is a many-to-many relationship. The events that occurred during the period before and after the creation of remains are diverse, and there are cases where a single event is related to multiple remains. Unlike traditional architectural cultural heritage, the relationship between war remains and events is very close. In the context of Red Cultural Heritage, specific events give remains vitality and rich connotations. The main part of the bombard of Chongqing Remains is an air-raid shelter built in anticipation of bombing during the eight years' war of resistance. The overall remain is developed and repaired to commemorate and protect the bombard of Chongqing Event. The relationship between war remains and events is fundamentally different from traditional architectural cultural heritage [4]. War remains have a weaker cultural foundation, but excel in recording and commemorating specific events. Therefore, historical events play a decisive role in the cultural information recording of war remains.
2. Relationship between War Remains and Individuals: Reflected through the actions of individuals in one or more events, war remains of residential categories are directly connected to individuals. For example, the relationship between the bombard of Chongqing Remains and Lu Zuofu is not direct, but through the bombard of Chongqing Event, Lu Zuofu's specific deeds and influence in the anti-invasion struggle can be linked to the bombing remains, enriching the overall content of the remains. Taking the example of the residence of Song Qingling in Chongqing, the architectural remain has a direct connection with individuals, serving as an important cultural heritage site for the red culture protection in Chongqing.
3. Relationship between War Remains and Time: War remains record specific events that occurred at specific time points or during specific periods, and the relationship between remains and time is detailed through events. For example, the connection between remains and May 3, 1939, and May 4, 1939, is established through the "May 3" and "May 4" bombing events. The establishment of relationships between time points helps discover all war remains during a certain period and helps establish the inherent connections between different war remains and events during the same period.
4. Relationship between War Remains and Locations: The relationship between remains and locations can be viewed from two aspects. On the one hand, there is a natural attribute relationship between remains and locations, and on the other hand, there is an indirect relationship between remains and other unrelated locations caused by the development of events or the migration of individuals. The direct and indirect relationships between remains and locations together constitute part of the content of event development or individual life.

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5. Relationship between War Remains and Digital Resources: The relationship between remains and digital resources mainly indicates how remains are reflected in digital resources, such as representation, description, and involvement of war remains in digital resources. Representation and description are direct manifestations of the relationship between remains and digital resources, while involvement is the expression of an indirect relationship. The expression of indirect relationships can greatly enrich the cultural connotations of remains.

6. Relationship between War Remains and Situational Background: War remains are produced under the influence of specific situational backgrounds during specific periods, and there is a many-to-many relationship between remains and backgrounds. For example, the bombard of Chongqing remains is closely connected to the Nationalist Government's anti-war situation, the progress of the invasion of China, and the global anti-fascist war situation. The Bombard of Chongqing Event occurred under the combined influence of these situational backgrounds, establishing an indirect connection between remains and these situational backgrounds.

Using the Bombard of Chongqing Remains as an example, some relationships between entities are shown in Figure 1.

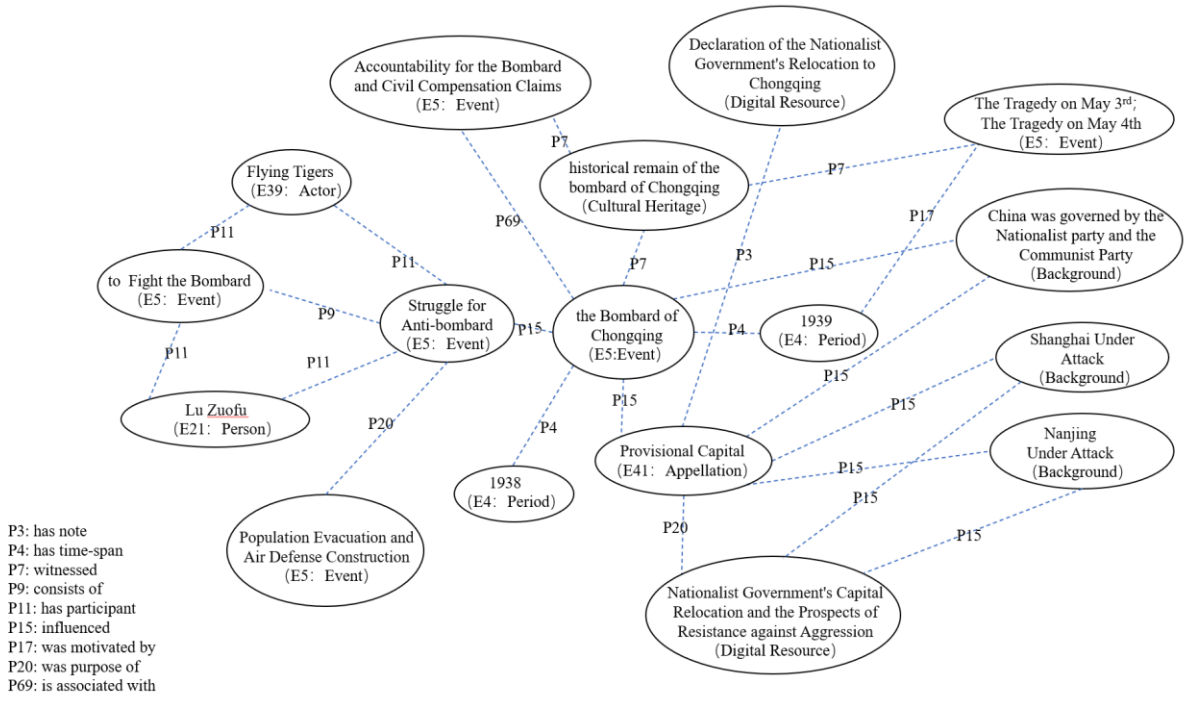


Figure 1: Schematic Diagram of Entity Relationships in the Eight Years' War of Resistance War Remains Description Model (Author's Illustration)

## 3. The Three-dimensional Expansion of the War Remains Model

The above-mentioned research, through information extraction and utilizing the CRM model, acquires entities, relationships, and entity information from heterogeneous data sources to form structured data. However, these results may contain a considerable amount of redundant and erroneous information, and the relationships between data are flattened, lacking hierarchy and logic. Therefore, it is necessary to clean and integrate the data to ensure the quality of knowledge. After these steps, knowledge inference and processing are employed to establish new associations between entities based on known entity relationships. Through computer inference, new knowledge is discovered from existing knowledge, and on this basis, three major paths for integrating digital resources from an application perspective are formed.

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### 3.1. Multiple Source Clustering and Graph Construction

From the perspective of resource integration, the heterogeneity of Chongqing Anti-invasion War remain digital resources requires higher granularity in the integration of data, entities, and other resources. Semantic mapping needs to be constructed to enhance the semantic connections and interoperability between non-structured resources. From the user's perspective, semantic connections and interoperability between non-structured resources can cluster digital resources in the same narrative context. Spatial mapping enables the integration of digital resources in a higher dimension.

To achieve the integration of digital resources at the semantic and interactive levels, a unified metadata standard can be utilized to finely index and logically associate resources themselves. This includes multiple attributes encoding for entities, relationships, eras, physical locations, situational backgrounds, etc., related to the Anti-invasion War remain digital resources. Ontology technology can be applied to further extract concepts, entities, relationships, etc., constructing multiple types of graphs such as entity graphs, knowledge graphs, and event graphs [5].

### 3.2. Knowledge Recombination and Virtual Scene Association

After completing the knowledge recombination and association of multiple digital resources, different digital resources are integrated into the knowledge graph to achieve three-dimensional associations of entities, concepts, and relationships between graphs. Based on the integrated knowledge graph, the mutual association and scenario switching of digital resources are realized, forming the three-dimensional digital modeling of entities. Taking Chongqing University's College of Engineering Bombing Monument as an example (as shown in Figure 2), this entity (Bombing Monument) serves as the physical link in the virtual scene. It connects different entities, enabling cross-temporal and spatial fusion. Users can traverse different cultural remians in different time and space to experience the scenes at that time. As entities, users can roam in different virtual time and space, becoming integrated into the fusion of associated digital resources.

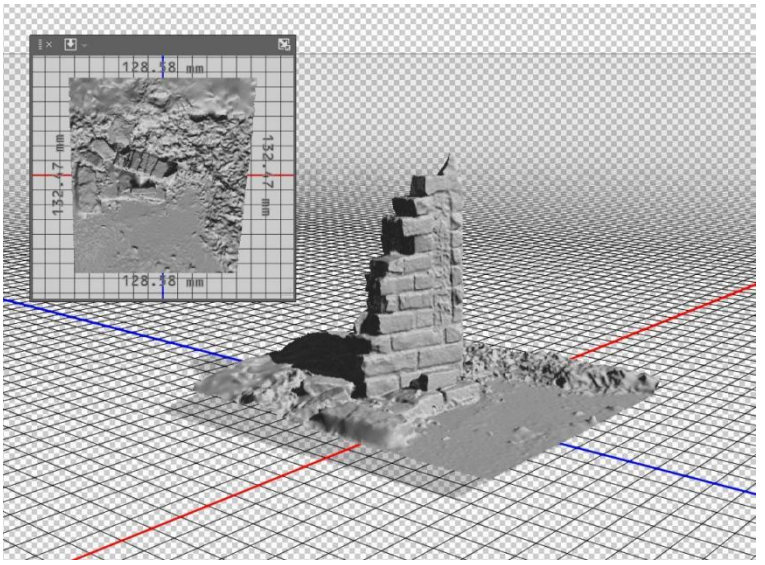


Figure 2: Scene Model of the Chongqing University Bombing Memorial Monument (Author's Illustration)

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### 3.3. XR Technology and Immersive Experience

In the process of integrating digital resources, interoperability and semantic relevance between resources are crucial. Concepts such as AR, VR, and the metaverse can provide users with immersive interactive experiences. After heterogeneous resources are integrated and associated based on ontology and graph technologies, wearable devices, augmented reality, virtual reality, hand tracking, haptic feedback devices, and full-body motion capture technologies can be combined to achieve the virtual presentation and scene switching of digital resources. This enables interactive operations and immersive experiences between users and entities. The immersive experiences and interactive operations brought by augmented reality and virtual reality technologies connect various entities and relationships under the temporal and spatial associations, providing users with a new narrative mode of virtual and real spaces overlaying and blending.

## 4. Conclusion

Currently, the field of cultural heritage has matured in terms of universal ontologies. However, there is a relative lack of research in protecting Chinese red cultural remains with distinctive characteristics. This paper, from the perspective of digital humanities, takes the Bombard of Chongqing Remain Site as an example. Based on the reusable ontology model CIDOC-CRM, it forms an ontology model suitable for Chongqing Anti-invasion War remains by determining entities and relationships through specific steps. This model enables the clarification of the intrinsic logical relationships involving figures, events, historical development processes, etc., related to remains, and facilitates knowledge secondary development. According to ontology technology, a digital communication path for Anti-invasion War remains is proposed, greatly enriching the cultural connotations of Chongqing's red culture, and deeply revealing the spiritual values carried by the remains.

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