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# Illuminating connections and contexts: building an ontology for Chinese ration coupon archival resources based on RiC-O

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## Abstract

**Introduction.** Ration coupons defined everyday life in China from 1953 to 1993, and evolving trends in research demand more sophisticated ways of describing archival resources that document this unique period of history. This study constructed the Chinese Ration Coupon Ontology (CRC-O) using the Records in Contexts-Ontology (RiC-O) model to represent and describe a resource collection of ration coupons, policy documents, and oral histories.

**Method.** CRC-O was built through combining a bottom-up process of inductively identifying key metadata elements through analysing the resources with a top-down application of RiC-O via mapping processes and creating local extensions.

**Results.** CRC-O provides a unified conceptual framework that links three types of resources through shared entities. It reuses 24 core classes and over 50 object and data properties from RiC-O and introduces local extensions. The construction process also illuminated the strengths and limitations of RiC-O.

**Conclusion.** The study offers an application of RiC-O to a new domain, demonstrating its capability to represent and integrate multiple types of archival resources, surface connections between resources, and enable rich, detailed descriptions.

# Introduction

From 1953 to 1993, China implemented a system of ration coupons () to manage the distribution of essential goods to address rapid population growth and resource scarcity (Jiao and Huang, 2010; Zhang, 2003). Triggered by a sharp urban population increase, in 1953, the Chinese government implemented the *Unified Purchase and Unified Marketing* policy to stabilise the market and ensure the equitable distribution of products. Each household received allocations of ration coupons that dictated specific quantities of goods they were allowed to purchase. The system was initially applied only to flour but soon expanded to cover nearly all everyday essentials (e.g., cooking oil, vegetables, and coal) (Lang, 1999; Perkins, 1966). As such, the 1950s to 1993 is often referred to as the Coupon Era, and the societal life of that era is called the Coupon Society.

The Coupon Era has been studied for decades, with earlier research primarily focusing on the economic and social impacts of the system, such as using government data and field surveys to explore its role in stabilising prices, balancing supply, and demand, and maintaining social stability (Chinn, 1980; Huenemann, 1966). Recently, scholars have started to examine the coupons as material and cultural objects and explore the lived experiences of the people who used them (Li, 2012; Liu, 2020; Xiao, 2022). This evolving research landscape calls for enhanced access to and more sophisticated ways of engaging with available archival resources that document the era.

In this paper, we report on our work in developing a specialised domain ontology that describes and links together multiple types of archival resources of the Coupon Era. We built the Chinese Ration Coupon Ontology (CRC-O) to describe and extract information from three heterogeneous types of materials—ration coupons, policy documents, and oral histories—to support integrated search and discovery across the content and contexts of the resources and illuminate their connections. The ontology is aligned with and extends the Records in Contexts Ontology (RiC-O) from the International Council on Archives (ICA). As an early case study of applying RiC-O to a complex set of archival resources from China, this paper describes the processes of, and lessons learned from implementing and extending RiC-O in a new domain.

# Background and related work

## Building a collection of ration coupon archival resources for evolving research needs

Our work is part of a larger project of building a digital memory platform about Beijing's history and culture. The platform consists of a digital repository of archival resources and thematic websites. The authors worked on collecting, describing, and preserving digitised archival resources about the Coupon Era in Beijing for a thematic collection under the larger repository. The resources were selected from collections of the Beijing Municipal Archives and several published books and include 382 digitised ration coupons (of 73 different types) from 1953-1996, 33 digitised policy documents from 1953-1982, and 87 digital textual documents of oral histories (published in 1998, 1999, and 2009).

A key step was determining how to describe and provide access to the collection. The three types of resources each provides a unique perspective for understanding the Coupon Society. Ration coupons contain information such as the amount or value of goods that could be exchanged, the institution that issued the coupon, and its validity period, and they are artifacts with material aspects and design elements. Official policy documents illuminate regulations governing the creation, distribution, and use of coupons. Oral histories offer personal experiences of those who lived under the rationing system, highlighting social interactions and emotional aspects of using coupons. Together, these archival materials are complex, heterogeneous resources that are also intricately interconnected, which requires thoughtful approaches to description.

In parallel, evolving academic research on the Coupon Era has created new demands for describing, organising, and analysing relevant archival resources to better support research needs. Earlier studies usually examined broader impacts of the coupon system from a top-down perspective, such as tracing the evolution of government policies to understand the role of the system (e.g., Rozelle et al., 2000). Recently, scholars have shifted their focus to the materiality and significance of coupons as objects and the powerful personal memories that they can evoke (Li, 2012; Liu, 2020; Xiao, 2022). Considering the resources in our collection, there is a broad range of information that may be important for researchers (e.g., visual information in the coupons, annotations to the policies, emotions expressed in oral histories). There is also potential in supporting new ways of exploration through providing integrated search and discovery across all three types of resources, such as creating tools that can enable users to find specific coupon types mentioned in oral histories that also have corresponding policy documents. Therefore, to maximise the added value of describing these resources to support diverse research needs, we decided to move beyond creating metadata records and explored building an ontology to capture more complex and granular information about the resources and uncover their connections.

### Ontologies for describing archival resources

Ontologies define concepts, relationships, and other distinctions that are relevant for modeling a domain (Joudrey et al., 2018) and can provide enhanced semantic clarity in description (Sicilia, 2006; Ulrich et al., 2022). Previous research has demonstrated the effectiveness of ontologies in structuring cultural heritage data and making it more accessible and interoperable for new applications (e.g., Pannach et al., 2024). Several existing ontology models are potentially applicable for describing archival resources, such as the CIDOC Conceptual Reference Model (CRM) and RiC-O. CIDOC CRM, while scalable with its high level of abstraction and rich categories and attributes, is more event-centric (Cardoso de Oliveira et al., 2024) and struggles to fully capture information about the production environment, evolution history, and relationships of the ration coupons. RiC-O is an ontology developed by the ICA for describing archival record resources and their contextual entities. It uses core entities such as Record, Agent, Event, and Rule for building multidimensional semantic networks covering the entire lifecyle of records. With RiC-O's ability to distinguish archival information from its social context and support fine-grained description, we assessed it was more appropriate for our collection.

RiC-O has been applied to describing general archival resources at national archives (Clavaud, 2019; Kim et al., 2024) and academic archives (de Souza and Flores, 2021) as well as specialised collections such as scientific correspondence (Santos and Revez, 2023) and architectural project files (Mikhaylova and Metilli, 2023). These projects adopted RiC-O as a foundation for modeling and added extensions and customisations to build their own ontologies. While they demonstrate the broad applicability and robustness of RiC-O, they also revealed several challenges. First, the complexity of the model posed a significant learning curve for archivists and created difficulties in implementation. Second, mapping metadata elements from existing standards (e.g., General International Standard Archival Description) to the semantic relationships in RiC-O with precision can be complex and time-consuming. Third, the model's high level of abstraction necessitated adjustments or significant extensions to cover specialised resource types (e.g., architectural files) or align with specific institutional practices. Our project adds to this body of work by offering an application of RiC-O to a new domain and expanding current understandings of its strengths and limitations.

## Methods

Our constructed ontology for the collection is named the Chinese Ration Coupon Ontology (CRC-O) for conciseness, but it models ration coupons, policy documents, and oral histories. We adopted established construction methods from previous studies (Jiang et al., 2021; Luo et al., 2013; Noy,

McGuinness, et al., 2001), combining a bottom-up analysis of archival resources with the top-down reuse of RiC-O.

First, we conducted an inductive, open-ended analysis of the three types of resources to identify key elements for description. The authors reviewed academic research on the Coupon Era to build a solid understanding of the subject matter and carefully engaged with the collected resources to fully grasp their content, context, and structure. We analysed each type of resource in depth and identified core elements for description that emerged as important (without following or referencing any predefined schemas). This process resulted in defining 18 elements for ration coupons (e.g., ID, Format, Published Time, Place, Validity), 19 elements for policy documents (e.g., Name, Seal, Abstract, Annotation, Time, Rule), and 25 elements for oral histories (e.g., Title, Content Summary, Language, Content Type, Scene Classification, Ration Coupons Mentioned). We also created metadata for all the resources using this set of elements to prepare for transforming the data into Resource Description Framework (RDF) triples for future work.

Next, we applied RiC-O to incorporate and express all the elements that were identified in the inductive analysis. After thoroughly reading the official RIC-O documentation, we mapped the metadata elements to the classes and properties in RIC-O. The mapping was time-consuming and required extensive discussions to ensure precision. For elements that cannot be directly mapped, we created subclasses or new attributes as local extensions. Finally, we synthesised the results from the modeling process to build the final ontology.

Our design also anticipated the needs of three user groups: those who lived through the Coupon Era who may want to relive memories and establish a sense of collective identity; younger generations interested in the era; and researchers seeking multidimensional evidence on policy evolution, material culture, and lived experiences. All groups will benefit from a system that supports cross-resource queries like '*Which oral histories mention this coupon type and what policies governed them?*' or '*How did the design of coupons for children evolve over time?*' This user-centric approach informed our attribute selections and modeling decisions, particularly the emphasis on linking entities such as Rules, Target Populations, and Time.

In the next section, we discuss the details of building CRC-O, including the construction of an overarching conceptual framework and highlights in applying RiCO.

## CRC-O construction based on RiC-O

### Building a conceptual framework

To enhance the reusability and expressiveness of our ontology, we adopted a modularisation approach to manage the complexity of the information (d'Aquin, 2011; d'Aquin et al., 2009). CRC-O consists of three modules: the Ration Coupon Module, Policy Documents Module, and Oral History Module. A key aspect of constructing CRC-O is building a conceptual framework that distils the interconnections between the three resource types to link the modules. We identified the following ways in which they are connected: (1) The government stipulates the rules for issuing and circulating ration coupons through policy documents (Policy Document Records); (2) Different ration coupons (Ration Coupon Records) target different populations (e.g., pastry coupons for children); (3) People belonging to specific target populations used a variety of ration coupons in their daily lives in accordance with relevant policy documents, and these experiences are captured in oral histories.

These connections were modelled in the following ways to form the conceptual framework. First, Ration Coupon Records and Target Populations were identified and designated as the two core entities that are shared by all three resource types. Second, Rules (i.e., specific regulations) within the Policy Document Records was established as a bridging entity that connects the Ration Coupon and Oral History modules. Rules were furthered classified into two subtypes: Administrative Rules

that govern the design, issuance, retrieval, and disposal of coupons, and Usage Rules that cover information such as issuance date, region of use, nominal value, and target populations. Third, beyond the core entities, Time and Place were assigned as supporting shared entities, because the resources can also be connected through temporal markers (e.g., issuance date and validity period of coupons, date of events in oral histories) and spatial markers (e.g., region of issuance of coupons, locations described in oral histories).

In sum, the Ration Coupon Records, Target Populations, Rules, Time, and Place entities enable the integration of the resources into a unified and semantically rich conceptual framework, which is illustrated in Figure 1.

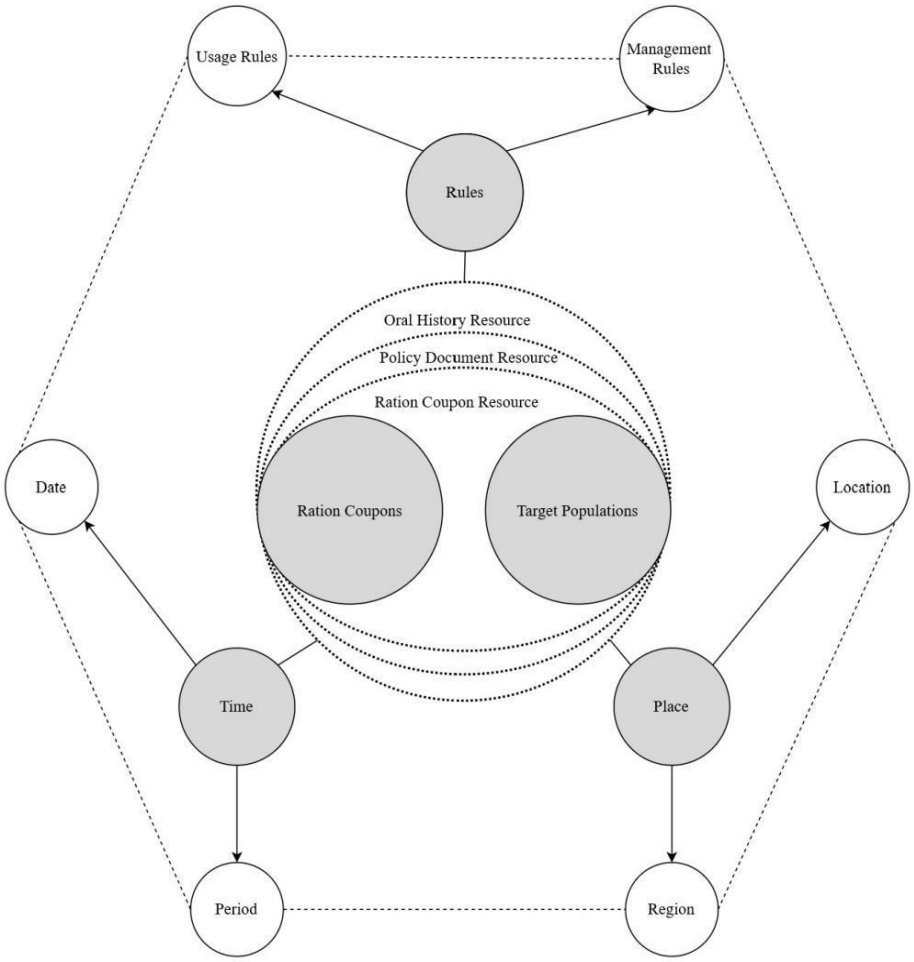


**Figure 1.** Conceptual framework of shared entities of CRC archival resources.

## Applying RiC-O: strengths, limitations, and extensions

As we applied RiC-O to our modeling, we noted two aspects that illuminate its strengths in representing complex archival resources. First, according to RiC-CM, a key innovation of RiC is its distinction between a Record and its Instantiation: A record is regarded as something intellectual which must have or had at least one physical incarnation (instantiation) but may have or have had many (International Council on Archives, 2016, p. 21). Modeling ration coupon resources validates the applicability of this concept: Although coupons of the same design were mass-produced, because so few of them still exist today, they have become conceptually closer to '*Records*' that document history (instead of widely available artifacts). With RiC's Record and Instantiation concepts, we were able to conceptualise the '*abstract idea*' of a specific coupon as a Record and

the actual remaining physical coupon copies (and its scanned copies) as its Instantiations. Therefore, this modeling example illustrates that the distinction is indeed valuable in a practical context.

Second, instead of situating records under archival hierarchies (fonds-series-files-records), RiC places them within a network of relationships (International Council on Archives, 2016, p. 11). RiC-O: Record Part, for example, helped us to model more granular attributes and build more connections. We used RiC-O: Record Part to model visual elements of coupons (e.g., patterns, icons, and watermarks), which enabled us to link them to coupons (RiC-O: Record) via the property rico:hasDirectConstituent. Therefore, we achieved more detailed descriptions while also enabling the searching and clustering of coupons based on visual features.

Our application of RiC also revealed limitations in its available entities. For example, while coupons can have multiple types of temporal information, such as issue date (specific year/month), validity period (e.g., '*valid this month*' or '*this year*'), and a historical period that it belongs to, RiC can only represent time through the Date class. Additionally, markings in policy documents such as signatures and revision traces convey crucial information, yet RiC-O does not provide a dedicated class for document annotations. Nevertheless, owing to RiC's flexibility and extensibility, we were able to address this issue through designing extensions. For example, in the Ration Coupon Module, we associated a coupon entity with its validity period via rico:isRelatedTo and linked it to its issue date using rico:hasPublicationDate. We also used rico:isWithin to associate specific issue dates with a historical period that it belongs to using a typology of Chinese historical periods. This allowed us to group coupons by time periods and provide temporal context for interpreting specific visual features.

The completed CRC-O reuses 24 core classes and over 50 object and data properties from RiC-O and introduced multiple new classes, object properties, and data properties tailored to domain-specific requirements (see Figures 2, 3, and 4 for models of each module).

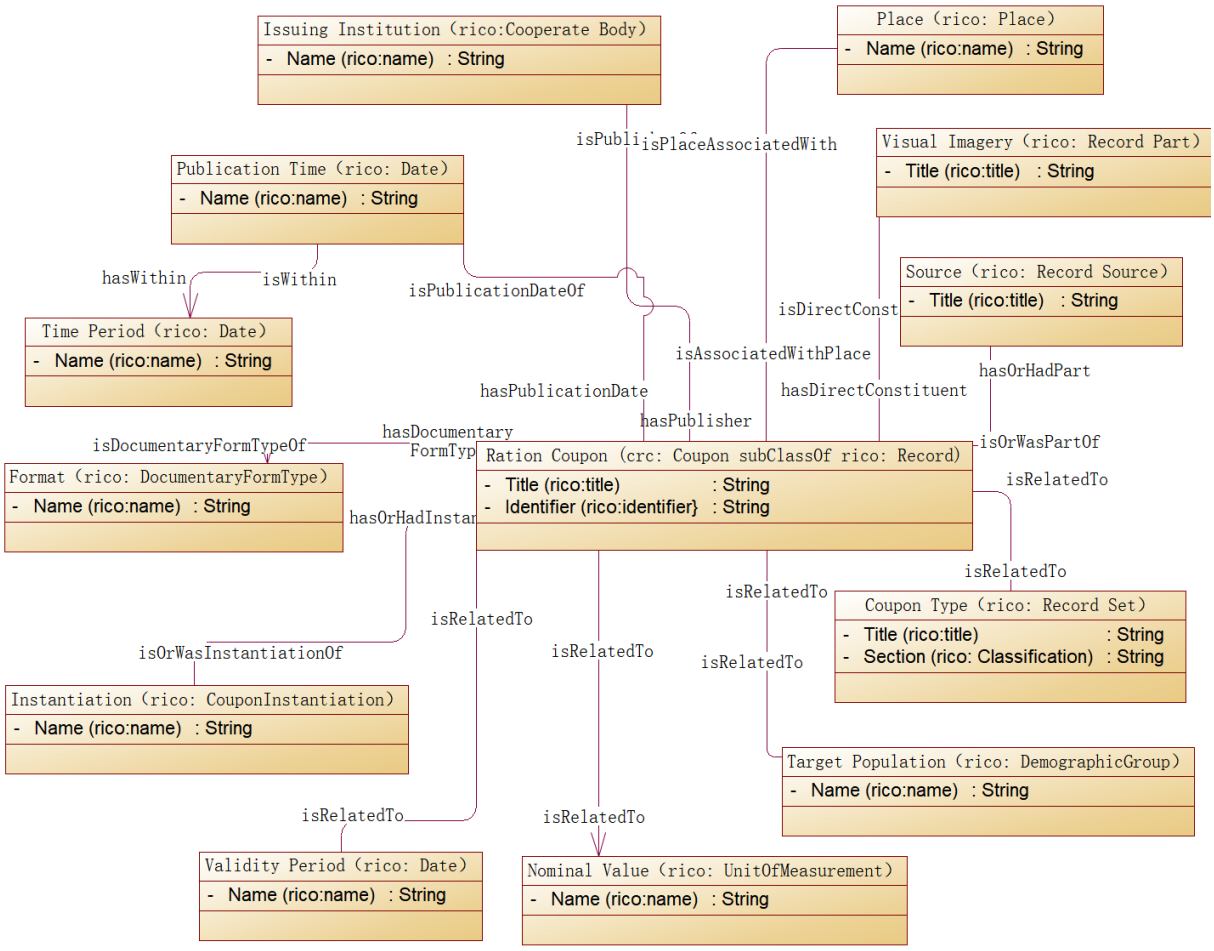


**Figure 2.** Class diagram of the ration coupon module.

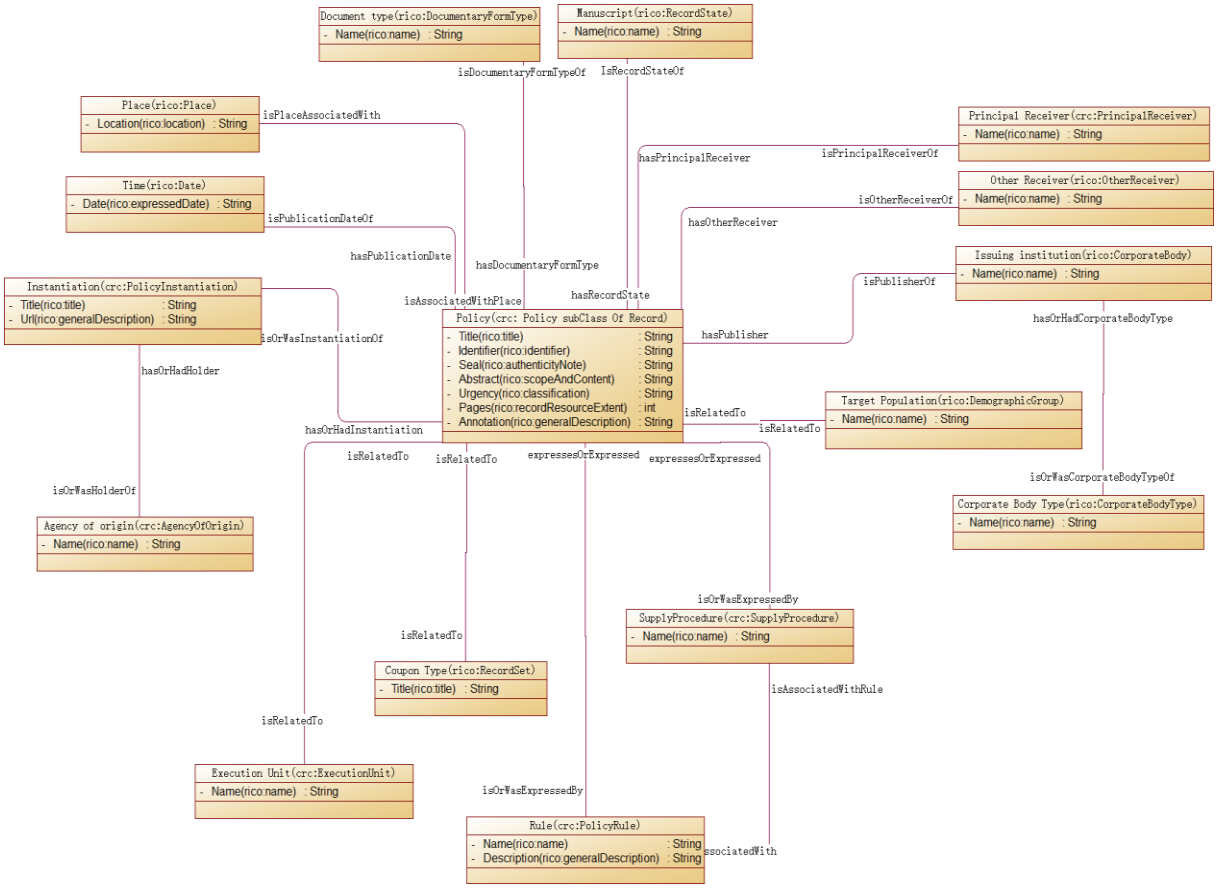


**Figure 3.** Class diagram of the policy documents module.

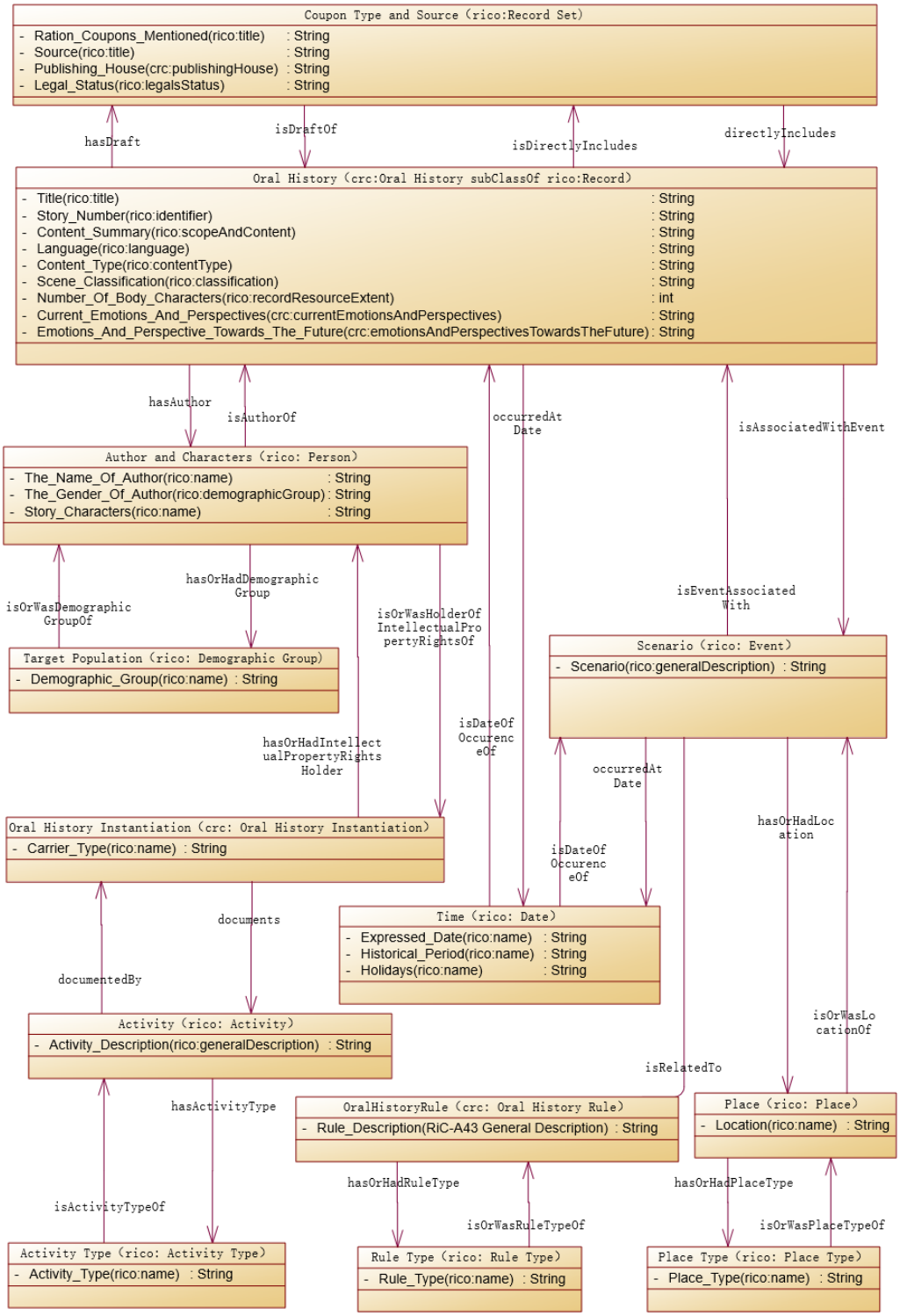


**Figure 4.** Class diagram of the oral history module.

## Discussion

This study enhances our understanding of RiC-O and its practical application in three ways.

First, it demonstrates the feasibility of applying RiC-O to build ontologies for archival collections that are small but complex and may lack specialised metadata schemas. For institutions interested

in similar initiatives, our method—combining a bottomup process of identifying metadata elements through resource analysis with a top-down application of RiC-O via mapping and local extensions—offers a useful approach. This method allowed us to remain '*grounded*' and be attentive to the features of each resource type while leveraging RiC-O's flexibility to represent content and context and build connections across resources.

Second, the process of constructing CRC-O highlights RiC-O's ability to integrate resources of different forms and domains. Our collection includes traditional archival materials, such as policy documents, alongside ration coupons that resemble museum objects. By applying RiC-O, we were able to describe these resources in an integrated way, establish sophisticated contextual networks, and provide users with richer information. This illustrates RiC-O's potential to support meaningful cross-domain integration, which is in line with RiC-CM's vision of facilitating collaborations across cultural heritage communities. Mapping RiC-O to other cultural heritage ontologies points to further opportunities for interoperability and broader cooperation.

Finally, the challenges we encountered suggest areas for improvement. Consistent with other case studies, RiC-O's complexity creates barriers to adoption: expertise in ontologies, knowledge graph construction, and domain knowledge is required even for small-scale projects. Clearer application guidance, such as the forthcoming RiC-AG, will therefore be essential. Additionally, our findings indicate that simplified date expressions in RiC-CM 1.0 may be problematic, and current entities are insufficient for representing annotations and visual elements. These limitations underscore the need for refinement to enhance RiC-O's usability across contexts.

## Conclusion

This research offers an application of RiC-O to a new domain, demonstrating its potential to represent and integrate multiple archival resource types and enable context-rich descriptions. It also introduces a hybrid top-down and bottom-up methodology for localising RiC-O and illustrates the potential of constructing a more multidimensional narrative of the Coupon Era by linking official records, artifacts, and oral histories.

Our future work will focus on three areas: (1) transforming the data into a knowledge graph and testing its capacity for complex SPARQL queries; (2) expanding CRC-O to include resources from additional regions in China; and (3) exploring mappings to CIDOC-CRM (widely used in museums where ration coupons are sometimes collected). This study represents an initial step in a continuing journey of building innovative tools to explore China's ration coupon archival resources.

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