An Extension of RiC-O for Architectural Archives

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Abstract

Architectural archives, usually held by private bodies, are important primary sources of information for architecture and urban development historians; for architects themselves, who research archives for inspiration and to prepare for restoration; and also for common citizens, who may find it interesting to discover the designs of their own homes. Cataloguing standards for archival descriptions of architectural records have existed at least since the 1980s, however, the rise of Linked Open Data as a framework for publishing cultural heritage data has allowed archivists to enhance the descriptions with rich contextual information and links to external knowledge bases. In this paper, we present an extension of RiC-Ontology designed for describing architectural archival records and the creative process that leads to their production, and we discuss its application to the project files of Italian architect and engineer Dino Tamburini (1924–2011). The ontology is suitable for representing typical architectural records such as drawings, written reports, bid documents and photographs, but also the different stages of an architectural project and their actors.

Keywords

ontology, architectural archive, RiC-O, Semantic Web, Linked Open Data

1. Introduction

The exploration of architectural archives is one of the activities carried out by architects in preparation for their work. Architectural records are used for inspiration and typology studies for new buildings, or as historical reference for restoration or restructuring of existing works. Architecture and art historians analyze records to study the urban development of a city, while biographers use them to trace changes in the style of a particular architect.

What design ideas were considered by an architect before developing the one that was realized? Are there any office buildings that were designed by a particular architect? How has a specific architectural project evolved over time? While traditional finding aids, which are focused on the hierarchical structure of the archive, could lead researchers to the right place to find answers to these questions, they are usually not easily accessible or searchable.

We believe that information search and exploration in architectural archives could be greatly improved by modeling data in a structured and formal way. By representing the archive as a semantic network, it would be easier and faster to answer complex queries, fostering new quantitative analyses alongside classical qualitative research.

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Architectural archives are usually owned by private bodies, and both cataloguing standards and the way to represent digitised versions vary from archive to archive. Archives that are included in national systems generally follow a tree-structure description, where the unit is a project. The descriptions of individual records, that are usually drawings, are mostly focused on their external aspects, such as execution and reproduction techniques, paper types, drawing tools, scale, dimensions. Contextual information includes creators and authors of records, and sometimes geographic locations.

Architectural records, however, are also reflections of the intellectual process of an architect, and by studying them as such, it is possible to reconstruct the knowledge process followed by the architect when developing each project. In our work, we adopt this wider perspective.

This paper presents an extension of the Records in Contexts Ontology (RiC-O) designed for the semantic annotation of typical architectural records such as drawings, reports, bid documents, photographs, and for linking them to the different phases of the architectural project. The ontology has been applied to the project files of Italian architect and engineer Dino Tamburini (1924–2011).

In Section 2, we describe the main related works. In Section 3, we present our ontology. Section 4 briefly discusses the application of the ontology to the case study of the Tamburini archive. Finally, Section 5 reports our conclusions.

2. Related Works

The benefits of a Linked Data approach for memory institutions have long been discussed in the literature [1]. Several semantic data models have been developed specifically for the description of cultural heritage by GLAM (Galleries, Libraries, Archives, and Museums).

The CIDOC Conceptual Reference Model [2] is a high-level event-oriented ontology for the description of cultural heritage developed by the International Council of Museums (ICOM). Europeana, the largest European digital library, represents data through the Europeana Data Model (EDM) [3], which is compatible with the CIDOC CRM.

At the same time, a standard model has been developed also in the library field, by the International Federation of Library Associations (IFLA). This model is called FRBR (Functional Requirements for Bibliographic Records) [4], and its successor is LRM (Library Reference Model) [5]. An ontology based on Semantic Web standards, called FRBRoo, has been developed on top of FRBR, and has seen wide adoption in the library and information science field [6].

Such standardization efforts based on Semantic Web technologies have long eluded the archival field, where until recently there was no widely adopted standard ontology. Architectural archives relied on guidelines for the description of architectural records which were published by the international community of archivists and architects since the early 2000s [7, 8]. The analysis of architectural project's phases and concrete examples soon followed [9, 10].

In Italy, significant work for preservation and dissemination of architectural archives was made by Asociazione Nazionale Archivi di Architettura, Museo MAXXI and Archivio Progetti IUAV Venezia [11, 12, 13, 14], while the first large-scale project for digital access to architectural heritage of the 20th century for the general public was SAN's Portale degli Architetti [15].

In 2016, the International Council for Archives (ICA) published the initial version of the

Records in Contexts Conceptual Model (RiC-CM), which was later expressed in a formal way through the RiC-Ontology (RiC-O) [16, 17]. This ontology focuses on the semantic links between records, their creators, function and is intended to produce more context-oriented descriptions for single documents, rather than structure-oriented descriptions for files as previous standards.

Independently from the efforts of ICA, alternative ontologies for archival description have recently been proposed, often within the scope of representation of a specific archive. ArDO is an ontology designed for describing the hierarchical nature of archival data and the dynamics of adopted classification, first used for description of records about the Weimar Republic [18]. ARKIVO is an ontology designed around the concepts of Collection and Historical Event that were used to describe holdings of Jozef Pilsudski Institute of America [19].

To the best of our knowledge, there is no mapping of existing archival guidelines for architectural records to Semantic Web technologies, however, the Post-War Queensland Architecture Digital Archive developed a functional upper ontology for describing their records [20].

3. Ontology Design

In this section, we propose an extension of RiC-O for the semantic annotation of architectural archives. The ITDT ontology[1] focuses on the reconstruction of the knowledge process behind an architectural project through document testimonies, thus providing a way to describe the phases and stages of development of a project, their participants and the documents that are produced as an outcome of this process.

The ontology was created to support the publishing of the architectural archive of Italian architect and engineer Dino Tamburini, therefore the development had the practical goal of modeling and sharing archival descriptions as Linked Open Data.[2]

To develop the ontology, we adopted an iterative design methodology, inspired by [21], that requires three steps: creation of motivating scenario and competency questions, formal ontology modeling and data and query testing. This method allowed us to test the model on real data early in the development process and verify its compliance with project tasks. Some design choices were driven by the need to translate the resulting knowledge graph into an almost flat structure for archive visualisation, therefore we avoided the use of non-binary relations and complex semantic expressions.

The design of RiC-O provides different possibilities for the description of specific types of records. First of all, the types could be designed as subclasses of the `rico:Record` class, and this would make it possible to arrange and represent them as a natural hierarchy [22, 18]. Alternatively, the record types could be implemented as instances of the class `rico:Type`. In this case, the intellectual purpose of the record would be expressed as an instance of `Content Type`, the physical characteristics through instances of `Representation Type` or `Carrier Type`, and the broader and narrow terms could be implemented via the appropriate properties from SKOS [23].

In our ontology, we opted to represent types of architectural records as subclasses, because the type, such as working, drawing or model, is an essential concept for the architectural

[1]The ontology is available in human-readable form at: https://dmikhaylova.github.io/itdt_ontology/, and as an OWL document (using the Turtle syntax) at: https://dmikhaylova.github.io/itdt_ontology/itdt.ttl.

[2]A sample dataset is available at: https://github.com/dmikhaylova/dt_archive/blob/main/dt.ttl.

archive. Indeed, these records differ in purpose, content and carrier, and their own properties are singular. We believe that the classification we created is suitable for reuse and extension by other architectural archives, as the record types are similar for all of them. However, we have also implemented other classifications, discussed in Sections 3.2 and 3.3, through the use of `rico:Type`.

In addition to RiC-O, our ontology builds on SKOS [23], FOAF [24] and OWL [25]. The main concept of the ontology is the Architectural Project, which is seen from three different perspectives, that of file, that of knowledge process and that of potential built work. The following sections describe the sections of the ontology dedicated to each of the perspective.

3.1. Project File Description

In architectural archives, the typical unit of description is the project file — a set of documents related to one architectural project. Each project file may be further divided into sub-files, often mirroring administrative procedures for architectural competitions, building permissions and public procurement.

RiC-O provides entities for multilevel archival description of the project file: the class `rico:RecordSet` represents the project file itself, the class `rico:Record` represents an individual document, and the property `rico:isOrWasIncludedIn` annotates the tree structure of an archive. To reflect the particular nature of architectural records, we extended class `Record` with subclass `itdt:ArchitecturalRecord`, and this one with further subclasses that represent graphical records, written documents and architectural models. In particular, subclasses for common types of drawings were defined based on descriptions provided in [7], [9], Art and Architecture Thesaurus [26] and actual archival records.

The class `itdt:ConceptualDrawing` aggregates small scale freehand drawing that gives a preliminary, symbolic idea of the design; `itdt:DesignDrawing` represents the refined version of conceptual drawings made with instruments; `itdt:Rendering` stands for detailed free-hand or instrument-aided drawings that features entire project, but also people, vegetation, vehicles and is made with shading, colour and perspective.

To translate three-dimensional design of a future building to two-dimensional medium such as paper, architects use four types of technical drawings: *elevations* (projections on vertical plane), *sections* (traversal or longitudinal cut), *floor plans* (horizontal cut through the building made above the floor) and *general plans* (depiction of the area for construction). These drawings are aggregated by class `itdt:WorkingDrawing` and its subclasses. Large scale, detailed drawings used directly on construction sites are represented by the class `itdt:ConstructionDrawings` and its subclasses.

Architectural photographs are often found in archives and used as a medium for study of urban context and to document construction works and final design of buildings and their decorative details. Photographs are aggregated by subclasses of `itdt:GraphicalRecord`: `itdt:ExteriorPhotograph`, `itdt:InteriorPhotograph`, `itdt:ProcessPhotograph` and `itdt:DetailPhotograph`.

Written documents are described by subclasses of `itdt:WrittenRecord`: `itdt:Report`, `itdt:Article`, `itdt:Invitation`. Finally, we have created a class `itdt:Model` with two subclasses `itdt:PhysicalModel` and `itdt:VirtualModel`. In the annotation of the Tamburini archive, we

use the class rico:Instantiation to describe simple photographs of architectural models and connect them with their digital copies through the property rico:hasDerivedInstantiation.

3.2. Knowledge Process Description

Architects generally see the architectural project as "a process tool for knowledge acquisition that helps to gradually construct a solution to a problem that they are faced with" [27] and the drawings as "fundamental thought-form of an architect" [28] in this process. In the traditional archival finding aids projects are listed in a project index, which is then referred in the files' description. To store projects in the graph, we have extended the class rico:Activity with a subclass itdt:ArchitecturalProject.

The typical 20th century architectural project develops in several phases. Different sources propose five to seven phases, including Analysis, Design, Execution, Acceptance and Follow-Up [9, 7]. Each phase results in particular types of drawings and documents. For example, during the Execution phase, engineers draft the construction drawings. However, the overlap is not full, as elevations may be created at different phases with different level of detail. Historians of architecture are particularly interested in the analysis and design phases, as the documents related to these phases provide a clue for understanding the creative process of an architect.

The ontology provides classes for the five phases described above, but also for the more granular stages of the design phase (itdt:SetupStage, itdt:ConciseIdeaStage, itdt:DevelopmentStage)[3] and execution phase (itdt:PermitStage, itdt:BidStage, itdt:ConstructionStage. The object property itdt:hasOrHadProjectPhase relates an architectural project to its phases and stages.

The records are connected to the stage or phase by object property rico:documents, as the super-class itdt:ArchitecturalProjectPhase is defined as subclass of rico:Activity. In the annotation of the Tamburini archive, for each project we have listed all phases that applied (e.g. the never-built design would end with the creative phase), even if they are not documented at all. This rule provides a way to note lack of records for a particular project.

The quantity and duration of phases depend, among other factors, on what is known as *project scale* [8], i.e. a common way to classify an architect's work by describing the magnitude of the intervention. The scale of a project is described by the class itdt:ProjectScaleType, that extends rico:Type and is linked to the project by the object property itdt:hasProjectScaleType. For example, for the Tamburini archive we implemented the classification proposed by [8]: "general planning", "implementation planning", "architectural design", "restoration", "interior design" and "industrial design".

Architectural projects of the late 1990s are rarely the work of a single studio. Complex documentation submitted for competitions and building permits requires collaboration of different professionals or companies. The ontology provides a class itdt:ProjectParticipation, whose instances represent the ternary relation between a project or a project phase/stage, an agent and a project role, that are expressed through the object properties itdt:isOrWasProjectParticipationOf, itdt:hasOrHadParticipant, itdt:hasOrHadProjectRole.

[3]The stages of the creative phase are based on [27], and in our opinion reflect the process followed by Tamburini in his work.

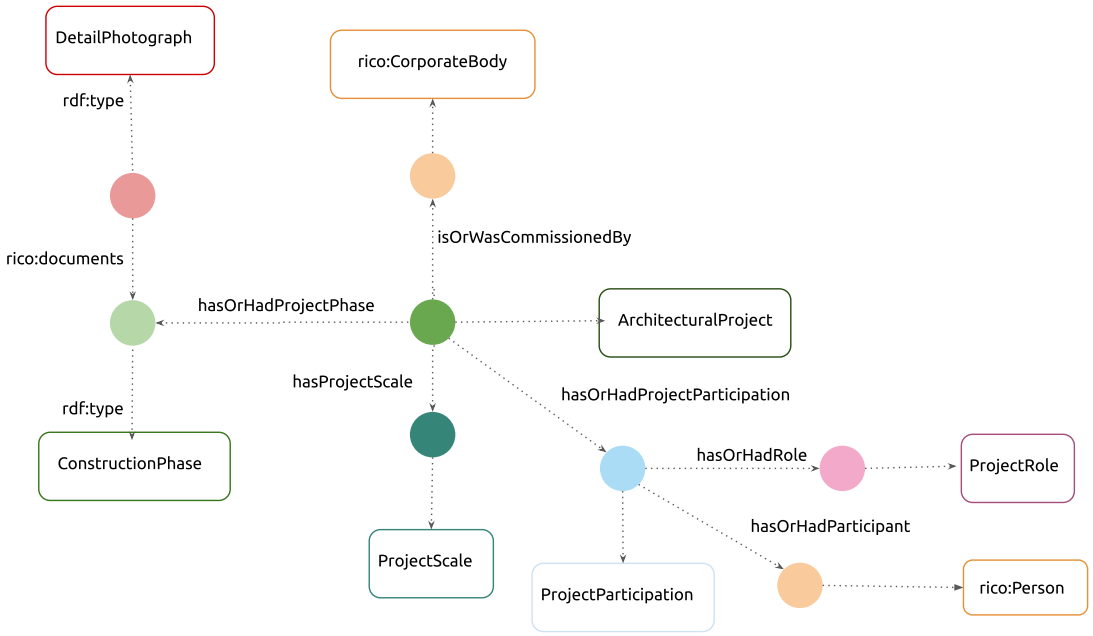

Figure 1: Graphical representation of the ontology. Circles stand for individuals, rectangles for classes. The custom prefix and the rdf:type property are omitted for visual clarity.

3.3. Architectural Artefact

The concept of Architectural project in the ontology relates to the intangible intellectual work, that is preparatory to the creation of an artefact.[4]

We introduce in the ontology the notion of *functional* and *formal types* of building [29, 30]. The functional type describes the intended use of future building (e.g. residential, commercial), instead a formal type is an idea of building that is recognisable by others but can be interpreted by an architect in many different ways (e.g. roman theatre, courtyard house). Building types are implemented as individuals of `FormalBuildingType` or `FunctionalBuildingType`, subclasses of `rico:Type`.

Architectural archives usually contain the project records that do not relate to any existing built work, either because the project was never carried out or because the building was demolished or altered. To provide means for transmitting this information, we implemented the data properties `itdt:wasCarriedOut` and `itdt:exists`.

4. Case Study: Project Files of Dino Tamburini

As a case study, the ontology presented in this paper has been applied to the private archive of Dino Tamburini (1924–2011). Tamburini, an Italian engineer and an architect, was an important

[4]We consider all object and data properties that have this class as domain as related to the project and not to the architectural artefact, even if their labels contain the word “building”.

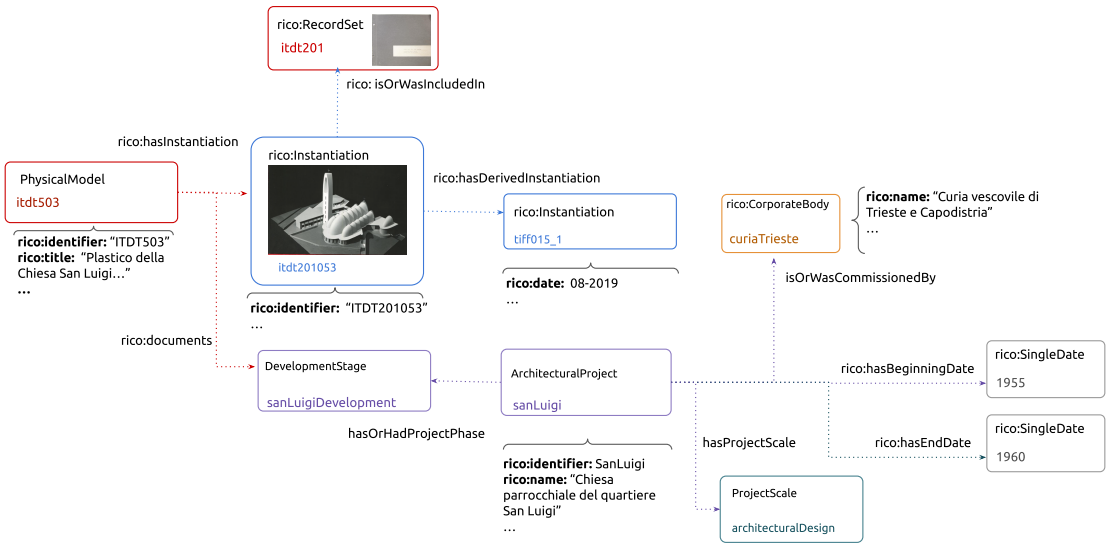

Figure 2: Example of annotation for Tamburini archive. Rectangles stand for classes, individuals' names are written in the same color of class. The color of connectors reflect property's domain. Data properties and their values are shown under curly brackets. The custom prefix is omitted for visual clarity.

figure for post-war reconstruction of Trieste. The representative of Modern movement and organic architecture, he participated in more than 150 architectural projects and designed public and private residential buildings, transport infrastructures, educational complexes, churches, theaters. Tamburini is best known for the restoration of Teatro Verdi, the Church dedicated to Saint Aloysius Gonzaga, and Trieste's first skyscrapers in via Conti. Tamburini's papers are currently in the process of being recognised as historical heritage by the Italian state.

The "Architecture" series of the archive contains documents created by Tamburini during his career (1948–2011) and existence of his architectural studio (1952–2007). The series contains files consisting of entire project documentation (mostly for later works) and so-called portfolios: photocopies of selected sketches, drawings, photographs and written documents arranged in chronological order by the creator (at least for the earlier works).

The creation of the ontology is one of the goals within a larger project of digitization, publishing of the archive and sharing it through SAN (the National Archival System of Italy) and, eventually, also through the Europeana digital library. Before this work started, the archive was not arranged and no finding aids existed. The development of the ontology was carried out in an iterative way in parallel with the description of the archive. At the moment, the arrangement of the archive exists only "on data".

During the annotation, we had to choose whether to apply the RiC-O principles to the letter, or adapt the ontology for our purposes. For example, in RiC-O each intellectual `rico:Record` should have at least one `rico:Instantiation` (both physical and digital), however in our case this would have resulted in a one-to-one mapping with significant duplication of data, therefore, we decided to simply create an instance of `rico:Record` corresponding to each document, and

use `rico:Instantiation` only for the digital copies of each document.

The distinction between the conceptual and the material is naturally present in architectural archives, as their arrangement is almost always only conceptual: for example, a large format drawing is often not stored in the same folder with other project documents. In this case, the drawing's record belongs to the conceptual record set, and its instantiation to the optional physical record set. The distinction between intellectual content and its instantiation adds to complexity.

Among the other modeling issues that we had to consider, there were the important choice between classification through subclasses and categorization through types (see Section 3), and the representation of temporal information. For example, the uncertainty of dating is modelled in RiC-O through a data property `rico:certainty`. In our annotation, the same year is often represented by two individuals of `rico:SingleDate`: certain and uncertain.

5. Conclusions

In this paper, we have presented an extension of Records in Contexts Ontology (RiC-O) that allows a structured and formal representation of data about architectural archives. The ontology extends RiC-O by modeling the architectural project, its different phases, and the specific types of record that are found in an architectural archive. Furthermore, the model also allows the description of architectural artifacts.

The ontology makes it possible to represent architectural archives in a structured and formal way, compatible with existing standards, thereby improving information search and exploration in this archival domain. We have successfully validated the model by applying it to a concrete case study — the archive of Italian architect Dino Tamburini. Both the ontology and a preliminary dataset have been published online.

As future work, we are working on a digital version of the archive that will be published online and shared through SAN (the National Archival System of Italy) and, eventually, also through the Europeana digital library. Furthermore, we also plan to investigate the application of the ontology to other architectural archives.

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