An Ontology for Architectural Heritage: Historical Figures and Organizations

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Abstract. The goal of the article is to present one of a total of seven ontologies in the project for the Semantic Modelling of the Bulgarian Pre- and Revival houses. The ontological representation of historical and contemporary figures and organizations concerning the residential revival architecture will be considered.

Keywords: Ontology, Semantic Modelling, Bulgarian Revival Architecture, Historical Figures, Cultural Heritage.

1 Introduction

The times we live in are different from the times of our grandparents, but we have something in common – they had their history, and they created our history, so we should remember and preserve it. Digitalization is a worldwide process, we should follow it to make our history relevant to the times in which we live, and to present it to future generations. The ontological approach is relevant in the case for a lot of reasons. An introduction, in a nutshell, to our main project of the Distributed e-Learning Center (DeLC) laboratory of the Faculty of Mathematics and Informatics (FMI), the University of Plovdiv, named Intelligent Tourist Guide Assistant is attached:

- Intelligent Tourist Guide Assistant (Glushkova, Stoyanova-Doycheva, Ivanova, Stoyanov, & Doychev, 2019) – It is a Cyber-Physical-Social (CPSS) and Internet of Things (IoT) system with the human factor at the focus. Some main components with an intelligent role are the intelligent agents and the ontologies as their knowledge base.
- Ontological Network for the Cultural and Historical Heritage (CHH-OntoNet) of Bulgaria – The ontologies are organized in hierarchies and they are separated as a module of the architecture of the system (Stoyanov, Glushkova, Stoyanova-Doycheva, Doychev, & Ivanova, 2019), called CHH-OntoNet.
- Cataloguing Cultural Objects (CCO) standard (Baca, Harpring, Lanzi, McRae, & Whiteside, 2006) – For the purposes of the project, the CCO standard was used. The choice of an international standard is an important decision for the future development and sharing of the application, but in addition to this opportunity, the standard fits well into the concept of movable or immovable

cultural heritage. The CCO standard includes a strategy for the case – architectural heritage.

- Semantic modelling of the Bulgarian Revival architecture – As this is the authors' principal interest in this work, the topic is described in more detail in the articles (Madanska, Bilyanov, Stoyanova-Doycheva, & Stoyanov, 2021) (Madanska, Stoyanov, & Stoyanova-Doycheva, 2021). The Web Ontology Language (OWL) ontologies are developed using the ontology development environment Protégé (Musen, 2015).

As it is well known, ontological engineering is often an interdisciplinary approach. There are many important points in the periphery that need to be considered to complete the main complex project for the domain of interest.

2 Agents Ontology

The Agents ontology is named in this way because it follows the CCO standard. The ontology embodies the concept of describing personalities and organizations associated with houses of cultural and historical significance. Many of these personalities have an important role not only in the houses as buildings but also in the Bulgarian history and culture.

2.1 Class Hierarchy

The class hierarchy definition is one of the first steps in making an ontology. Some classes are the authors' decision, but there are also classes directly taken from the requirements of the CCO standard, like the human factor and the people's role in terms of the cultural property – in this case, a house, i.e., the builders of the house, the restorers (if any), as well as the owners, also organizations and institutions related to architectural sites. Considering the selected sites of Cultural and Historical Heritage (CHH), which are also sites of the National Institute for Immovable Cultural Heritage (NIICH) (National Institute for Immovable Cultural Heritage, 2022), many of them have a history of registration as a cultural asset by NIICH, which is under the direct jurisdiction of the Ministry of Culture of the Republic of Bulgaria. Monuments have a different status according to the law of the same and this is described in the "DocumentedStatute" class and its respective subclasses.

The corporate bodies themselves – institutes, institutions, museums, and non-governmental organizations that play (or have played) a role in the described CHH objects are affected in the "CorporateBody" class and its subclasses. Nationality is a feature of both individuals and institutions, some of which are national, the United Nations Educational, Scientific and Cultural Organization (UNESCO) may also be included in a future stage. All unknown personalities are united in classes with analogical naming and their life role (different or not from the role they had regarding the houses) is described in "PersonLifeRole". Its subclasses are the concepts of architects, merchants, construction technicians, and others.

Figure 1 is attached for an illustrative purpose of the most basic part of the class hierarchy.

Fig. 1. Part of the class hierarchy of the Agents ontology

2.2 Properties

Similarly to the class hierarchy, there also is a property hierarchy. Properties are predicates in the triples of RDF (Resource Description Framework) – base of OWL. There

is a variety of object properties (Fig. 2), including interpersonal and family relationships, among others. They are characterized as functional, inverse functional, symmetric, asymmetric, reflexive, irreflexive, and transitive. For example, "hasAs-sociativeRelationshipWith" has the following sub-properties: "hasFather", "is-MotherOf", "isChildOf", "hasKinship", "isSiblingOf".

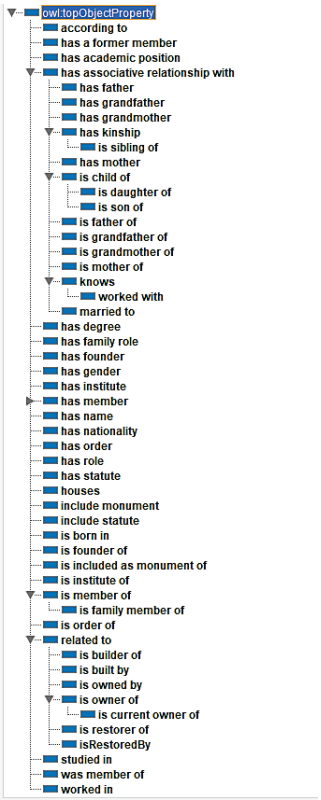

Fig. 2. Part of the object properties hierarchy of the Agents ontology

The subclasses of "owl:topDataProperty" in the ontology are: "hasBirthDateValue", "hasDeathDateValue", "hasDateOfEstablishmentValue", "hasDateOfDissolution-Value", "hasCABIDValue", "hasOrderValue", and others. It is recommended to have the "value" suffix to connect the individual with the corresponding value from the datatype – integer, decimal, string, and so on. Data properties also have their (mainly functional) characteristics.

2.3 Axioms

Each class is characterized based on axioms. The primitive class "Institute" is represented as the named class of things that are connected by the "isInstituteOf" property limited existentially (at least once) with the individuals of the "Institution" class. The

individual of the “Institute” class – “National Institute of Immovable Heritage”, also meets these conditions. The “Institution” class is a subclass of “CorporateBody” and is linked by the “hasInstitute” property with an existential restriction to the “Institute” concept. Its instance is the “Ministry of Culture of the Republic of Bulgaria”.

Some of the houses are house museums, such as the Hadjichoneva house in the Ustovo district, the town of Smolyan (in the Rhodope mountains), or the Moskoyani house in the town of Nessebar on the Bulgarian Black Sea coast. The “Documented-Statute” class is described by the axiom that it is a concept of the things that have at least one relationship through the “according to” property to the “Institution” class. This is because the status of cultural value is registered by a certain state or world institution, which is usually the Ministry of Culture of the Republic of Bulgaria. The cultural properties are listed in the State Gazette. This is a legal right enforced by law, therefore, there is a “Law” class. Its individual is the “Bulgarian Cultural Heritage Act” and, according to it, the included house individuals are listed as heritage. Some of the houses are listed in the State Gazette of Bulgaria, which is described as an individual of the “Listing” class.

Figure 3 illustrates other class examples from the class hierarchy in the ontology and the description of the “Man” class.

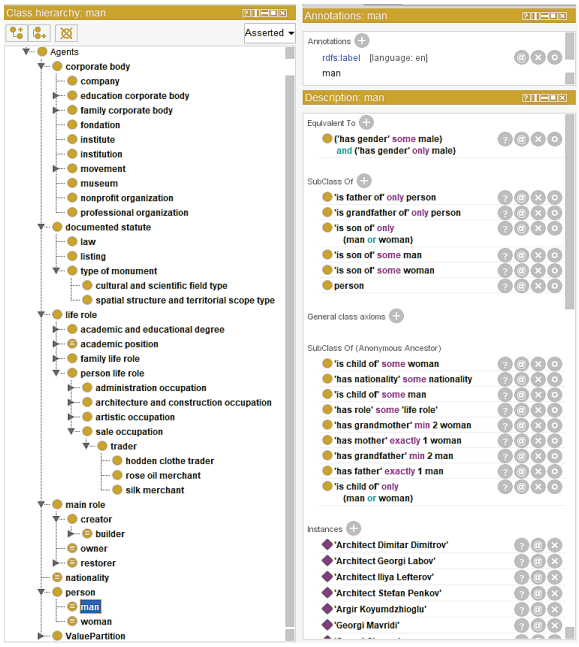

Fig. 3. Class description – an axioms example

2.4 Individuals

The individuals in the ontology are described in detail. There are historical figures like Yordan Yovkov who is a prominent Bulgarian writer, Stoyan Stoyanov Mihaylovski –

more popular as Hilarion of Makariopolis (a clergyman), and the Greek family of merchants Kordopoulos that have a large participation in the wine industry in Melnik – owners of the largest Revival house on the Balkan Peninsula, which is preserved to this day. The life roles of some of the people are the ruler of Ottoman Shiroka Luka – Hodja Salih Madzerski, the hodden (important for the traditional Bulgarian man costume) Bulgarian clothes trader Pangal Valchu, or the world-famous rose oil merchant Hristo Daskalov.

The next figure illustrates the Pangalova house case, which is one of the most popular Rhodope Revival Houses; a museum until a few years ago, now in need of restoration. The creators of this work of art and architecture remain little known to the public. However, the population of Smolyan realized the talent of one of the masters and named a street after him (Harit Kisyov). Figure 4 shows his brother as the focus of the case – Valchu Kisyov, through a graphic visual representation from the Web version of Protégé. Both of them have the same role for the Pangalova house – a builder.

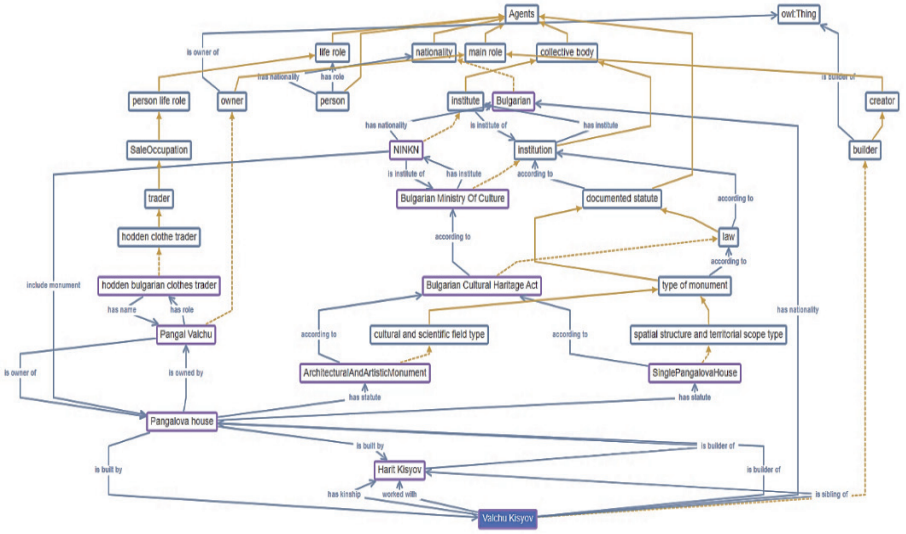

Fig. 4. The Pangalova House Case with the focus on Valcho Kisyov

2.5 Cellfie Plugin: Automatically Generated Axioms

Some of the individuals are introduced through the user interface of Protégé, while for others the Cellfie plugin is used.

The ability to create OWL axioms from an Excel spreadsheet is built into the development environment Protégé Desktop. The Cellfie plugin provides data import from Excel spreadsheets into an OWL ontology. It includes transformation rules describing how to implement the data available to successfully convert it into "object-predicate-subject" triples. Fig. 5 shows the way axioms are generated.

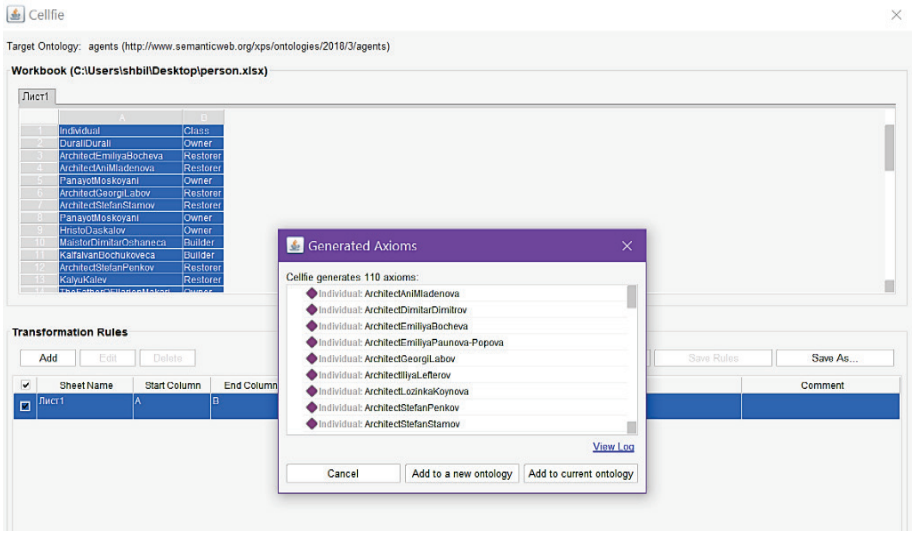

Fig. 5. Cellfie-generated axioms

3 Reasoning

Individualities are described by axioms. For illustrative purposes, a brief example is considered in Fig. 6.

Professor Architect Stefan Stamov has made an outstanding contribution to the restoration of cultural monuments in Bulgaria as well as to the research and analysis of Bulgarian Revival architecture. He is an authoritative figure who writes numerous books on architectural topics. Details of his life are presented in this work. Similar ones are applied to other instances of the classes “Person”, “CorporateBody”, and others.

In this case, the object properties: “was a member of”, “was born in”, “worked in”, “studied in”, “is a restorer of”, “has nationality” are explicitly applied and connect the individual of Professor Stamov with specific individuals from other classes in the ontology.

When applying the Reasoner (HermiT), additional statements are made (against a yellow background in Fig. 6). For example, Prof. Stamov is the founder of a specific foundation; he has met and worked with Architect Labov; in addition to that, he is connected in some way with the Kordopulova House, and he is a member of the Union of Architects in Bulgaria, and others. The individual is characterized as a restorer due to the type of activity performed. Other examples of the ontology are similarly characterized – as owners or builders (due to their specific role concerning the revival houses).

In addition, axioms are applied to characterise the person as part of the multitude of individuals that have an academic position and a scientific degree, respectively – Professor Doctor.

Specific values from the datatype string are added via a link to the data proper-ties - “has a date of birth” and “has a date of death”.

Metadata in the form of annotations is also included for the elements of the on-tology. In the example below, there are labels (in Bulgarian and English), comments, and "rdfs:seeAlso" for additional information.

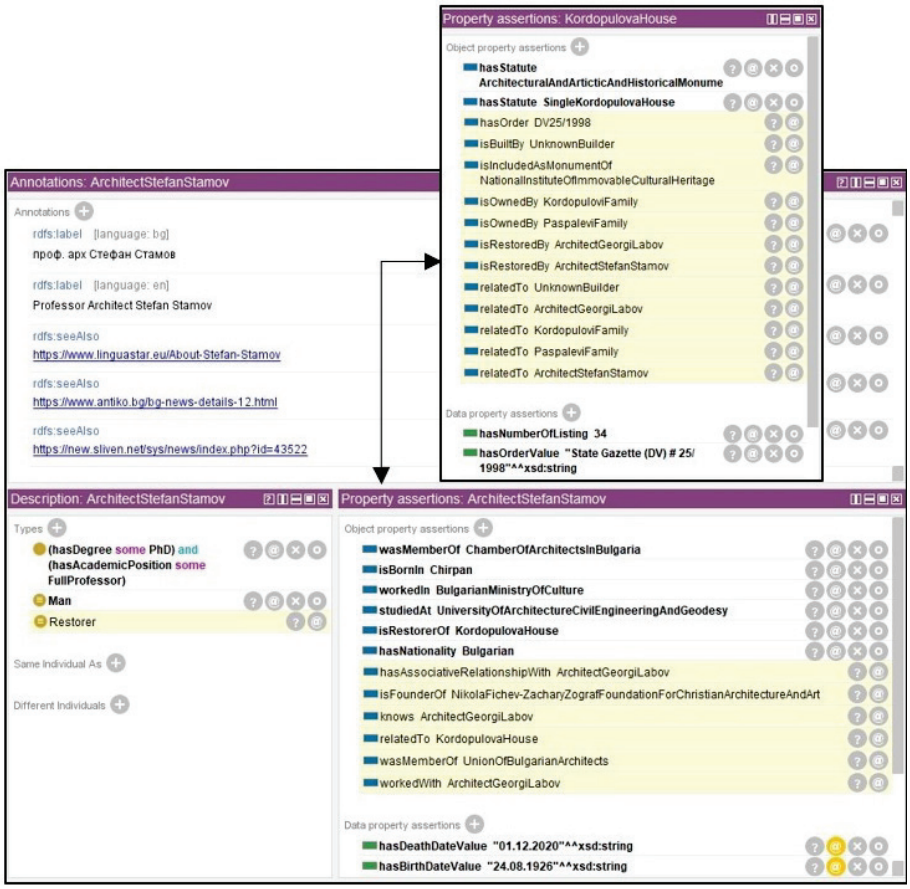

Fig. 6. An individual example

Similarly, specific information about the houses is presented – their connections with individuals and organizations from the ontology as well as the status of the value – architectural and construction, art, and others (as specified in the register of the National Institute of Immovable Cultural Heritage (National Institute for Immovable Cultural Heritage, 2022)); entry through the State Gazette – number and year; monument recognized by the specific institution, number of listing, etc.

4 SPARQL Querying

OWL ontologies have a specific query language – SPARQL Protocol and RDF Query Language (SPARQL). The SPARQL query is a graph with variables instead of values, where data is represented. If any results correspond to the template, they are displayed in tabular form. Instead of using the entire Internationalized Resource Identifier (IRI) of the ontology in the query, its abbreviation is created using the PREFIX keyword.

The following sample query (Fig. 7) results in a person who is an individual of the "Man" class, and he also has an academic position "Professor" and a scientific degree "Doctor", in addition, he is "Bulgarian" by nationality who studied at the University of Architecture, Civil Engineering, and Geodesy and worked in the Ministry of Culture of the Republic of Bulgaria. As a result, the variable occupies the value of "Professor Architect Stefan Stamov" because this is the only individual of those available in the Agents ontology that meets the set of criteria, i.e. satisfies the conditions of the template.

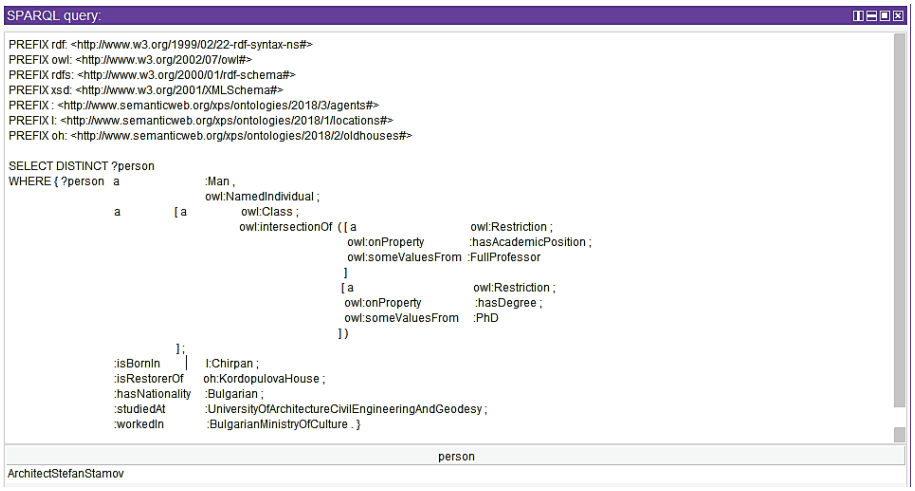

Fig. 7. SPARQL query

5 Conclusions

Currently, the Agents ontology includes 1302 axioms, 61 classes, 54 object properties, 8 data properties, and 124 individuals. Ontology engineering is not a quick and easy task, but it is with perspective for future studies. The project for Semantic Modelling of the Bulgarian Revival houses is the first of its kind; as far as we are aware, there isn't another ontology focused on the topic of Bulgarian Revival houses or Bulgarian architecture in general. Nevertheless, it lays a good foundation so that the knowledge can be reused for various cases and applications, including for education. Using ontologies, our team works both in the field of Cultural and Historical Heritage and Education

(Stoyanov, Glushkova, Stoyanova-Doycheva, Ivanova, Tabakova-Komsalova, & Doukovska, 2022).

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