Building OWL Ontology of Unique Bulgarian Bells Using Protégé Platform

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Abstract. We describe an ontological representation of data in an archive containing detailed description of church bells. As an object of cultural heritage the bell has general properties such as geometric dimensions, weight, sound of each of the bells, the pitch of the tone as well as acoustical diagrams obtained using contemporary equipment. We use Protégé platform in order to define basic ontological objects and relations between them.

Keywords: Bells, Cultural Heritage, Knowledge Technologies and Applications.

1 Introduction

Church bells are one of the most important parts of our cultural heritage. As a historical object the bell has general properties such as geometric dimensions, weight, etc. and one very specific property – its sound. That is why we create an archive that contains records of the sound of each of the bells, acoustical diagrams, videos and images obtained using contemporary equipment.

The collection of information is done by different specialists (engineers, mathematicians, computer scientists, historians, accredited bells assessors, etc.) using specialized equipment.

The aim of the Knowledge - Fund BellKnow is to do research and identification of valuable bells located in churches and monasteries and to create archive using modern technologies for analysis, storage and protection of audio information.

In this article we present digital archive of unique Bulgarian bells and extend our previous work on semantic annotation of digitalized materials.

We use the Protégé platform in order to define an OWL based representation of basic objects and their relations in the BellKnow ontology.

The developed methodology is applied in the project "Research and Identification of Valuable Bells of the Historic and Culture Heritage of Bulgaria and Development of Audio and Video Archive with Advanced Technologies" (BELL) [1,2,3,5]. In our research we also consider some experiences in the same area and we use several techniques for the creation and analysis of digital archives and libraries in [4, 8, 9, 10].

2 The BellKnow Data Organization

The aim of the project **BellKnow** was to develop an archive containing detailed description of church bells, as well as to develop a digital archive for analysis, reservation and data protection.

A digital archive **BellKnow** is developed by using advanced information technologies for analysis, reservation and data protection, and it contains [1, 5]:

- The main bells' characteristics;
- Digital photos and video recordings of the bells while being tolled;
- The frequency spectrum of the bells during a stroke;
- The bells' frequency spectrum after transitive process;

Charts representing the sound fade by time, sound stream, sound pressure etc. Organization of the BellKnow archive [1]:

- Digital data
  - More than 3 000 digital records;
  - Including photo pictures, video clips, and audio records;
  - Technical data, historical references, passports, diagrams etc.
  - Tree file structure
  - Digital files format, parameters, coding;
  - Specific signature for file name;
  - Additional META textual data for indexing of media files:
    - Title (name of subject);
    - Creator (name of digitalizer);
    - Description (additional data);
    - Date (date of creation);
    - Type (type of media);
    - Format (file format, codec and parameters);
    - Identifier (geographic coordinates);
    - Rights (owner of property rights).

3 OWL Ontologies

In recent years the development of ontologies has become very popular in different scientific areas. Ontologies have become common especially on the World-Wide Web.

Ontology defines a common vocabulary for researchers who need to share information in a domain. It includes machine-interpretable definitions of basic concepts in the domain and relations among them.

Sharing common understanding of the structure of information among people or software agents is one of the more common goals in developing ontologies [7].

There are a lot of definitions of ontology in the literature. An ontology is a formal explicit description of concepts in a domain of discourse called classes, properties of each concept describing various features and attributes of the concept, and restrictions on properties. If we consider ontology with a set of individual instances of classes this results to a knowledge base.

Classes are one of the main parts of most ontologies. Classes describe the concepts in the domain.

A class can have subclasses that represent concepts that are more specific than the superclass. Properties describe features and attributes of classes and instances. In practical terms, developing ontology includes:

- defining classes in the ontology;
- arranging the classes in a subclass–superclass hierarchy;
- defining properties and describing allowed values for them;
- filling in the values for properties for instances.

We can then create a knowledge base by defining individual instances of these classes filling property value information and additional restrictions.

4 BellKnow Ontology

Using the information of metadata annotation we define an ontological describing the Bulgarian bells. The basic schema of these digital resources is shown in Figure 1.

This scheme shows the basic **BellKnow** ontology classes (bell, history information, technical data, location, media files, and audio characteristics) and their properties. Next we will consider basic OWL ontology components and how these components are realized in the **BellKnow** ontology in Protégé.

An OWL ontology consists of individuals, properties, and classes, which roughly correspond to Protégé's framework objects [6]:

Individuals - represent objects in the domain that we are interested in. For example an individual is each different bell.

Properties - Properties are binary relations between individuals. For example, the property *hasLocation* might link the individual *Bell1AN* to the individual *StAleksanderNevskiCatedral*, or the property *hasBell* might link the individual *StAleksanderNevskiCatedral* to the individual *Bell1AN*. Properties can have inverses. For example, the inverse of hasLocation is isLocatationOf. Properties can be limited to having a single value – i.e. to being functional. They can also be either transitive or symmetric.

Classes – OWL classes are sets that contain individuals. For example, the class Bell would contain all the individuals that are bells in our domain of interest. Classes may be organized into a superclass-subclass hierarchy. In OWL classes are built up of descriptions that specify the conditions that must be satisfied by an individual for it to be a member of the class.

We start creating ontology using *Create New OWL Ontology* from Protégé's main menu. Next we could start building a class hierarchy using *Classes Tab*. The empty ontology contains one class called *Thing*. The class *Thing* is the class that represents the set containing all individuals. Because of this, all classes are subclasses of *Thing*. First we create **BellKnow**'s main class *Bell*.

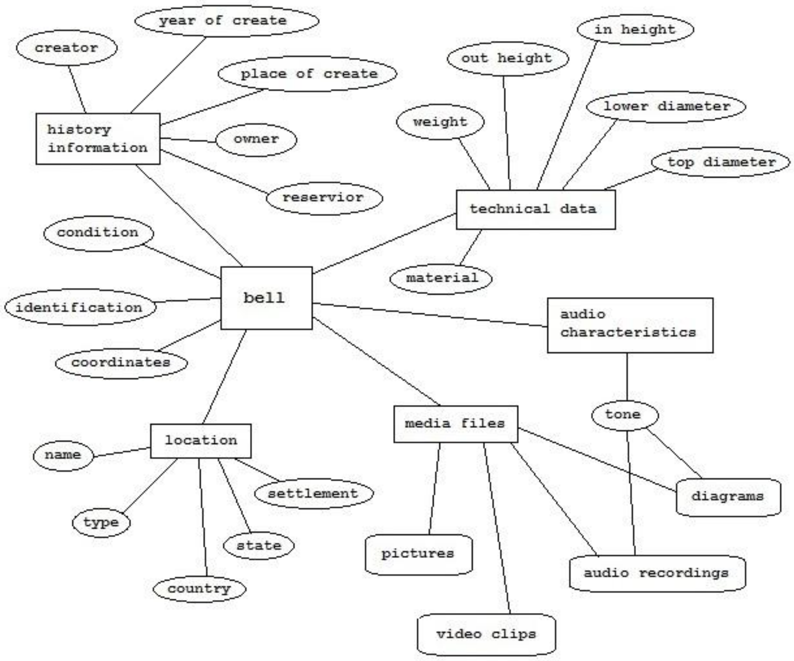

Fig. 1. Ontology create

After that we could continue building the **BellKnow** ontology hierarchy by adding classes and subclasses.

The next step is to create OWL Properties. There are three main types of properties: *Object properties*, *Datatype properties* and *Annotation properties*. Object properties are relationships between two individuals. Annotation properties can be used to add metadata to classes, individuals and properties. Using the Datatype property, we can add a restriction to the class states that all individuals of the class must meet specific restrictions. Properties may be created using the *Object Properties tab*.

Example properties:

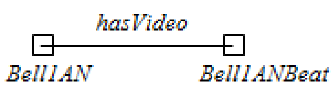

Fig. 2. Example 1

An Object **property** linking the individual *Bell1AN* to the individual *Bell1ANBeat*.

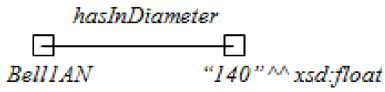

Fig. 3. Example 2

A Datatype property linking the individual *Bell1AN* to the data literal *140*, which has a type of an *xsd:float*.

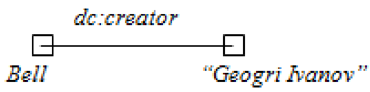

Fig. 4. Example 3

An Annotation property, linking the class *Bell* to the data literal (string) *Geogri Ivanov*.

We can also add additional Datatype and Range restrictions to the Properties. Finally we can use one of the key features of OWL-DL language - *reasoner*. It helps to test whether or not one class is a subclass of another class and whether or not it is possible for the class to have any instances.

5 Conclusion

We present organization and annotation of digital fund with unique Bulgarian bells **BellKnow**. In the paper is also described a platform for OWL ontology management called Protégé. Basic functionality of Protégé is presented and the process of implementation of **BellKnow** ontology in Protégé is discussed.

Future work in this direction will be to extend and specify **BellKnow** ontology and to finish its implementation in Protégé platform. Also we will use extended version of ontology in specialized information system, semantic search engines and thematic dictionaries.

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