Ontologies as a Method for Displaying Domains of the World Cultural and Historical Heritage

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Abstract **– The digitization within all cultural areas imposes its requirements on the collection, preservation and visualization of cultural and historical heritage data. It offers new forms of analysis, and increased levels of access for academics and ordinary users. Beyond standard search-oriented interfaces, modern technologies provide visual access to cultural collections represented as complex and comprehensive information spaces through interactive visualizations. This article reviews the types of technology used to visualize and socialize the cultural and historical heritage. It offers various models in which semantic network visualization software can be used for this purpose. The main features and qualities of semantic networks are highlighted as a resource for storing information, and systematizing data from different application areas.**

Keywords **– semantic net, applied ontologies, visualization of cultural heritage.**

1. Introduction

Tangible and intangible cultural heritage is a valuable historical resource in every country. Their protection and socialization are important for the sustainable development concerning national culture.

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Modern information and communication technologies provide enormous opportunities in the field of digitization and promotion of cultural heritage.

There are scientific developments on this topic, but they are predominantly oriented either to the cultural heritage or to the technological problems of digitization of the heritage. There are still no interdisciplinary studies related to the emerging models of socialization and heritage visualization, and their experimental implementation with the participation of representatives of all stakeholders.

There is no doubt that visual information is extremely important in promoting the qualities of an object,regarding its cultural and historical heritage. During the recent years, the possibilities for submitting such information were limited only to museum exposures, two-dimensional printed images or video and motion picture films. The development of modern interactive multimedia technologies, and the distribution of their products on digital media or on Internet, significantly increased the visual presentation of objects [1].

Generally, modern technologies can be represented in several groups:

• Still popular and growing interactive applications based on 2D technologies. These are interactive environments with multiple photomaterial, projection of video on different screens (facades, books, and dummies), presentation of virtual maps accompanied by digital images (look at Figure 1), diagrams with factual information, etc.

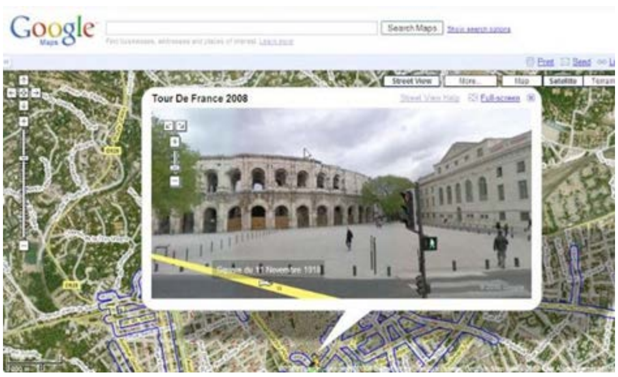

Figure 1. 2D visualization

• Nowadays, 3D visualization technologies are gradually implemented. 3D scanning technologies, supported with virtual and added reality technologies, are extremely attractive for the perception of archaeological monuments at the various stages of discovering, exploring, restoring and conserving (look at Figure 2).

Figure 2. 3D visualization

They contribute greatly to the easy dissemination of information to the general public. Obviously, these state-of-the-art technologies can help explorers and amateurs to"see" the artifact, building or complex, and walk around it without it necessarily being rebuilt.

• Although it is a new technology, 3D printing is taking the lead with its advantages. The digital storage of artifacts in collections guarantees their preservation if the originals are damaged for one reason or another, and their printed copies provide the opportunity for research and direct contact with exhibits stored at different locations around the world (look at Figure 3)

Figure 3. 3D printing demonstration

2. Problem Formulation

Semantic networks are differentiated as niche technologies because, although in practice they are often visualized as two-dimensional objects, they are theoretically abstract structures that allow dynamic image changes. It is extremely appropriate to present the information when it is necessary to describe the global range of the key knowledge due to the massive and fragmented nature of the data. To solve this problem, it is appropriate to define ontologies. In computer science, theontology is defined as an attempt to formalize a certain area of knowledge comprehensively and in detail, using a conceptual framework. Typically, this framework consists of hierarchical data structures, and they contain relevant objects, links between them and rules adopted in this area. It is applied as a form of presenting knowledge about the real world or parts of it. [2]

One should bear in mind that cultural phenomena, even the subject of the cultural heritage, are difficult to classify,since they are organized into dynamic structures whose functional, social and ideological elements pass through and intertwine, but rarely have strictly defined limits. This is a contradiction that can only be solved by the joint work of a large team of scientists from different areas of knowledge. Such a dynamic information product should be created to allow systematizations to be combined in a variety of formal, temporal, functional, semantic sections of the subject cultural heritage [3]. This requires ontologies built up regarding cultural and historical heritage domains to be defined, with the help of cultural heritage experts and engineers,who are to regulate the concept, attribute and carry out the relationship of knowledge in this particular field.

2.1 The concept of semantic networks

The Semantic Information Model can be described as a conceptual diagram of the data, and presented as an oriented graph. The nodes of the column are called objects, links, or ribs. As a rule, they serve to present physical objects, concepts or situations. Connections in the semantic network are used to represent relationships.

The common ontological representation of the objects that make up a certain semantic knowledge network determines the system of properties of these objects [4].

Structurally, theontology consists of some basic elements and advanced elements. The basic elements are: classes (also called concepts, frames), slots (or properties, roles, attributes) and instances or individuals, axioms and external links to other ontologies and thesaurus. Elements are associated with relations, and there are two main types - hierarchical and non-hierarchical (associative).

Basic elements are mandatory for building the ontology. Similar to object-oriented programming, the classes determine the properties of the instances that belong to these classes. [5]

Semantic network structures provide intuitive and useful presentation of the information used to model semantic knowledge and conclusions.

In the earliest conceptual models of semantic networks, Collins and Quillian (1969) try to solve these questions by suggesting concepts to be presented as nodes in a tree-structured hierarchy, and the relationships being determined by their classes.

Quillian uses semantic networks to analyze the meaning of words in sentences. Since then, semantic networks have been successfully used to solve many problems related to the presentation of knowledge. The understanding of the meaning achieved by semantic networks allows us to go beyond the scope of simple software expert systems.

3. Problem Solution

The merging of multiple semantic networks leads to the idea of ontologies. These are large network structures that include all the concepts of a given area of knowledge. The word ontology is used to describe artifacts of different complexity in their structure. They range from simple classifications to frameworks with various metadata.

Despite the extensive experience and software tools available, the creation of ontologies is still more art than science, as there are practically no generally accepted and sufficiently detailed methodologies for their development that can be used in all practical cases. Software development activities based on the use of ontologies are further hampered by the fact that knowledge sources, even in relatively narrow areas are various (for example, based on different conceptualizations of the field using different terminology, having different range or different degree of detail using different units of measurement, etc.)(Look at Figure 4).

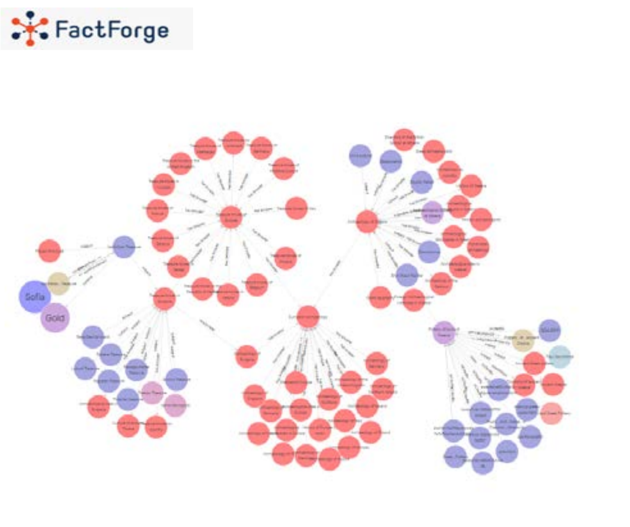

Figure 4. Merging of ontologies regarding the cultural heritage of Bulgaria and Greece (For visualization is being used software system FactForge.)

This means that interoperability and the integration of knowledge derived from such sources requires comparing and constructing mapping between relevant ontologies, eventually followed by merging these ontologies [6].

Automatic or semi-automatic detection/ construction of such matches is called ontology alignment. The result of ontology merging is the emergence of a new ontology that essentially constitutes a union of those. A major challenge in merging ontologies is the requirement that the result reflects all correlations and differences between these ontologies [6]. The result of the comparison of two ontologies is a specification of the semantic overlap of these ontologies.

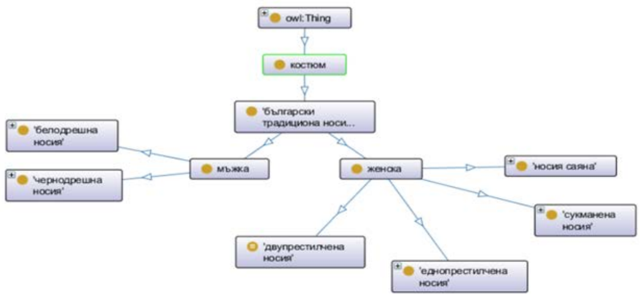

Figure 5. Ontology of the national costume (For visualization is being used Protégé 5.5.0.) [9]

The benchmarking process goes through three main stages:

(1) Mapping discovery;
(2) Appropriate mapping representation;
(3) Mapping exploitation / execution [7],[8].

This approach can be used to make the comparison among simple subject ontologies in the development of academic digital libraries. The merging of ontologies aims to create a new ontology that unites two or more given ontologies. Most of the new ontology replaces those given, and is used instead.

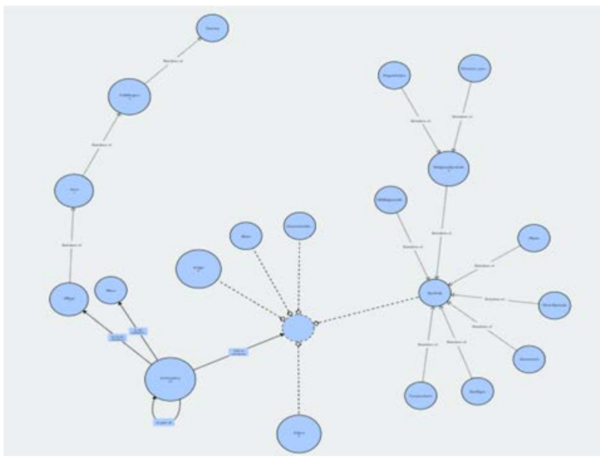

Figure 6. Representation of the characteristics of Bulgarian national embroidery via ontological model (For visualization is being used WebVOWL).

3.1 Ontology alignment management

Although that currently there are no tools available and capable of managing the whole ontology alignment process, there are tools which exist in order to provide partial support. These tools are listed below.

• MAFRA offers the ability to create, manipulate, store and process alignments (in the form of 'semantic bridges').

•Protégé offers support for ontology matching at design-time through the use of the PROMPT suite. The alignments can be stored and shared through Protégé server mode.

• FOAM serves as a framework in which matching algorithms can be integrated. FOAM is available as a Protégé plug-in, and is integrated into the KAON2 ontology management environment.

• Web Service Modelling Toolkit (WSMT)10 is a stand-alone system that serves as a design-time alignment creator and editor.

• NeOn is a proposed toolkit for ontology management which provides run-time and design-time ontology alignment support. See Section 11 for more information about NeOn

• WebVOWL is a web application for the interactive visualization of ontologies. It implements the Visual Notation for OWL Ontologies (VOWL) by providing graphical depictions for elements of the Web Ontology Language (OWL) that are combined to a force-directed graph layout representing the ontology.

All these environments are suitable for the creation of applied ontologies. These are ontologies that encompass the necessary data for modeling knowledge regarding a particular conceptual model. Typically, applied ontologies are a mixture of classes taken from the subject and general ontologies. They are not extensively usable for widespread use, and they are strictly formalized. Some examples of applied ontologies are: ontologies of study subjects, ontologies of information systems in a given subject area, and so on [10].

4. Conclusion

The main challenge in thevisualizing cultural and historical heritage is to choose a suitable technology that, in a sufficiently precise and attractive way, contributes to the presentation of scientific information.

Semantic network structures provide intuitive and useful presentation of the information used to model semantic knowledge and conclusions.

In the engineering of knowledge, the ontology means a detailed description of a subject area that is used for the formal and declarative definition of its conceptualization.

The positive side of the semantic network concept is obvious. It gives access to precisely structured information for any application, regardless of the platform and programming language. The programs themselves can find the resources they need, process the information, summarize data, and extract logical links from them.

These methodologies are based on a number of principles laid down in the ontology project, such as:

• Clarity - ontology manages to effectively translate the meaning of the introduced terms; clear and fixed formalism is being used and definitions are set in the form of logical axioms;

• Coherence - the definitions introduced have to be logically non-contradictory;

• Extendibility;

• Minimal encoding bias;

• Minimal ontological commitment - the anthology contains only the most significant assumptions about the model world, in order to give freedom for expansion and specialization.

The purpose of creating and using ontologies consists mainly of their ability to "talk" about the subject area.

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