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# Owl Ontologies Use for Higher Education Competences Development

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## Abstract

*The ontology defines a common vocabulary for researchers who need to share information from a domain. It includes the definitions of some fundamental concepts in the domain and the relationships between them. The ontologies design represents an iterative process. This process starts with a rough form of it that, then, it is reviewed and refined by adding additional details.*

*The competence concept has gained importance in the higher education systems both national and European level and the necessity to improve the quality and the relevance of skills and competences that young people obtain after they graduate school was enforced.*

*This paper aims to achieve an OWL ontology for professional and transversal competences development in higher education, thus providing a solid basis to apply and use the knowledge in order to resolve, successfully, a certain category of learning situations, as well as for professional or personnel development, in terms of effectiveness and efficiency.*

**Keywords:** *owl ontology; professional competence; competence; higher education*

**JEL Classification:** *C63; C81*

## Introduction

Strengthening the universities transformation process into organizations that have been continuously learning consists in increasing the quality of professional competences training in a European conception.

Higher education has the professional qualification mission which consists of a components set that allows a person to carry out tasks that are specific to one or more occupations, describing the results according to the labour market requirements (Buzoianu 2011, Matei 2013).

Society has enforced changes regarding the ratio between the supply and the demand on the labour market and the structure of competences that are needed to perform an activity. The permanent updating of the development tools for the higher education centred on competences is carried out by the National Higher Education Qualifications Framework (Gogot 2004).

The education quality is defined as a set of characteristics belonging to a study programme and it is directly linked to the learning results that are proved by students.

The learning results represent what a learning person can do after the learning process completion and are defined in the form of knowledge, skills and competences (Figure 1) (Autoritatea Națională pentru Calificări).

There are the following competences categories in higher education: professional competences and transversal competences.

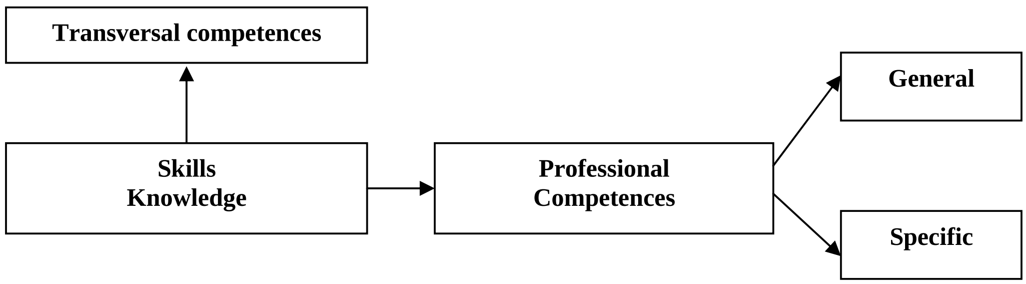


**Fig. 1.** Learning results

Source: Autoritatea Națională pentru Calificări

The professional competences represent the ability to adequately select, combine and use knowledge and skills, in order to successfully resolve a certain category of working situations. The general professional competences are developed within a broader study program and the specific professional competences are created within a narrower study program (Autoritatea Națională pentru Calificări).

Transversal competences refer to personal development, social interaction, autonomy and responsibility and represent capacities that transcend a certain study program, having a transdisciplinary nature.

Consequently, the professional and transversal competences describe the field or program of study in higher education. The qualification description is made by identifying for each study programme the correlation between the competences and the content areas, as well as between the courses and the credit points that are allocated to them (Autoritatea Națională pentru Calificări).

## Ontologies Classification

In the past years, ontologies are used in many scientific communities (Bodea et al 2010; Eriksson 2007) as a method to reuse and process the knowledge from a particular field.

Most ontologies use languages that can represent a subset of first-order logic, used in the decision making process. Due to this characteristic, the ontology design stages are: determining the ontology domain and scope; reusing the existing ontologies; enumeration important terms in the ontology; defining the classes and the class hierarchy; defining the classes' properties (slots); defining the slots facets; creation instances.

Ontologies can be classified according to several criteria (Andone et al 2001; Niculescu 2002; Niculescu 2008; Trăuşan – Matu 2004).

In terms of the computer programs that use ontologies, there are two types of ontologies (Trăuşan – Matu, 2004):

- *ontologies for knowledge based systems* that are characterized by a relatively small number of concepts, but related to each other by a large and varied number of relationships. The concepts are grouped in complex conceptual schemas or scenarios. There may be one or more customizations for each concept.

- *lexicalized ontologies* that include a very large number of concepts, connected by a small number of relationships types. An example is WordNet ontology (Wordnet Princeton University 2015), in which the concepts are represented by sets of synonyms. Such ontologies are used in natural language processing systems.

Another classification (Niculescu 2002; Niculescu 2008) split ontologies in (Figure 2):

- *high level ontologies* describe the general concepts such as: space, time, matter, objects, events, action which are independent of a particular issue or area and can be approximated for many users communities;
- *domain ontologies* treat the terms corresponding to a generic domain (e.g. medicine, automobiles etc.);
- *activity ontologies* describe the vocabulary specific to generic activity (e.g. diagnosis, sale etc.);
- *application ontologies* outline the concepts related to both a particular field and a specific activity. They correspond to the roles played by the field entities in the implementation of some particular activities.

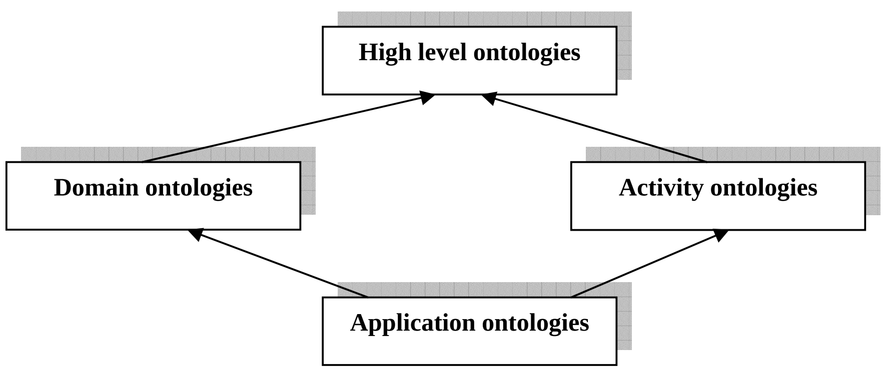


**Fig. 2.** Relationships between ontologies types, by the level of generality.
Source: Guarino (1998), Niculescu (2008).

In terms of the field to which they refer, ontologies that are placed on the web are:

- *general ontologies*, such as: Cyc, Sowa ontology, WordNet, FrameNet or Mikrokosmos. They are dedicated, especially, to computational linguistics applications;
- *ontologies for a particular field* (for example: an ontology for programming).

Ontologies represent the binder that integrates the database systems, the distributed object oriented systems, the knowledge-based systems in various integrating applications that are based on collaboration. They reduce semantic ambiguities in terms of knowledge sharing and reuse (Trăuşan – Matu 2004).

## OWL Ontology for Higher Education Competences Development

One of the current interest directions in the academic and industrial communities circumscribed to the semantic Web is that of knowledge management, especially in the context of organizations intranet or in the field of virtual education.

The problems that are faced by researchers are those related to (Buraga 2004):

- *information searching* – keywords based searching methods have led to irrelevant results, not taking into account the structure of the desired resources content or their relationships with other related resources;
- *information retrieval* – automated retrieval tools of the information coming from multiple sources are not yet flexible enough to be able to retrieve the information from the non-textual sources or from different knowledge fields;
- *knowledge repositories maintenance* – semantic representations processed by the computer must be identified in order obtain consistent, accurate and easy to update information; this aspect will lead to a formal verification of the knowledge consistency and to creation of trust relationships in the Web available resources;
- *automated document generation* – this aspect will lead to automated reconfiguration of the web sites content presentation methods, based on the cognitive profile of visitors or on other relevant factors.

In order to solve the above aspects, the semantic Web has adopted a layered view (Figure 3).

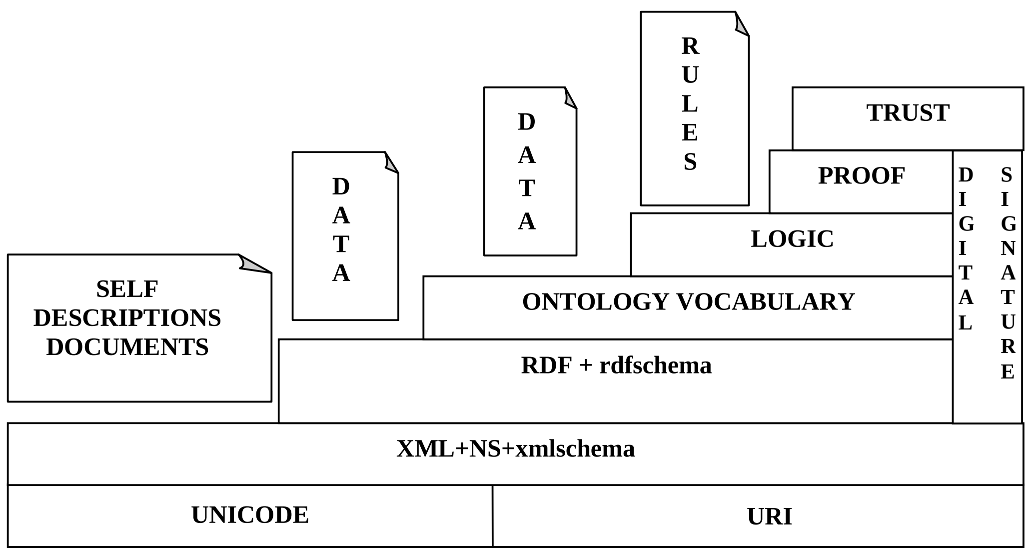


**Fig. 3.** Semantic Web specifying layers.

Source: Buraga (2004).

Ontologies are based on knowledge domain. OWL ontologies provide various elements that can be used in order to build *taxonomies* that are also called the class hierarchies. The taxonomies can be used to dynamically discover relationships (Buraga, 2004, Nicula, C.).

There are languages for building ontologies that provide different facilities. The latest development in the standard languages for building ontologies is OWL that is produced by Word Wide Web Consortium. OWL describes the concepts, but it also has a rich set of operators and it is based on a different logical model that provides the ability to define concepts and describe them, at the same time.

OWL is a language designed to define ontologies. It has three distinct languages OWL Lite, OWL DL and OWL Full that differ by what they can express (IBM and Sandpiper Software 2006). OWL Lite allows the description of classification hierarchies that do not possess complicated restrictions. OWL DL includes OWL Lite and guarantees that all declarations will be processed by the machine. OWL Full includes OWL DL and offers maximum expressiveness and the syntactic freedom of RDF.

A tool for creating ontologies is Protégé Editor. This editor allows the addition of plug-ins and, thus, it can be extended in order to satisfy any necessity. The plugin that provides the access to OWL mechanisms achieves OWL ontologies creation, editing, saving and importing, as well as working with databases by a JDBC driver that stores ontologies.

An OWL ontology is composed of individuals, properties and classes. Individuals represent domain objects that we are interested in. In OWL must be explicitly specified that individuals are the same to each other or distinct from each other. The properties represent facts regarding to a class members or to individuals. OWL classes are interpreted as sets containing individuals (IBM and Sandpiper Software 2006).

In OWL there are 2 types of properties, namely data type properties and object properties and subproperties of data type properties can be created. OWL does not allow combining object properties and data type properties in order to create an object property that is the subproperty of the data type property and vice-versa.

Forwards, it is presented an application for higher education competences development that was created with the Protégé OWL editor.

When a new project is created with the Protégé OWL editor, the class hierarchy contains only the **owl: Thing** class system. The OWL ontology for the higher education competences development is composed of three basic classes (Figure 4): **Abilitati**, **Competente** and **Cunostinte.**

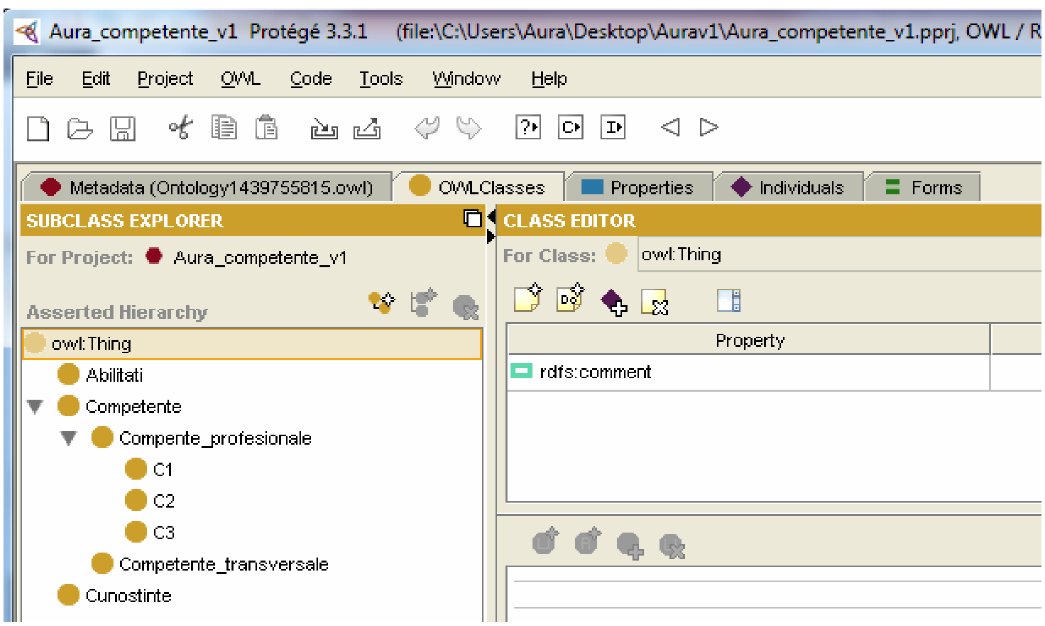


**Fig. 4.** Class hierarchy in OWL

Source: made by the author

These classes are disjoint because one individual (an object) can only be the instance of a single class from the three classes. After creating the basic classes, I have created 2 subclasses for the **Competence** basic class, namely: **Competente_profesionale** class and **Competente_transversale** class **.** The **Competente_profesionale** subclass, in turn, derives in 3 subclasses: **C1**, **C2** and **C3**.

In OWL, the subclass term means necessary implication. For example, if **Competente_profesionale** is the subclass of the **Competente** class, then all instances of the **Competente_profesionale** class are, also, instances of the **Competente** class. The class hierarchy is presented in Figure 4.

The OWL properties represent relationships between individuals. In Figure 5 are exemplified the properties types: object properties and data type properties.

OWL can accept the following properties types (Horridge et al 2004):

- *inverse properties* in which each object property may have a corresponding inverse property;
- *functional properties* in which at most one individual is related to the initial individual through that property;
- *inverse functional properties*: If a property is inverse functional then it means that the property is inverse functional;
- *transitive properties*: If a property P is transitive and relates individual A to individual B and, also, individual B to individual C, then individual A is related to C via property P;
- *symmetric properties*: If a property P is symmetric and relates individual A to individual B, then the individual B is, also, related to individual A.

The **Competente_profesionale** subclass contains (Figure 5):

- ***5 data type properties***: *cod, descriere, nume, standarde_minimale (*inherited from **Competente** class*)*, as well as the *tip* property which is its own property;
- ***2 object properties***: *implica* and *poseda* which store the individuals belonging to **Abilitati** and **Cunostinte** classes.

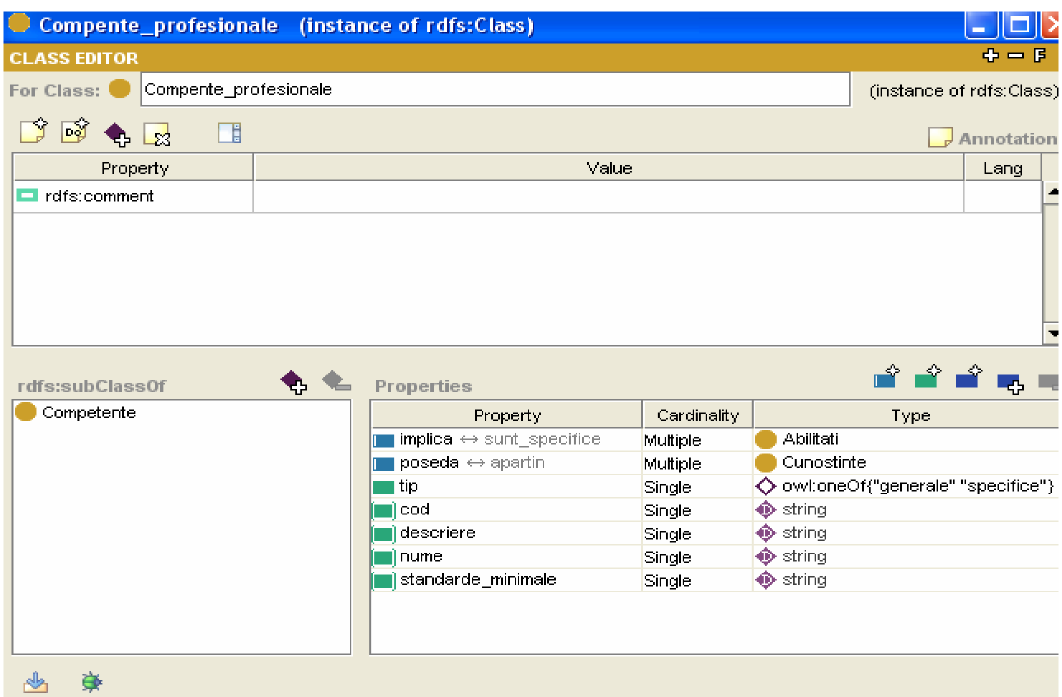


**Fig. 5.** Competente_profesionale subclass properties

Source: made by the author

Individuals represent objects from the domain the user is interested in. Individuals are known as instances and can be referred as “instances of classes”. In Figure 6 is presented an individual for the **C1** class that is a subclass of the **Competente_profesionale** class.

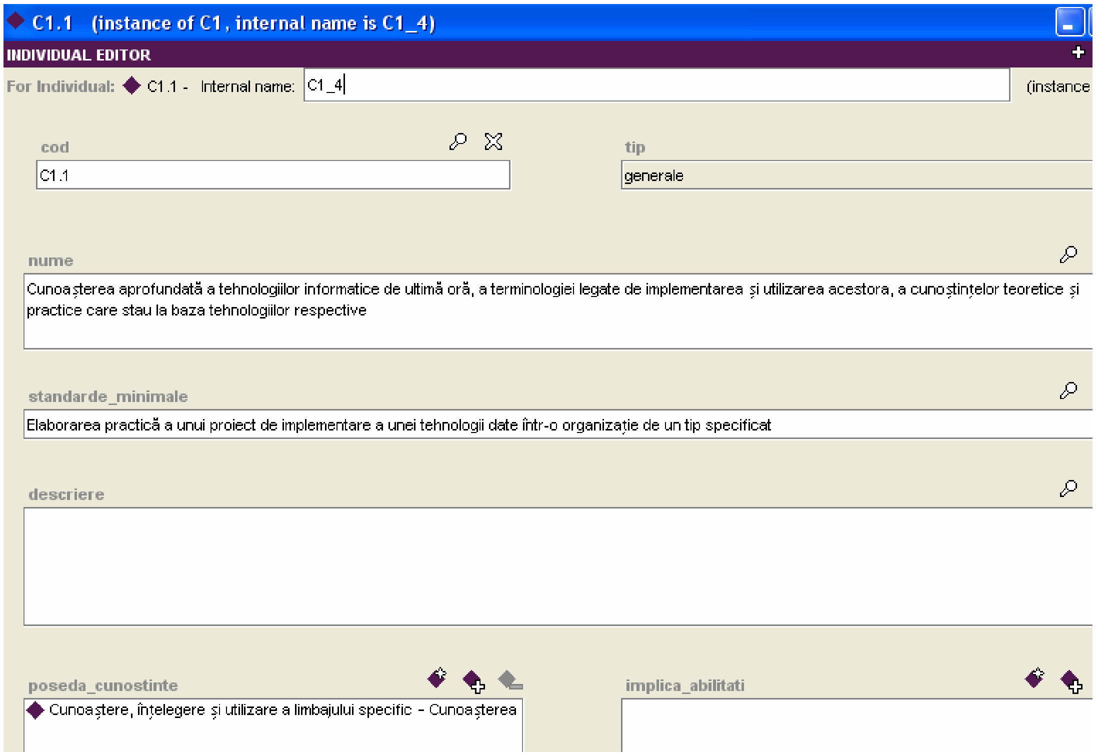


**Fig. 6.** C1 subclass individuals

Source: made by the author

## Conclusions

In the past years the social, scientific, cultural and economic environment has recorded major changes. New information and communication technologies do nothing but to intensify this process and education providers, in particular universities, should be more sensitive towards the labour market needs that are continuously changing.

The author presents in this article a solution for modelling the higher education professional and transversal competences. This ontology can ensure:

- a shared and common understanding of knowledge from the competences domain;
- an explicit conceptualization that describes data semantics;
- an analysis of the knowledge from the higher education competences domain.

Competences modelling can offer a solid base in order to use the knowledge of all persons that are involved: teachers, managerial staff, as well as students, having as a consequence the strengthening of the university transformation process into an organization that has been continuously learning, being able to adapt to the knowledge-based society requirements.

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