# AN ONTOLOGICAL APPROACH FOR THE ACTIVITY IN AN AUTOMATIC CONTROL FACULTY

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Abstract: The current work aims at offering a new, ontology-based approach for organizing and retrieving the information about the educational offer and the activity of the department of Automatic Control of the Faculty of Automatic Control and Computer Science at the University Politehnica of Bucharest. The project is divided into 2 main phases. The first phase consists of creating an ontology which contains information about the disciplines, the teachers, the teaching resources, the research and publication activity in our faculty, while the second phase consists of developing an application for exploring and querying this ontology in a controlled natural language.

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## 1 INTRODUCTION

The current work proposes an ontological approach for modelling the activity in the department of Automatic Control of the Faculty of Automatic Control and Computer Science at the University Politehnica of Bucharest. The main phases of our project are: creating an ontology which contains information about the educational, research, publication and administrative activity in our faculty and developing an application which explores and queries this ontology in a controlled natural language.

The rest of the paper is structured as follows: Section 2 presents an overview on ontologies; Section 3 presents our ontological approach, focusing on the architecture of our system, the creation of the ontology, the application for exploring the ontology in natural language and an evaluation of the application; Section 4 draws the conclusions of our work and discusses some possible future developments.

## 2 ONTOLOGIES BACKGROUND

The origin of the term "ontology" is found in philosophy, where the result of the efforts to organize and model the universe is called ontology.

Over time, the term has been borrowed in other domains as well. In computer science, an ontology is used to model the knowledge in a specific domain. It contains the concepts related to that domain, as well as the relations between them.

The most well known definition of ontologies in computer science was given by Gruber, in 1993: "An ontology is an explicit specification of a conceptualization." (Gruber, 1993).

An ontology is made up of several main concepts (Horridge, 2009a), which will be described shortly in what follows. *The classes* (also called types, species or categories) define the concepts of the domain. A class is a blueprint of an object. *The instances* are members of the classes. They can be actual things, such as persons, objects, animals, etc., or even abstract notions. The ontology produces the taxonomy of its instances. *The attributes* are properties of the objects in the ontology. They can be represented as simple data types (strings, numbers, boolean or enumerations) or they can be a reference to another object of the ontology. *Relations* indicate how the concepts and the instances are interconnected and how they communicate. The entire set of relations in an ontology defines the semantics of the domain (Horridge, 2009a).

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# 3 OUR APPROACH

## 3.1 The Goal

When we started this project, we had in mind a number of objectives. First of all, we wanted to create an ontology which models the educational activity of the department of Automatic Control of the Faculty of Automatic Control and Computer Science at the University Politehnica of Bucharest. The ontology contains information about the disciplines, the specializations, the teachers, the teaching resources, the research activities, the publication activities in our faculty, as well as all the connections between these elements. After creating the ontology, we wanted to provide the users the possibility to visually explore it in a friendly way. Thus, we implemented an exploration application, which loads the ontology and allows the users to browse through the instances and concepts of the ontology. The last step of the project is to establish a grammar, based on which the ontology can be queried in controlled natural language. Both the ontology and the grammar are easily extensible.

The application is designed in an open and user friendly manner, so that it can be used by individuals with limited background knowledge about ontologies or the OWL language (Antoniou, 2008). Moreover, the application can load any ontology and query it in natural language, based on the created grammar.

## 3.2 The System Design

Figure 1 presents an overview of the architecture of the system we propose. Mainly, the ontology exploration application is a mediator between the user and the ontology.


Figure 1: Overview of the architecture of the system.

The application accesses the ontology through an OWL/XML parser from the OWL API (Horridge, 2009b).

Figure 2 illustrates the UML use case diagram (UML Standard, 2011) of the application.

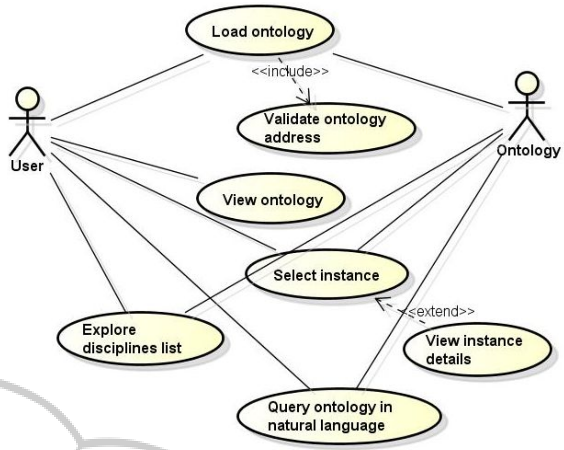


Figure 2: Use case diagram.

The ontology was created under Protégé 4.1 platform (Horridge, 2009a), with full support for OWL 2.0 (Antoniou, 2008). Two inference mechanisms, Hermit (Motik, 2009) and Pellet (Pellet, 2010), have been used to check the consistency of the ontology. Both of them can be installed as Protégé plug-ins.

The application for exploring the ontology was implemented in Java (Sierra, 2008) and uses several OWL API and Pellet libraries.

## 3.3 Creating the Ontology

The ontology models a knowledge base of the didactic, research and administrative activities in the department of Automatic Control of the Faculty of Automatic Control and Computer Science at the University Politehnica of Bucharest. It covers information about: disciplines, specializations, human resources, publications, research activities and teaching resources. During the creation phase of the ontology, the following sources have been consulted: the official web site of the Faculty of Automatic Control and Computer Science (http://acs.pub.ro), the official web site of the department of Automatic Control and Industrial Informatics (http://www.aii.pub.ro/), the official web site of the department of Automatic Control and System Engineering (http://ics.pub.ro/), and the students' web site (https://studenti.pub.ro).

The main classes of the ontology are presented in Figure 3.

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Figure 3: The main classes of the ontology.

These classes define the taxonomy and the vocabulary of the ontology, which will be intensively used by the queries in natural language. The classes are disjoint (Horridge, 2009a).

Each of the classes in the ontology has a set of subclasses and a number of properties. The connections and the restrictions between these classes are established through object and date properties. Figure 4 depicts the set of object property assertions and data property assertions defined for the Databases course. The object property assertions specify when the course is taught, who teaches it, in what room, what formative category it belongs to, to which package of courses it belongs and what is the laboratory room for this course. The data property assertions establish the criteria for passing the practical and theoretical exams, the credit point associated to this course and the number of points assigned to each activity.

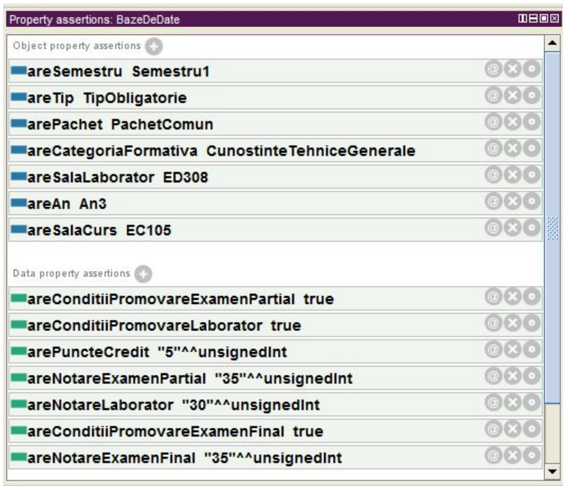


Figure 4: The properties for the Databases course.

Each class has one or more members, which represent the instances of the ontology. Currently, the ontology has 67 classes and 253 instances.

## 3.4 Exploring the Ontology

The exploration application aims at providing a friendly experience for the users who want to access the ontology. The application has 3 modules: the ontology exploration module, the natural language querying module and the disciplines’ correlations module. The users do not have the permission to modify the ontology. Mainly, the exploration part of the application allows the users to browse through the classes and the instances of the ontology. When selecting an instance of the ontology, the users will visualize in a friendly way all the available details, as well as the relations the instance has with other instances. For instance, if a user selects the name of a teacher, the application will display: the personal details such as email address, office, telephone number, the courses taught by that teacher, the teaching resources linked to him/her, the research projects he/she is involved in, the books, magazine or proceedings articles published (with correspond-ding details).

In what follows, we will discuss the possibility of querying the ontology in controlled natural language. The application will interpret the questions, parse the ontology and provide the answers to the users. Our approach for natural language querying is based on RDF triples (Antoniou, 2008) and it is designed to interpret the Romanian language syntax, with or without the punctuation specific to interrogative sentences. When a user launches a question in natural language, a string processor class maps it to an RDF triple and then identifies the subject and the predicate of the triple. For example, if a user introduces the question: “What email does Alexandra Cernian have?” (in Romanian), the subject – Alexandra Cernian and the predicate - has email, will be identified. Afterward, the ontology is checked to see if these elements are found. If they are found, that means that there is a corresponding triple in the ontology. Finding the triple leads to finding the missing element (the object). For our example, it will be found that there is an instance called AlexandraCernian, which has the property HasEmail with the value alexandra.cernian@aii.pub.ro. The questions must respect a certain grammar, which will be described in the next paragraph.

The application identifies and interprets the following types of questions (Cernian, 2011):

- Category membership. The predicate must contain the “are” or “belong” keywords.
- Figures about instances. The question must begin with “how many” and the predicate must be the “has” keyword. It must not contain the following keywords: “are” and “belong”.
- Relations between instances. The question must begin with “what” or “who”. The predicate must contain “has” and must not contain “are” or “belong”.
- Unknown type. Any question that does not fall under any of the 3 categories described above is considered to be of unknown type. In this case, the system will try to establish if there is any matching entity in the ontology.

A matching index is used to establish the correspondance between a term in a key position within the question and an entity or a relation in the ontology.

The application has been tested with a set of 75 questions in natural language. The questions belong to all 4 possible categories descibed above. The results of the tests proved that the information is correctly retrived from the ontology. So, the application is able to correclty interpret natural language and extract the most relevant information from the ontology.

## 4 CONCLUSIONS

This paper presented an ongoing project for an ontological modelling of the educational, research and publication activity in the department of Automatic Control of the Faculty of Automatic Control and Computer Science at the University Politehnica of Bucharest. The ontology created contains information about the human resources, disciplines, teaching resources, administrative details about the courses and the personnel, research activities and publication activities. An application was also developed for exploring the ontology. Through this application, the user can browse through the content of the ontology in a friendly way and, moreover, he can query the ontology in natural language, provided he formulates the questions according to a specific grammar. The ontology is easily extensible, so it can constantly reflect the updates in our faculty. The experimental results were very satisfactory and encourage us to pursue with improving the informational content of the ontology and of the application. As a future plan, we also intend to extend the grammar, in order to improve the natural language processing capabilities.

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Pellet Reasoner: http://clarkparsia.com/pellet

UML Standard: http://www.uml.org/