

# An Ontology for Representing Information over Social Service in an Educational Institution

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**Abstract:** In this paper, we present a method for constructing a manual ontology for the search of information over social service in a higher level education institution. We use some steps from methodology proposed by Grüninger and Fox. The ontology model will be useful to answer the questions of the students interested in the procedures of the social service. A scenario, competition questions, classes, and relationships are part of the design process. The answer to these questions leads us to the evaluation of the ontology. The ontology is made into Protégé and queries are written in the SPARQL query language.

## 1 INTRODUCTION

Actually, the continuous increase in the amount of information produced both on the Web and in local repositories makes it complex and costly to analyze, categorize and retrieve information without considering the semantics of the whole or each document. This is a challenge for software developers. The development of technologies and communications in some sectors of society has triggered the digitization of large volumes of data or information (Proenza-Arias and Pérez-Sosa, 2012).

Nowadays universities are a sector that generates a large amount of data or information from different areas of work. This information is in most cases not managed in an appropriate way and much less accessible to the public which requires it (Mora and Segarra, 2016).

However, there are sources of information on the Web that have search engines that respond to user requests, such engines work syntactically, that is, they normally return information in which items related to the query appear, this type of responses may yield unexpected or unnecessary results.

To solve many of these problems, the Semantic Web is used, it proposes to overcome the limitations of the current web by introducing explicit descriptions of the meaning, as well as a classification and structure of resources with explicit semantics that can be processed by machines (Castells, 2003).

Given these changes, it is essential to unify the content through a common language and for this we use the notion of “ontology” of the field of Artificial Intelligence. Gruber (Gruber, 1993) defines an ontology as “a formal explicit specification of a shared conceptualization”. An ontology defines a hierarchy of concepts and relationships to describe a domain which will serve for the exchange of information. On the other hand, the use of ontologies is very common in areas of business, finance, internet, medicine and the industry as data sources integrator’s, as well as, organization and knowledge representation.

The purpose of this work is the design of an ontological model, and its implantation in the Protégé tool (Musen, 2015). The aim is that the users can use the ontology to query information about processes that are required to perform and to enroll in the social service.

This paper is structured as follows: Section 2 describes the related work, Section 3 describes the methodology used and the proposal of the ontological model, Section 4 shows the design of the ontology developed with the Protégé tool and finally, in Section 5 we present the conclusions and future work.

## 2 RELATED WORK

In this section, the related works to the design of ontologies are mentioned.

In Proenza Arias y Prez Sosa (Proenza-Arias and Pérez-Sosa, 2012), they create ontologies for classifying and searching audio-visual materials over a media catalog. Their ontology has been named OntoCatMedia. Also, they used the methodology Methontology for the construction of OntoCatMedia. They employed the semantic reasoners Pellet and FaCT++ for the inference of new knowledge, both integrated into the Protégé tool.

In Mora Arciniega and Segarra Faggioni (Mora and Segarra, 2016) describes the realization of an ontological model for the representation of academic data and its publications with semantic technology using the concepts of ontologies and linked data. The proposal contemplates the development of an ontology to represent the plans of a course and the publications of them through the best practices of linked data.

In Cadena et al. (Cadena et al., 2013), proposes a methodology for the comparison of geographic data through ontologies. In this methodology, the four stages are considered, in the conceptualization stage the specific domain to which the data correspond and describes this conceptualization in an application ontology. This ontology describes the properties and relations that are presented in the geographic data sets to compare.

In Báez et al. (Baez et al., 2016), proposes an ontology that contains information related to teachers, students, administrative personnel, curricula, infrastructure, projects, lines of research, of a higher educational institution. It is intended that said information is being in a structured form and that can be consulted by humans and other computer systems. The proposed ontological model is divided into an approach, description of the entities and classes of equivalence.

In Rose Gómez et al. (Rose-Gomez et al., 2016), presents the use of the natural language for the search of information of an academic organization. For the creation of the knowledge model, they use the KoFI methodology, which consists of four stages: Identification of knowledge sources, Identification of knowledge types/themes, identification of knowledge flows and identification of problems affecting the flow of knowledge. With the analysis of the four stages, they obtain a model goal that is the basis of the knowledge model which considers a data repository and a knowledge repository. The data repository includes a database for the documents and for the repository of knowledge use an ontology designed through the Methontology methodology and implemented with the Protégé tool.

In Rosell León et al. (Rosell et al., 2016) describes the development of an ontology named UH-Ontology

for the management of data of a university. The methodology that is used for the elaboration of UH-Ontology consists of seven steps; 1) Determine the domain and scope of the ontology, 2) Reuse existing ontologies, 3) List important terms, 4) Define classes and class hierarchy, 5) Define class properties (SLOTS), 6) Define facets of Slots and 7) Create instances. The tool used for the modeling and implementation of the ontology is Protégé 4.3.

In Bravo et al., (Bravo et al., 2016) describes a methodology for the design of ontologies, the work focuses on clarity and coherence criteria, having as main objective the creation of consistent ontologies.

In Tabares García and Jiménez Builes (Tabares and Jiménez, 2014) present the construction of an ontology for the process of evaluation in higher education, for this work they use the methodology of Methontology and the tool of Protégé 3.4.8.

In Bravo, Martínez Reyes and Rodríguez (Bravo et al., 2014) describes an ontological model for the representation of academic and institutional context. The system offers a basic content that provides answers to academic questions such as tutorials, thesis supervision, as well as the location of people, libraries, buildings, highways, class schedules and program of events. The main objective of the ontological model is to show the advantages of solutions based on ontologies, this model is implemented in the Spanish language. The ontological model integrates three ontologies which are GeographicArea (“AreaGeografica”), Person (“Persona”) and Academic (“Academica”). They also present the evaluation of the ontology by means of answers to questions of competency through SQRWL. This ontological model is implemented through a mobile interface and desktop interface where the user can interact with the model, it shows an example where a student can get the office and the classrooms of a teacher.

In this paper, we propose the creation of an ontological model following the methodology of Gruber and Fox’s that consists of the phases of identification of scenarios, analysis through a set of questions of competency, determination of main concepts and their properties, as well as of relations and axioms formal. The purpose of our ontological model is to obtain information, as we mentioned in the previous works, it is intended that the information is structured on the model, it will facilitate its later retrieval. The design of the ontology is created through the Protégé tool (Musen, 2015).

### 3 ONTOLOGY DESIGN

The construction of systems based on ontologies requires a clear methodology since it is not only the construction of a system but also the generation of a model of experimentation and research. The methodology of Grüniger and Fox's is used for the accomplishment of this work. It is developed in 1995 at the University of Toronto and is inspired by the development of knowledge based on systems using first order logic. The methodology proposes to identify the main scenarios, that is, possible applications in which the ontology will be used.

Then a set of questions in natural language called competency questions will be used to determine the scope of the ontology, these questions and their answers are used to extract the main concepts and their properties, relationships and formal axioms in the construction of the ontology (Gómez-Pérez et al., 2004).

Then, the proposed ontology model is presented following the methodology, and it is divided into the scenario, classes description, properties identification and design.

#### 3.1 Scenario

The model will provide information about the steps to follow to inscribe and to release the social service, and it will solve some doubts of the user. In the case of the required documentation, a list of the necessary documents will be displayed to the user, dividing them into sections so that it is easy for them to identify what they need to carry in each type of procedure. The types of procedures considered are the inscription and the release of social service. The documents required in the registration procedure are the letter of acceptance provided by the person in charge of the program, the registration form, and a folder. In addition, the student must have at least 180 credit approved. In the case of the documentation required in the release, the student must submit to the social service coordinator the activity report signed by the person in charge of the program, the letter of termination of the social service, the appointment sheet, the report stored on a CD, and performance sheet.

The user will be able to see a list of the different dependencies that offer the social service divided into three types such as education, business, and community (programs).

In addition, each program shows the related information, for example, the location, the name of the responsible for the social service program, the type of student grant, the start date, the completion date, the

duration, the current status of the program, etc.

A section will be dedicated to the different consequences that the student may have in case of infringement in any rule, such as dropping out of social service after the period of withdrawing, or that the student does not comply with the guidelines established by the program.

#### 3.2 Competency Questions

In order to carry out this work, a series of questions were elaborated. These questions are elaborated with the purpose of having an idea of how the user could perform a search of information within the system. Some questions are as follows:

1. In what period can I register the social service?
2. How many credits are needed to register the social service?
3. What documentation do I need to register the social service?
4. Where is the office of the social service coordinator?
5. What are the types of programs that exist in social service?
6. How many hours are you in social service?
7. What is the office hours of the social service coordinator?
8. How many credits does the social service give me?
9. Who is responsible for registering social service programs?

The questions of competency allow us to define the classes and the relations that exist between them, besides that they were a fundamental piece for obtaining the class properties or attributes.

#### 3.3 Classes Description

In this section, the analysis is performed considering mainly the scenario and the competency questions, in this way we get the classes that contain the ontology model.

In principle the classes that define the ontology model are obtained. Table 1 describes the classes that have been carried out so far, and the Figure 1 shows the hierarchy class.

#### 3.4 Data Properties Definition

In addition, we get the relationships that exist between the classes and their properties, which are called

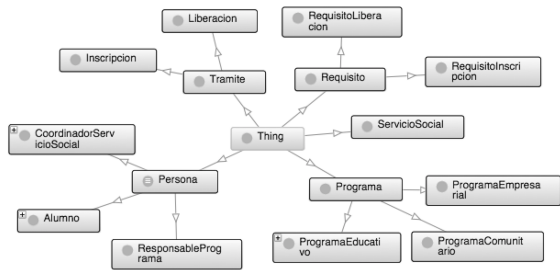


Figure 1: Hierarchy class.

“Data Properties” in the field of ontologies. Table 2 shows the data properties for the Person (“Persona”) concept and its subconcepts.

Table 3 shows the data properties for the Social Service (“Servicio Social”) concept and “Programa” (Program) concept.

### 3.5 Object Properties Definition

The classes have relations between them. The Figure 2 shows object properties diagram. The Table 4 describes the object properties.

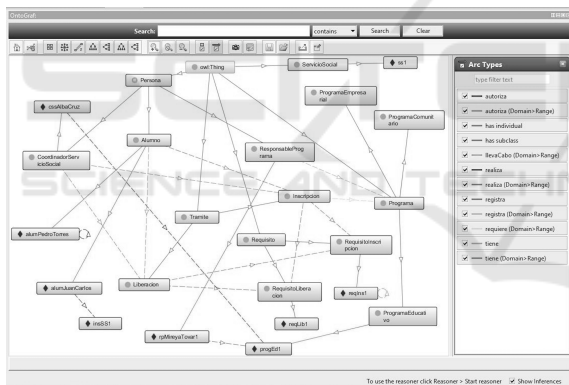


Figure 2: Object properties diagram.

## 4 RESULTS

In this section presents the formatization of the competency questions (see Table 5) presented in Section 3.2.

The design of the ontology model is created in the Protégé tool, which is an open source software that allows building an ontology through its interface that helps the developer in the process.

Subsequently, the evaluation of the ontology is done through the response that it produces when answering the competency questions. In this case we use the SPARQL query language. Below are the

answers to the competency questions.

1. In what period can I register the social service? (See Figure 6)

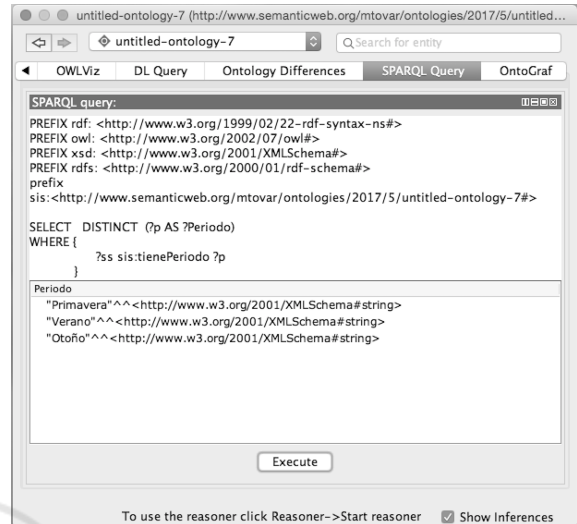


Figure 3: Answer to question 1.

2. How many credits are needed to register the social service?



Figure 4: Answer to question 2.

3. What documentation do I need to register the social service?
4. Where is the office of the social service coordinator?
5. What are the types of programs that exist in social service?
6. How many hours are you in social service?

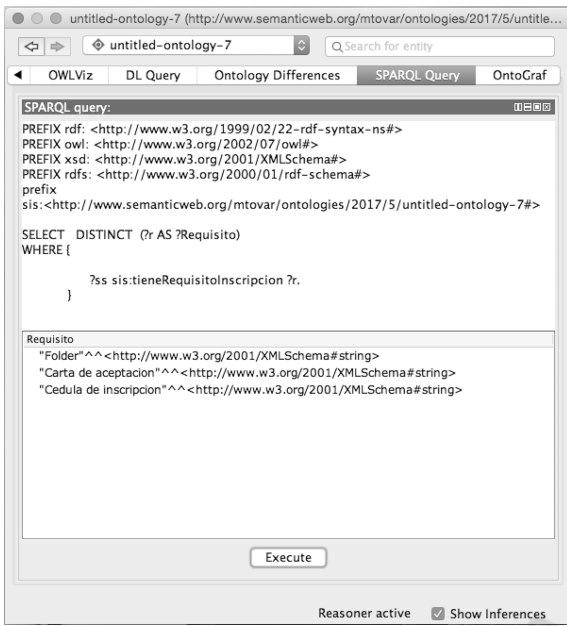


Figure 5: Answer to question 3.

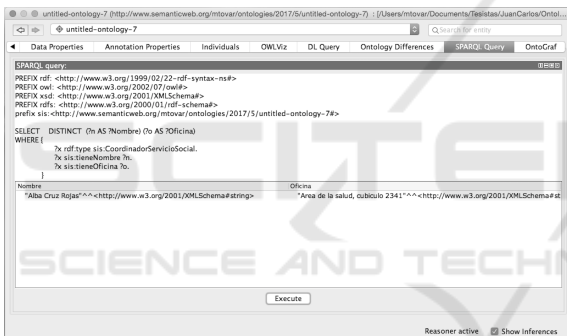


Figure 6: Answer to question 4.

7. What is the office hours of the social service coordinator?
8. How many credits does the social service give me?
9. Who is responsible for registering social service programs?

In Figure 12, the Social Service ontology proposed is shown, it is constructed with the Protégé tool.

## 5 CONCLUSIONS

The realization of the ontologies pretends to make the information search more efficient and of simple form, and the realization of the ontologies of separated form helps to find the vulnerabilities that the system can have and in this way to reach the fixed objective.

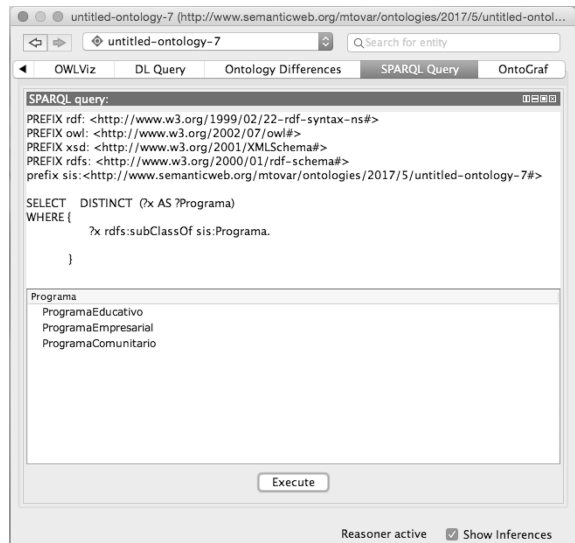


Figure 7: Answer to question 5.

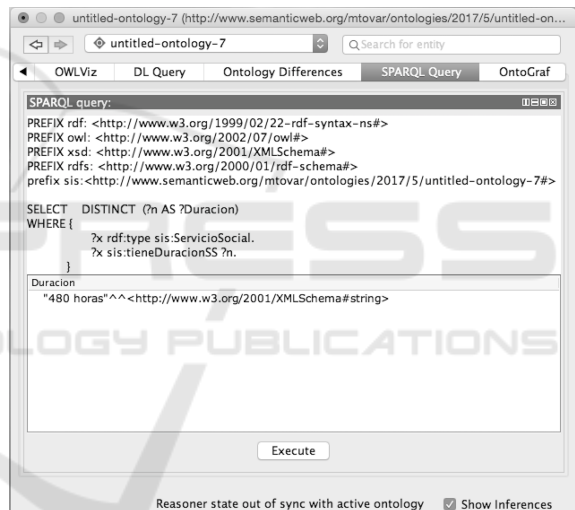


Figure 8: Answer to question 6.

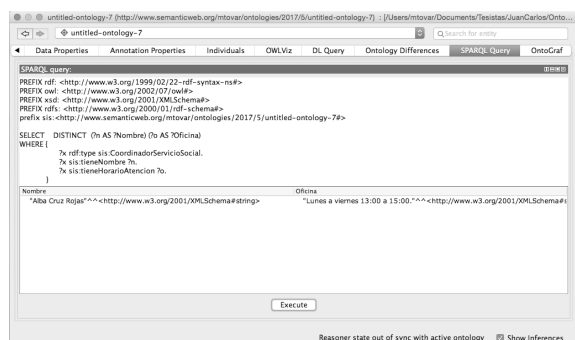


Figure 9: Answer to question 7.

Ontologies are a powerful tool for information structuring, and, widely used in Knowledge Engineering, Artificial Intelligence, natural language processing,

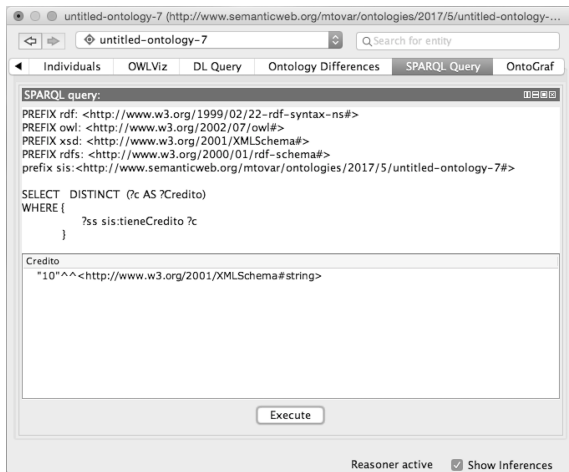


Figure 10: Answer to question 8.

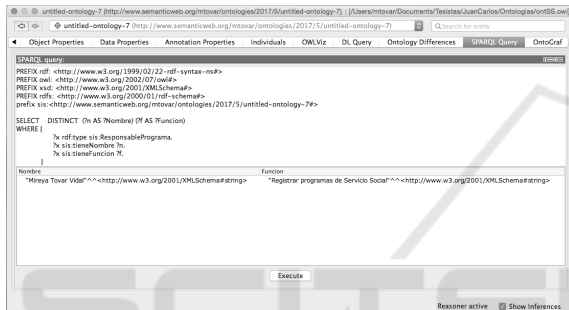


Figure 11: Answer to question 9.

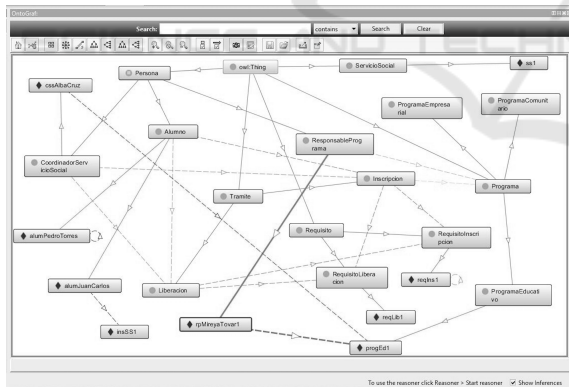


Figure 12: The ontology proposed.

information retrieval, education, etc.

The design of an ontology model for the search of information within an education institution is very useful as it provides us with clear and concise answers. In addition, there is a more efficient organization of information and data.

The main contribution of this paper is the application of a methodology for the creation of an academic ontology, which therefore supports the task of search information about social service in the academic do-

main.

As future work is intended to create a system which helps users to find information about the procedures and requirements they need to register and to realise the social service. This system will use the ontology model created as a source of information and it will give answers in a clear and precise form what the user wants.

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Table 1: Class description.

Class	Description
Person ( <i>Persona</i> )	This concept includes any person involved in the system.
SocialServiceCoordinator ( <i>CoordinadorServicioSocial</i> )	Subconcept of person that keeps track of the social service of students.
ProgramResponsible ( <i>ResponsablePrograma</i> )	Responsible for the social service program.
Student ( <i>Alumno</i> )	Provider of social service. Subconcept of person.
Program ( <i>Programa</i> )	A project presented to the students to carry out their social service.
EducationProgram ( <i>ProgramaEducativo</i> )	Type of program focused on the education. Subconcept of program.
CommunityProgram ( <i>ProgramaComunitario</i> )	Type of program focused on the community. Subconcept of program.
BusinessProgram ( <i>ProgramaEmpresarial</i> )	Type of program offered by a company. Subconcept of program.
Procedure ( <i>Tramite</i> )	A procedure that the student must carry out to register or to release the social service.
Inscription ( <i>Inscripcion</i> )	A procedure that the student must carry out to register the social service. Subconcept of procedure.
Release ( <i>Liberacion</i> )	A procedure that the student must carry out to release the social service. Subconcept of procedure.
Requirement ( <i>Requisito</i> )	Things that are wanted for the inscription or release of social service.
InscriptionRequirement ( <i>RequisitoInscripcion</i> )	Things that are wanted for the inscription of social service. Subconcept of requirement.
ReleaseRequirement ( <i>RequisitoLiberacion</i> )	Things that are wanted for the release of social service. Subconcept of requirement.

Table 2: Data properties for the Person (“Persona”) concept and its sub-concepts.

Data properties	Domain	Range
hasName ( <i>tieneNombre</i> )	Person ( <i>Persona</i> )	String
hasDirection ( <i>tieneDireccion</i> )	Person ( <i>Persona</i> )	String
hasTelephone ( <i>tieneTelefono</i> )	Person ( <i>Persona</i> )	String
hasGender ( <i>tieneSexo</i> )	Person ( <i>Persona</i> )	String
hasEmail ( <i>tieneEmail</i> )	Person ( <i>Persona</i> )	String
hasEnrollment ( <i>tieneMatricula</i> )	Student ( <i>Alumno</i> )	String
hasCaree ( <i>tieneCarrera</i> )	Student ( <i>Alumno</i> )	String
hasPosition  ( <i>tienePuesto</i> )	SocialService- Coordinator, ProgramResponsible ( <i>CoordinadorServi- cioSocial, Responsa- blePrograma</i> )	String
hasOffice  ( <i>tieneOficina</i> )	SocialService- Coordinator, ProgramResponsible ( <i>CoordinadorServi- cioSocial, Responsa- blePrograma</i> )	String
hasWorkerNumber  ( <i>tieneNoTrabajador</i> )	SocialService- Coordinator, ProgramResponsible ( <i>CoordinadorServi- cioSocial, Responsa- blePrograma</i> )	String
hasOfficeHours  ( <i>tieneHorarioA- tencion</i> )	SocialService- Coordinator, ProgramResponsible ( <i>CoordinadorServi- cioSocial, Responsa- blePrograma</i> )	String
hasFunction  ( <i>tieneFuncion</i> )	SocialService- Coordinator, ProgramResponsible ( <i>CoordinadorServi- cioSocial, Responsa- blePrograma</i> )	String

Table 3: Data type properties for the Social Service (“Servicio Social”) concept and Program (“Programa”) concept.

Data properties	Domain	Range
hasSector ( <i>tieneSector</i> )	SocialService ( <i>ServicioSocial</i> )	String
hasPeriod ( <i>tienePeriodo</i> )	SocialService ( <i>ServicioSocial</i> )	String
hasTypeService ( <i>tieneTipoServicio</i> )	SocialService ( <i>ServicioSocial</i> )	String
hasCredit ( <i>tieneCreditos</i> )	SocialService ( <i>ServicioSocial</i> )	String
hasDurationSS ( <i>tieneDuracionSS</i> )	SocialService ( <i>ServicioSocial</i> )	String
hasNumberProgram ( <i>tieneNoPrograma</i> )	Program ( <i>Programa</i> )	String
hasDateRegistration ( <i>tieneFechaRegistro</i> )	Program ( <i>Programa</i> )	String
hasStatus ( <i>tieneEstatus</i> )	Program ( <i>Programa</i> )	String
hasNameProgram ( <i>tieneNombre- Programa</i> )	Program ( <i>Programa</i> )	String
hasDateStart ( <i>tieneFechaInicio</i> )	Program ( <i>Programa</i> )	Date
hasDateEnd ( <i>tieneFecha- Termino</i> )	Program ( <i>Programa</i> )	Date
hasDuration ( <i>tieneDuracion</i> )	Program ( <i>Programa</i> )	String
hasCurrentPeriod ( <i>tienePeriodoActual</i> )	Program ( <i>Programa</i> )	String
hasInscription- Number ( <i>tieneNu- meroInscription</i> )	Inscription ( <i>Inscripcion</i> )	String
hasMinimumCredit ( <i>tieneCreditoMinimo</i> )	Inscription ( <i>Inscripcion</i> )	positive- Integer
hasInscriptionCredit ( <i>tieneCredito- Inscripcion</i> )	Inscription ( <i>Inscripcion</i> )	positive- Integer
hasRelease- Requirement ( <i>tieneRequisito- Liberacion</i> )	Release- Requirement ( <i>Requisio- Liberacion</i> )	String
hasInscription- Requirement ( <i>tieneRequisito- Inscripcion</i> )	Inscription Inscription- Requirement ( <i>Inscripcion, Requisito- Inscripcion</i> )	String



Table 4: Object properties.

Object properties	Domain	Range
authorizes ( <i>autoriza</i> )	SocialService-Coordinator ( <i>CoordinadorServicio-Social</i> )	Inscription, Release ( <i>Inscripcion, Liberacion</i> )
performed ( <i>realiza</i> )	Student ( <i>Alumno</i> )	Inscription ( <i>Inscripcion</i> )
register ( <i>registra</i> )	Program-Responsible ( <i>Responsable-Programa</i> )	Program ( <i>Programa</i> )
require ( <i>requiere</i> )	Inscription ( <i>Inscripcion</i> )	Program ( <i>Programa</i> )
has ( <i>tiene</i> )	Release, Inscription ( <i>Liberacion, Inscripcion</i> )	Release-Requirement, inscription-Requirement, ( <i>requisito-Liberacion, requisito-Inscripcion</i> )
isRegisteredBy ( <i>esRegistradoPor</i> )	Program ( <i>Programa</i> )	Program-Responsible ( <i>Responsable-Programa</i> )
carryOut ( <i>llevaCabo</i> )	Student ( <i>Alumno</i> )	Release ( <i>Liberacion</i> )

Table 5: Competency questions.

No.	Question
1	In what period can I register the social service? $\exists x y (SocialService(\$x) \wedge hasPeriod(\$x, \$y))?$
2	How many credits are needed to register the social service? $\exists x y (Inscription(\$x) \wedge hasInscriptionCredit(\$x, \$y))?$
3	What documentation do I need to register the social service? $\exists x y (Inscription(\$x) \wedge hasInscriptionRequirement(\$x, \$y))?$
4	Where is the office of the social service coordinator? $\exists x y ((Inscription(\$x) \vee inscriptionRequirement(\$x)) \wedge hasInscriptionRequirement(\$x, \$y))?$
5	What are the types of programs that exist in social service? $\exists x (Program(\$x))?$
6	How many hours are you in social service? $\exists x y (SocialService(\$x) \wedge hasDurationSS(\$x, \$y))?$
7	What is the office hours of the social service coordinator? $\exists x y n (SocialServiceCoordinator(\$x) \wedge hasName(\$x, \$n) \wedge hasOffice(\$x, \$y))?$
8	How many credits does the social service give me? $\exists x y (SocialService(\$x) \wedge hasCredit(\$x, \$y))?$
9	Who is responsible for registering social service programs? $\exists x y (ProgramResponsible(\$x) \wedge hasName(\$x, \$y))?$