Researcher Profile Ontology for Academic Environment

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Abstract. Universities must know the research profiles and professional competences of professors and researchers to be more competitive and know how to offer creative solutions (through courses, diplomas, research projects, etc.) to complex needs of society. Therefore the representation, management, and exploitation of researcher profiles are important tasks that must be addressed. In this paper we investigate on the use of ontologies as the main solution approach to support the representation of researcher profiles in a given academic environment. We describe the ontology model design, the automatic ontology population process, and the discovery and enrichment of interesting semantic relations between researcher profiles. The functional competency of the resulting ontology is evaluated utilizing a set of inference rules and queries.

Keywords: Researcher profile · Ontology population · Ontology enrichment

1 Introduction

Currently, higher education institutions and research centers hire highly specialized human resources who have postgraduate studies. The capacity, expertise and talent accumulated by academic and research staff is one of the most important assets available to institutions. Representing, quantifying and knowing how to better manage these highly specialized human resources is a very important issue; however, it is not an easy task to perform, since it requires the acquisition, representation and intelligent treatment of large volumes of data. A good management of highly specialized human resources can be carried out through the administration of researcher profiles to enable: finding similar profiles to establish new collaborations, looking for specific profiles that allow to integrate a work team with specialists, discovering groups or classes of researchers that address similar topics, discovering groups of researchers that address different problems but that use similar solution techniques and methods, among other possible applications.

A researcher profile is constituted with the relevant information regarding previous academic work experience in different research institutions, education and level of studies considering undergraduate, graduate, and specialization studies; an important aspect of a researcher profile is the set of scientific published articles, chapters, and books, as they represent the researcher topics of interest, and the researcher most active collaborations.

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In this paper, we present an ontology solution approach for the acquisition, representation and management of researcher profiles. This ontology solution is evaluated using a set of competency questions through which the functional competency of the ontology is evaluated satisfactorily.

This paper reports a contribution in the area of ontology learning, which is defined as the process of automatic or semi-automatic construction, enrichment and adaptation of ontologies [1]. Accordingly, the main tasks involved in ontology learning are: ontology enrichment, extending an existing ontology with additional concepts and semantic relations; inconsistency resolution, resolving inconsistencies that appear in an ontology aiming at producing and maintaining a consistent ontology; and ontology population, adding new instances of concepts to the ontology. The methodological process followed for the construction and evaluation of the proposed solution consist of four phases: ontology design, ontology population, ontology enrichment, and ontology evaluation.

2 Analysis of Related Work

In this section we describe the related works that address the representation and management of researcher or academic profiles. We analyze their applications and concept coverage.

Yao, Tang and Li [2] address the problem of researcher profiling by annotating a collection of researcher web pages, and defined a series of difficulties found using this approach. Authors identify tokens in the Web page heuristically, assign tags to each token (Position, Affiliation, Email, Address, Phone, Fax), using the tags, they perform the profiling extraction.

In Liu et al. [3] authors address the problem of finding experts with required expertise. They describe two ontologies: an expert ontology, which defines concepts such as: Person, Publication, Project, and Research Interests; and a domain ontology which stores the key concepts (research areas), the attributes of the concepts and the relations between concepts (for example, broader, narrower and part-of).

ArnetMiner is one of the most outstanding researcher profile searcher and mining tool presented in 2008 by Tang et al. [4]. ArnetMiner extracts automatically topics of expertise of a person based on the documents accessed by that person; it constructs a user profile using a set of topics with weights determining his level of interest. ArnetMiner represents all extracted data in a relational database, and the schema of a researcher profile consisting of two main entities: ***Researcher*** and ***Publication***.

Thiagarajan et al. in 2008 [5] addressed the problem of expert finding by computing the similarity between two user profiles with an ***ontology-based*** Spreading Activation Network (SAN). In this work authors represent the user profile as a set of topics with weights determining the level of interest. As a data source for profile extraction they obtained a set of documents and information provided by participants and used WordNet for term expansion.

Sadaf Adnan et al. in 2009 [6] presented a multi-agent paradigm supported by a semantic web architecture to address the challenges of researcher profiling and

association. Authors describe an ontological model to represent information such as researcher profiles, conference papers, research centers, etc.

In 2010 Punnarut and Sriharee [7] described a skill classification ontology model containing skills of research in the area of computer and information science. Their main contributions are: a process to build the skill classification ontology, a methodology to determine expertise of the researcher using the skill classification ontology, and a method to retrieve the relevant researchers who may have competency matched to the desired expertise.

In 2012 Kamsiang and Senivongse [8] described a solution approach to address the problem of identifying common research interests between researchers. Their approach is based on the generation of researcher profile ontologies from keywords in a particular subject area during a certain period; keywords were taken from ISI Web of Knowledge. To compare the similarity between profile ontologies, authors presented an ontology matching algorithm.

In 2013 Whaling et al. [9] described Lens, an open source faceted browser for research profiling. The main objective of this work is to make available a number of coexisting dimensions that can be simultaneously browsed by the user. The information was extracted from public available data about researchers at the University of Chicago. They developed a prototype for the university profiling system to help researchers to find collaborators.

In 2014 Ahmed et al. [10] described the design of OntoSSN, a scientific social network ontology. However, authors did not implement any publication extraction mechanism, nor they evaluated the efficiency and performance of their ontology considering real research data.

In 2015 Sinha et al. [11] presented a search paradigm implemented in academic publications area. Authors describe a graph-based model comprised of six entities: field of study (research interest), author, institution, paper, venue and event. They addressed the author name disambiguation by obtaining context information: affiliation, coauthors, year and venue of the publication.

In 2017 Sateli, Löffler, König-Ries, and Witte [12] described ScholarLens, a semantic approach to extract competences from research publications and for the automatic generation of semantic user profiles. In [12] authors argued that scholarly applications require not only semantic representation of research objects (publications, projects, software) but also users (researchers, professors, and students).

There are very few semantic models that include information on publications, research projects, research products and profiles of interested users, such as researchers, students, professors and entrepreneurs interested in innovation.

Table 1 shows a comparison of related work considering the most important questions regarding the automatic extraction and representation of Researcher Profiling: What sources of information are utilized? What representation mechanism is used? Are the basic information data and contact information data possible to extract? What other important aspects of the researcher profile are being considered?

As Table 1 shows, authors of related work have utilized different data sources; it is possible to state that using all possible sources of information could produce a more complete profile; however, the consistency and the actualization of the information is a problem to address. It is also visible that majority of authors are selecting ontologies as

Table 1. Comparison of related work.

Refs.	Profile information source	Information extraction method	Representation mechanism	Basic information			Contact information				Educational history	Expertise or research interests	Research projects	Publications
				Photo	Affiliation	Position	Address	Email	Telephone	URL				
[2]	Web pages and DBLP	Automatic extraction and semantic annotation	Ontologies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
[3]	Heterogeneous data sources	Wrapers	Ontologies	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes
[4]	Homepages from the Web and online digital libraries	Probabilistic framework based on Hidden Markov Random Fields	Relational Data Base (RNKB)	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	No	Yes
[5]	Documents and information provided by participants and WordNet	Spreading Activation Network	Ontologies	No	No	No	No	No	No	No	No	Yes	No	Yes
[6]	Manually provided by users and DBLP	Agent-based	Ontologies	No	No	No	No	No	No	No	No	Yes	No	Yes
[7]	Research papers and research projects the proceedings of the JCSSE and NCSEC conferences and the research report of NRCT. The ACM taxonomy	Extracting text from titles and using probabilistic approach	Ontologies	No	No	No	No	No	No	Yes	No	Yes	Yes	Yes

(*continued*)

Table 1. (*continued*)

Refs.	Profile information source	Information extraction method	Representation mechanism	Basic information			Contact information				Educational history	Expertise or research interests	Research projects	Publications
				Photo	Affiliation	Position	Address	Email	Telephone	URL				
[8]	Keywords in a particular subject area during a certain period are taken from ISI Web of Knowledge	Obtaining Domain Ontology (ODO) algorithm proposed by Y. J. An, J. Geller, Y. Wu, and S. A. Chun, "Automatic generation of ontology from the deep Web"	Ontologies	No	No	No	No	No	No	No	No	Yes	No	Yes
[9]	Publicly available data about researchers at the University of Chicago	Faceted browser for research networking	RDF data on the VIVO ontology											
[10]	Manually designed the model, recording of large amount of publications was not tested	No information extraction was utilised	Ontologies	No	No	No	No	No	No	No	No	No	Yes	Yes
[11]	Collect data from ACM and IEEE Data from indexed pages and feeds from publishers	Parsing data and applying author name disambiguation	Heterogeneous graph	No	Yes	No	No	Yes	No	Yes	No	Yes	No	Yes
[12]	Manually obtained a collection of research articles fro a given user	Utilization of text mining techniques and semantic annotation of articles	RDF vocabularies	No	No	No	No	No	No	No	No	Yes	No	Yes

the representation model. Motivated by these related works, we propose an ontology-based solution approach for the acquisition, representation and management of researcher profiles.

3 Methodology

The scientific methodology that was followed to build a solution is shown in Fig. 1 and described in this section.

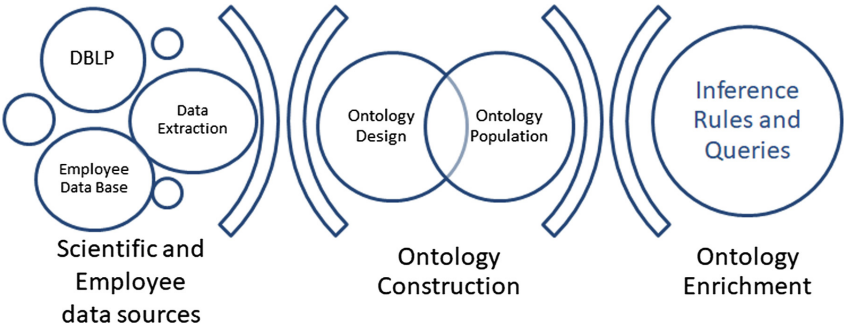

Fig. 1. Methodology for the extraction of researcher profile, ontology construction and enrichment.

3.1 Scientific Data Sources

In order to obtain data of researcher's different sources can be utilized by crawling and extracting data from researcher's home pages, URL's and key words of Web pages, E-mail communications, organizational and institutional documents or databases. There are also different repositories publicly available to extract scientific publication data, for instance: DBLP, CiteSeer, Google Scholar, Scopus, and ArnetMiner. For reference: in [2] and [4] authors extracted information from researcher's homepages and the digital libraries DBLP and CiteSeer. In [5] authors extracted information from documents provided by participants and WordNet.

In this work, we count with an excel database with researchers data records from two academic departments of the university. This database consists of researchers' full names, email, department, academic project, and academic title. Additionally, we selected DBLP (Digital Bibliography & Library Project) [13] to extract publication data and enrich the ontology model. DBLP is a computer science bibliography dataset available as one big XML file containing: ***dblp.xml*** an XML file which contains all bibliographic records, and ***dblp.dtd*** the corresponding document type definition to validate the XML file. The following code is a fragment of the dblp.xml file.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE dblp SYSTEM "dblp.dtd">
<dblp>
[...]
<article key="journals/cacm/Gentry10" mdate="2010-04-26">
<author>Craig Gentry</author>
<title>Computing arbitrary functions of encrypted data.
</title>
<pages>97-105</pages>
<year>2010</year>
<volume>53</volume>
<journal>Commun. ACM</journal>
<number>3</number>
<ee>http://doi.acm.org/10.1145/1666420.1666444</ee>
<url>db/journals/cacm/cacm53.html#Gentry10</url>
</article>
```

3.2 Ontology Construction

The objective of this phase is to design an ontology specifying a set of initial requirements consisting of the concepts that the ontology must include and the competency. Once the ontology model has been axiomatically defined and ontructed, then a set of Java modules should be implemented to fully automate the population of the ontology considering the data sources available.

3.3 Ontology Enrichment

The objective of this phase is to automatically process and analyze the population of the ontology to discover new interesting semantic relations between individuals. In order to execute ontology enrichment in this project a set of semantic inference rules and queries were defined.

4 Specification of Ontology Requirements

The main objective of the ontology model reported in this paper is to represent, process, and reason about the information of researcher profiles, considering that every research institution requires the efficient management and dissemination of information relative to the professors and research activities. The ultimate goal of this project is the smart provisioning of services to academic communities in which users search for specialized information (such as publications, coauthoring, conferences, etc.) and are also interested in establishing collaborations with other researchers. Considering this motivation, the following requirements were defined in order to guide the ontology design, construction and evaluation.

4.1 Concept Coverage

For the definition of the scope of the ontology, we reviewed the concepts of research profile. Yao, Tang and Li [2] described profiling as the process of obtaining the values associated with the different properties that constitute the person model. Authors define the schema of a researcher profile containing: name, affiliation, position, phone, address, email, research interests, and postgraduate studies. From this definition we consider that the entities (or objects) that constitute a researcher profile are: ***Person*** (for example professors, students, staff, etc.), and ***Publication*** (to extract research interests). From this initial analysis we have defined the concept coverage requirements of the ontology and defined the main objective of the ontology, which is to facilitate researcher profile representation and processing in the academic environment.

The ontology model should include the following concepts:

(a) A complete definition of ***Person*** (***Researcher***) consisting of full name, unique identifier, department, gender, affiliation department, academic title, etc.
(b) A complete definition of ***Publication*** consisting of: title, authors, key words, volume, year of publication, among others.
(c) A semantic relationship to correlate a ***Researcher*** as an ***author*** of a ***Publication***.
(d) A semantic relationship to correlate ***collaborations*** between ***Researcher*** individuals.

4.2 Competency of the Ontology

Based on the definition of Gruninger and Fox [8] the competence of an ontology model is the set of questions that the ontology can answer. Evaluation of the competency of an ontology system is crucial to verify that a representational model is complete with respect to a given set of competency questions. The following constitutes the types of information that results of interest for the evaluation of the ontology model:

1. To know how many scientific works does a given researcher has published
2. To find groups of authorship collaborations
3. To know the researcher's publications from a topic with high degree studies
4. To answer about statistical data of publications
5. To know the scientific productivity of a given department
6. To know the number of female researchers from a given department with published scientific works.

5 Ontology Design

Ontology design is the process of selecting and applying methods, techniques and principles with the objective of producing an ontology model. In this section, the design considerations that were taken into account are described.

5.1 Person Ontology

Person ontology (shown in Fig. 2) was designed to represent all possible academics that hold a permanent or temporal position as professor or researcher at the university, such as: academic visitor, full time professor, external sabbaticals, etc. This ontology also represents postgraduate students, and research oriented undergraduate students, among others. An important characteristic of this ontology is that it uses a unique identifier for every type of person. The concept ***Person*** is defined as an equivalence through the ***hasName*** and ***hasGender*** data properties, indicating that every person individual is obligated to have name and gender to be classified as type of ***Person*** class. The concept ***Employee*** is defined as a sub class of a ***Person*** that ***hasEconomicNumber*** data property (see Fig. 3). Whereas the concept ***Student*** is defined as a sub class of ***Person*** that ***hasStudentId***. An important concept is a ***Professor*** which is an ***Academic***, is an ***Employee*** and is a ***Person*** that ***hasCategory***, ***hasDepartment***, and ***hasEmail***; and inherits the data property of an ***Academic hasProject***. The class hierarchy of the ***Person*** ontology shows the sub-classification of the class ***Student*** into ***RegularStudent*** and ***AssistantStudent***. This classification addresses the particular need to represent the two types of students that exist in the university where an individual of the ***AssistantStudent*** class is considered to be an ***Academic***, an ***Employee*** and a ***Student***.

5.2 Publication Class

Scientific published articles, chapters, and books are the most important sources of information in order to fully integrate a researcher profile. Scientific publications contain the author's topics of interest, conferences and journals of preference, the years of publications and periodicity; also the researcher most active collaborations. In order to build a researcher profile, the design and construction of a ***Publication*** class considered as input the information extracted from the DBLP digital library, extracting the most relevant bibliographic information on major computer science publications. The ***Publication Class*** defines the same attributes utilized in DBLP: ***hasAuthor*** to post process semantic relations between ***Professor*** and ***Publication*** classes, ***hasEE*** is a

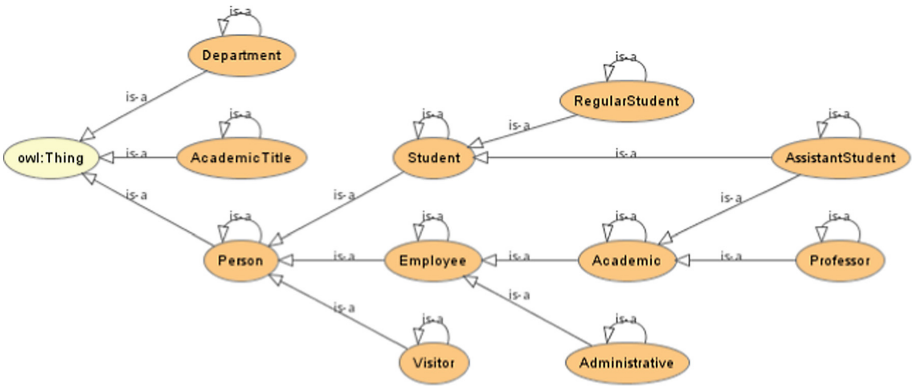

Fig. 2. Hierarchy class of the Person ontology.

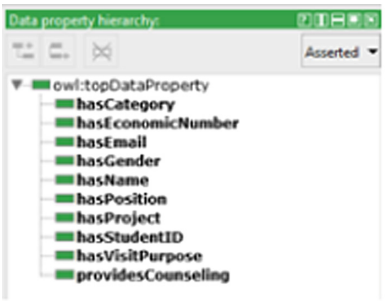

Fig. 3. Data properties defined for the Person ontology.

DBLP unique identifier of the publication, ***hasKey*** to aggregate the set of keywords, ***hasPages***, ***hasTitle***, ***hasURL***, ***hasVolume***, and ***hasYear***; all datatype attributes extracted from the DBLP xml file and represented in the ontology model as data type properties (see Fig. 4).

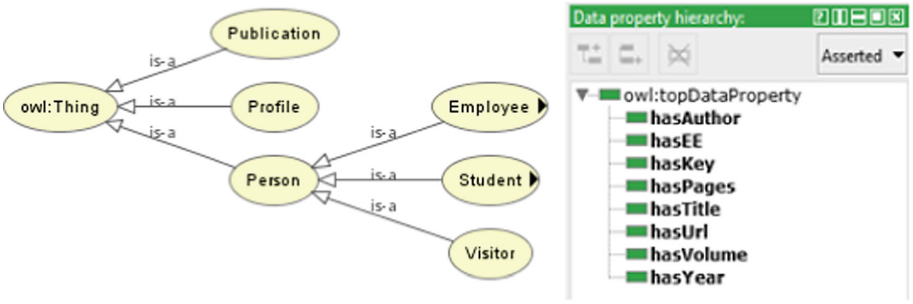

Fig. 4. Publication class hierarchy and data properties.

5.3 Researcher Profile Ontology

The Researcher Profile Ontology shown in Fig. 5 incorporates the conceptualizations from ***Person Ontology*** and ***Publication Class***. From ***Person*** ontology imports ***Professor*** personal data, such as full name, and economical number; from the ***Publication*** Class imports publications organized by year, type of publication, among others. Additionally, incorporates ***Department*** and ***AcademicTitle*** concepts. All these conceptualizations are used to complete the definition of a ***Researcher Profile***, considering the associated publications, the affiliated department, the academic title obtained, and the rest of personal data.

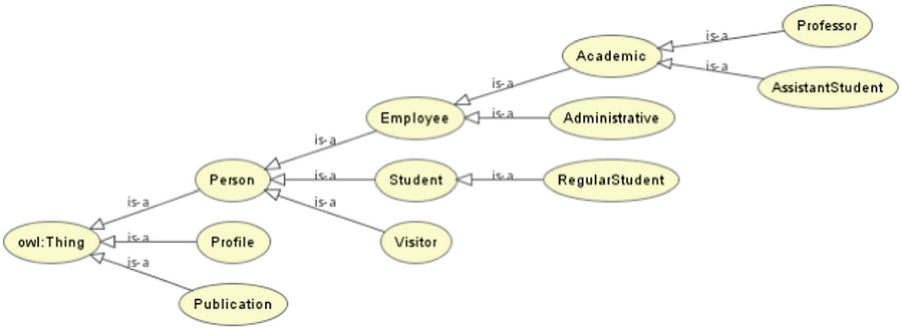

Fig. 5. Researcher Profile class hierarchy.

6 Ontology Population

Ontology population is the process of adding (instantiating) new individuals in the ontology concepts (classes). Automated ontology population is desirable due to the large amount of data that must be extracted and instantiated in the ***Person*** and ***Publication*** concepts.

6.1 Person Ontology Population

For ***Person*** ontology population, initially the data source came from a set of excel files that the management staff of the university uses for different purposes. These excel files contain the information of all academic staff who is affiliated with the university, such as: professor's full name, gender, department, email, economical number, academic projects, and alias. For the automated population of the ***Person*** ontology, two Java modules were developed: a module to parse and extract the information from the source files; and another module to interact with the ontologies using the Java OWL Application Programming Interface (OWL API) to load and manipulate ontologies, creating new individuals, instantiating object properties and data properties with individuals, and register them in the ontology. Alias names are important in order to facilitate the semantic association of the researcher individual with all his publications. Figure 6 shows an example of an individual from the ***Person*** – ***Professor*** class which was automatically populated.

6.2 Publication Class Population

For ***Publication*** Class population, the data was extracted from the DBLP XML file, which contains more than a million of Computer Science publications. The XML file from the DBLP contains publication title, author names, publication year, volume, EE (a unique publication identifier), URL, and pages. However, it does not provide the abstract and keywords of publications. A Java module was built to interact with the

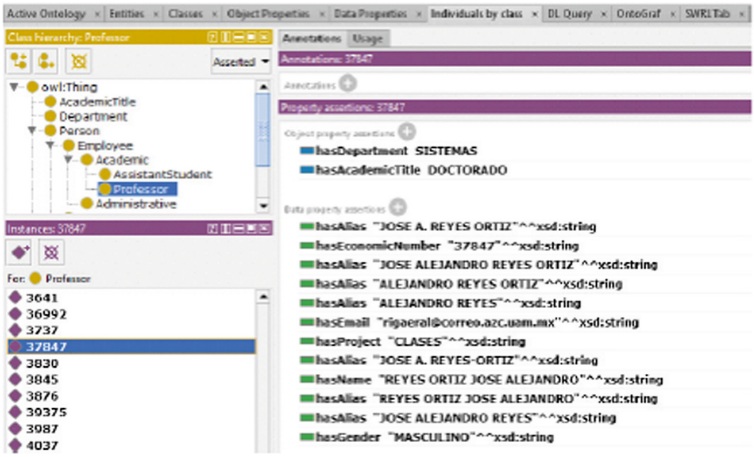

Fig. 6. Person Ontology population.

ontologies using the OWL API to load and manipulate ontologies, creating new individuals, instantiating object properties and data properties. Figure 7 shows an example of a ***Publication*** Class individual automatically created.

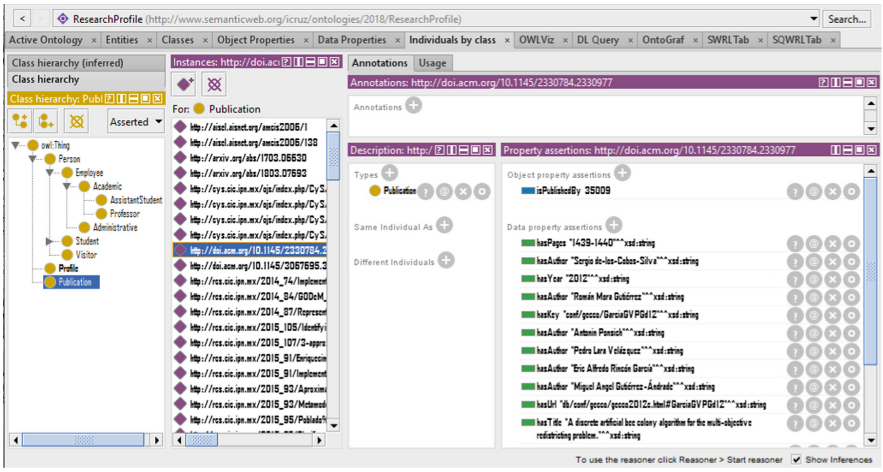

Fig. 7. Publication Class population.

7 Ontology Enrichment

Ontology enrichment is the automatic process of analyzing the population data values and discovering new interesting semantic relations between individuals. Of particular interest in this enrichment process is the automatic discovery of authorships and

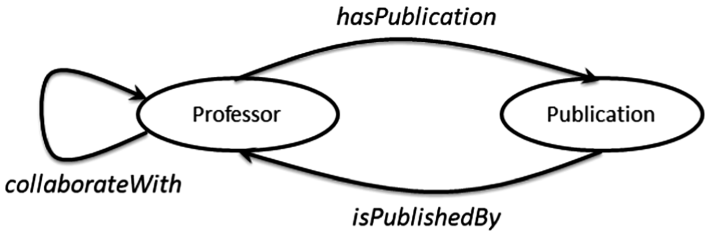

Fig. 8. Object properties utilized for ontology enrichment.

collaboration relations between authors of publications. For this, the object properties shown in Fig. 8 and inference rules were defined.

isPublishedBy is an object property with domain ***Publication*** and range ***Professor***. This object property is instantiated during the ***Publication*** automated population, for each ***Publication*** instance, the list of authors is extracted and a Java module that recognizes authorships is executed (using the aliases); as an outcome the exact correlation is established. This object property has an inverse definition ***hasPublication***, which has as domain the ***Professor*** class and range the ***Publication*** class. By executing the reasoner, this inverse semantic relationship is inferred.

collaborateWith is an object property with domain ***Person*** and range ***Person***. This object property was defined to establish semantic relationships between authors of publications, considering that there is the possibility of students, visitors and professors to collaborate. In order to find collaboration relationships, the following SWRL rule is fired resulting in new object property instantiations. Figure 9 shows the result of the ontology enrichment process after the execution of the rule.

```
Publication(?pub) ^ isPublishedBy(?pub, ?prof) ^
isPublishedBy(?pub, ?prof2) ^ differentFrom(?prof,
?prof2) ^
-> collaborateWith(?prof, ?prof2)
```

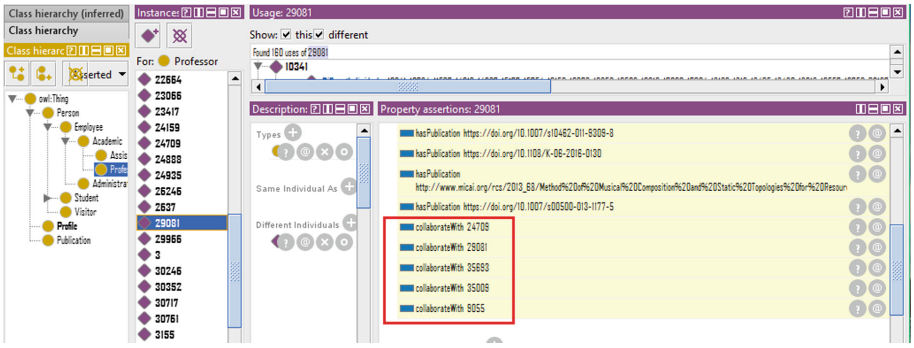

Fig. 9. Result of the execution of rule to find collaborations between professors.

8 Ontology Evaluation

Ontology Evaluation [14] concerns the correct building of the ontology, ensuring that its definitions correctly implement the ontology requirements and competency questions. For evaluation the competence of the ontology was considered, that is, if it is able to respond to a set of competency questions; and the verification of requirements compliance. The following competency questions were coded in SWRL and Description Logic (DL) language as queries and their results were correct.

8.1 Researcher Publications

To know how many scientific publications does a given researcher has published, the following rule queries were defined and executed. Figure 10 shows the result of this competency question.

SQWRL query:

```
person:Professor(?prof1) ^
researchprofile:hasPublication(?prof1, ?pub) ^
person:hasName(?prof1, ?name) ^
swrlb:equal(?name, "LAUREANO CRUCES ANA LILIA
CONCEPCION")
-> sqwrl:select(?pub) ^ sqwrl:count(?pub)
```

DL query:

```
isPublishedBy some (Professor and hasName value
"LAUREANO CRUCES ANA LILIA CONCEPCION")
```

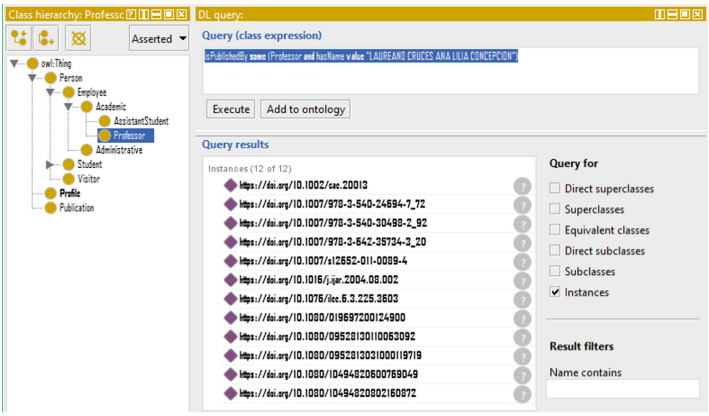

Fig. 10. Publications of a given Professor.

8.2 Collaboration Between Researchers

To find groups of authorship collaborations, the following semantic Web rules were defined and executed. The result is shown in Fig. 11.

SQWRL query:

```
person:Professor(?p1) ^
researchprofile:collaborateWith(?p1, ?p2) ^
person:hasEconomicNumber(?p1, ?e) ^
swrlb:equal(?e, "14233")
-> sqwrl:select(?p1, ?p2)
```

DL query:

```
collaborateWith some (Professor and hasName value
"LAUREANO CRUCES ANA LILIA CONCEPCION")
```

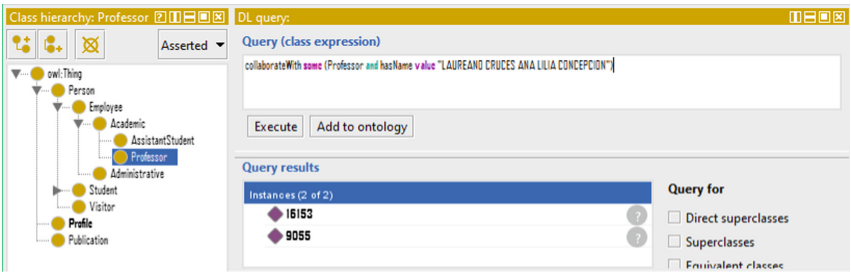

Fig. 11. Find collaborators of researchers.

8.3 Qualified and Specialized Researchers

In order to know the researcher's publications from a specialized topic with high degree studies, the following semantic Web rule was utilized. Figure 12 shows the result of the execution.

SQWRL query:

```
person:Professor(?professor) ^
person:hasDepartment(?professor, "ELECTRONICA") ^
person:hasAcademicTitle(?professor, "DOCTORADO") ^
researchprofile:hasPublication(?professor, ?pub)
-> sqwrl:select (?professor)
```

DL query:

```
Professor and (hasAcademicTitle value "DOCTORADO")
and (hasDepartment value "ELECTRONICA")
```

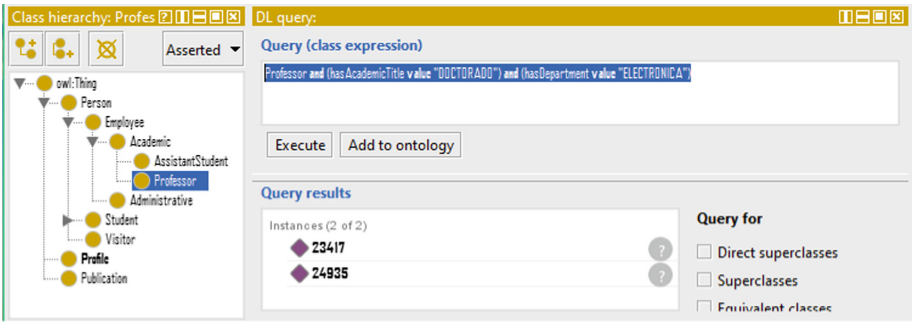

Fig. 12. Finding specialized researchers.

8.4 Publications by Year

The ontology is capable of answering statistical data of publications, for instance: How many publications were there in the year 2017? Figure 13 shows the result of this rule.

SQWRL query:

```
publication:Publication(?pub) ^
publication:hasYear(?pub, ?y) ^
swrlb:equal(?y, "2017") -> sqwrl:count(?pub)
```

DL query:

```
Publication and hasYear value "2017"
```

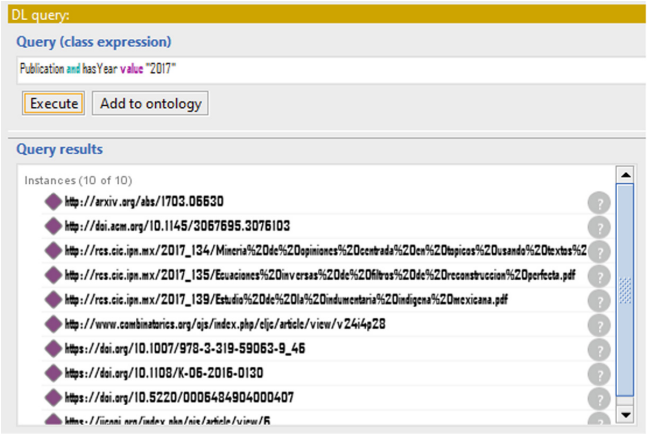

Fig. 13. Finding specialized researchers.

8.5 Publications by Department

In order to know the scientific productivity of a given department, the following semantic Web rules were used. Figure 14 shows the result.

SQWRL query:

```
publication:Publication(?pub) ^
researchprofile:isPublishedBy(?pub, ?prof) ^
person:hasDepartment(?prof, "SISTEMAS") ->
sqwrl:select(?pub)
```

DL query:

```
Publication and isPublishedBy some (Professor and
hasDepartment value "SISTEMAS")
```

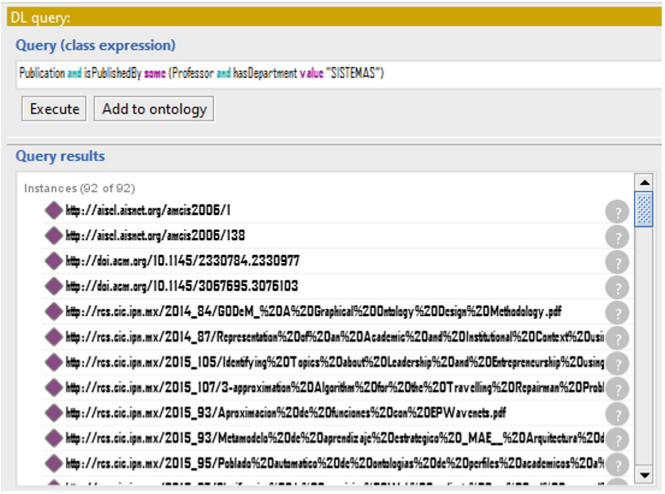

Fig. 14. Publications by department.

8.6 Publications by Gender

To know who are the female researchers that have published scientific works, the following semantic Web rules were used. Figure 15 shows the results.

SQWRL query:

```
person:Professor(?prof) ^ person:hasGender(?prof,
"FEMENINO") ^ researchprofile:hasPublication(?prof, ?pub)
-> sqwrl:select(?prof)
```

DL query:

```
Professor  and (hasGender value "FEMENINO") and
hasPublication some Publication
```

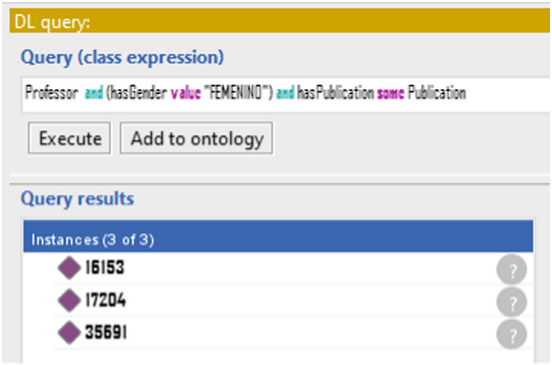

Fig. 15. Publications by gender.

9 Conclusions

In the work reported in this paper, an ontology-based approach was used to populate a ***Researcher Profile Ontology***. The researcher profile ontology consists of three main concepts: the ***Person Ontology***, the ***Publication Class***, and the ***Profile Ontology***. For automated population of the ***Person Ontology***, a dataset of 373 professors was used, two departments were instantiated in the ***Department*** class, 50 professor individuals are from the ***Systems Department*** and 60 from ***Electronics Department***. 100% of them were correctly inserted in the Person ontology, specifically in the ***Professor*** class. For experimentation purposes two ontologies were generated: one was used for professors of the electronics department and another for professors of the systems department. The ontology had a total of 50 researchers in total. Once the universe of professors was divided, the ***Publication*** ontology was populated using as a data source the DBLP file, which contains approximately one million articles and more than 56 million lines. The result of the population of the ***Publication*** Class with professors of the Systems department resulted in a total of 135 publications that coincided between the aliases of the professors and the authors indicated within the <author> label of the DBLP. At the same time 116 collaboration relationships were found among the professors from the Systems department.

The ontology of ***Professor*** from the Electronics department, with a total of 58 professors, was subjected to the same test as the ontology of the Systems department and 22 publications were found from the same DBLP file, that is, all the aliases were compared of the researchers of the Electronics department against the authors of the million articles of the DBLP. In this ontology 4 collaborative relationships were found, that is, in two publications two or more professors from the same department participated. As future work, other sources can be considered to continue enriching the ontologies with more semantic relationships, such as ArnetMiner [4] which contains abstracts and keywords of publications in order to enable the semantic relationship between publications, researchers and topics of interest. In this way the ontology would comply with the characteristic of being scalable and make the profile of each researcher a more complete.

References

1. Maedche, A., Staab, S.: Ontology learning. In: Handbook on Ontologies (2004)
2. Yao, L., Tang, J., Li, J.: A unified approach to researcher profiling. In: Proceedings of the IEEE/WIC/ACM International Conference on Web Intelligence, pp. 359–366. IEEE Computer Society, November 2007
3. Liu, P., Liu, K., Liu, J.: Ontology-based expertise matching system within academia. In: International Conference on Wireless Communications, Networking and Mobile Computing. WiCom 2007, pp. 5431–5434. IEEE, September 2007
4. Tang, J., Zhang, J., Yao, L., Li, J., Zhang, L., Su, Z.: Arnetminer: extraction and mining of academic social networks. In: Proceedings of the 14th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, pp. 990–998. ACM, August 2008
5. Thiagarajan, R., Manjunath, G., Stumptner, M.: Finding experts by semantic matching of user profiles (Doctoral dissertation, CEUR-WS) (2008)
6. Adnan, S., Tahir, A., Basharat, A., de Cesare, S.: Semantic agent oriented architecture for researcher profiling and association (semora). In: IEEE/WIC/ACM International Joint Conferences on Web Intelligence and Intelligent Agent Technologies. WI-IAT'09, vol. 3, pp. 559–562. IEEE, September 2009
7. Punnarut, R., Sriharee, G.: A researcher expertise search system using ontology-based data mining. In: Proceedings of the Seventh Asia-Pacific Conference on Conceptual Modelling, vol. 110, pp. 71–78. Australian Computer Society, Inc., January 2010
8. Kamsiang, N., Senivongse, T.: Identifying common research interest through matching of ontological research profiles. In: Proceedings of the World Congress on Engineering and Computer Science, vol. 1 (2012)
9. Whaling, R., Malik, T., Foster, I.: Lens: a faceted browser for research networking platforms. In: 2013 IEEE 9th International Conference on eScience (eScience), pp. 196–203. IEEE, October 2013
10. Ahmed, E.B., Tebourski, W., Karaa, W.B.A., Gargouri, F.: ONTOSSN: scientific social network ontology. In: 2014 15th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD), pp. 1–4. IEEE, June 2014
11. Sinha, A., Shen, Z., Song, Y., Ma, H., Eide, D., Hsu, B.J.P., Wang, K.: An overview of microsoft academic service (mas) and applications. In: Proceedings of the 24th International Conference on World Wide Web, pp. 243–246. ACM, May 2015
12. Sateli, B., Löffler, F., König-Ries, B., Witte, R.: ScholarLens: extracting competences from research publications for the automatic generation of semantic user profiles. PeerJ Comput. Sci. **3**, e121 (2017)
13. https://dblp.uni-trier.de/db/about/
14. Gómez-Pérez, A.: Towards a framework to verify knowledge sharing technology. Expert Syst. Appl. **11**(4), 519–529 (1996)