Towards a Study Opportunities Recommender System in Ontological Principles-based on Semantic Web Environment

ANA MARÍA BORGES
Simón Bolívar University
Department of Processes and Systems
Valle de Sartenejas 89000 Baruta, Caracas
VENEZUELA
aborges@usb.ve

MARLA CORNIEL
Simón Bolívar University
Engineering PHD Student
Valle de Sartenejas 89000 Baruta, Caracas
VENEZUELA
corniell@cantv.net

RICHARD GIL
Simón Bolívar University
Department of Processes and Systems
Valle de Sartenejas 89000 Baruta, Caracas
VENEZUELA
rgil@usb.ve

LEONARDO CONTRERAS
Simón Bolívar University
Department of Processes and Systems
Valle de Sartenejas 89000 Baruta, Caracas
VENEZUELA
leocon@usb.ve

RAFAEL H. BORGES
Ministry of Health – Venezuelan Central University
Biomedicina Institute
San José, Distrito Capital, Caracas
VENEZUELA
rhborges2002@yahoo.com

Abstract: A professional career selection is a complicated process for university student candidates and often little technical tolls are available for who aim to enter to the superior education system, since it is necessary to consider the incidence of a multiplicity of variables to obtain a "satisfactory answer" that comes near to the idea that they have preconceived. These variables build up a complex relations map that requires the formulation of an exhaustive and rigorous conceptual scheme.
In this research a domain ontological model is presented as support to the student's decision making for opportunities of University studies level of the Venezuelan education system. For the declaration of the domain ontological model developed, the information provided by two organisms (OPSU & CNU) is used. Both are responsible to design the policies and strategies for the superior education in Venezuela. The ontology is designed and created using Methontology approach, since this methodology offers the possibility of improving the progressive creation or captures and knowledge articulation, its elements and relations. In order to represent the ontology Protégé 3.1.1 tool is used, based on the ontological language for the Web: OWL (Web Ontology Language) and; finally, to accede and to visualize the ontology, an application based on the Semantic Web is developed.
In the field of the computation, computer science and systems, the concept of profiles or users models has many meanings and connotations, its first and greater diffusion arise with the development and use of on-line increasing systems; however, they have gain great preponderance recently, not only to refer and/or to respond to the passive user who approaches "the system", but for the possibility of taking care of a user stimulated and attracted by "the system". In that sense, the possibility of this "personalized attention" and/or recommendations from "the system" will be obviously conditioned by the user context.
Centered on the possibility of giving that "customized attention" from which they must select an option between many, it is tried in the future to construct a meta-ontology that integrates the domain ontology with a user profile ontology, thus aiming towards to a Semantic Recommendation System under Multiagent approach in the future, that could be useful to support students decision making process for career selection over different study opportunities in Higher Education level in Venezuela.

Key-Words: Study Opportunities, Ontology, Semantic Web, Ontology Development, User Profiles, User Context, Intelligent Agents.

1 Introduction

A modern and intelligent organization success is centered in the Knowledge Management. This aspect is so important that the strategies that are used to impel their development, to disclose it and to preserve it belong to the scope of the Knowledge Engineering. In this case, the ontological paradigm is very important, not only in applications for knowledge management, but also, as indicates [1], in the processing of natural language, electronic commerce, integration and information retrieval, design and data bases integration, bioinformatics, education, and a new emergent field as it is the Semantic Web.

In this scope, the use of ontologies allows to adapt prolific surroundings to serve and manage terminologies related to a specific dominion, which contributes in the conformation of the knowledge base. Under this perspective, how it is demonstrated in specialized literature, there is a complex relations map in which it is necessary to evaluate the incidence of a multiplicity of variables to obtain an answer, requires the formulation of an exhaustive and rigorous conceptual scheme, within a given domain, to generate a knowledge base that could responds to specific queries and requirements; the design of this kind of systems is fundamental to model knowledge and they show information with greater meaning (semantic), more intelligent, that admits as well more "smart searches", made either by human agents or by computerized agents (*softbots*), and evolution the information networks in knowledge networks.

Similarly, the possibility of a "personalized attention" and/or recommendations from "the system" are considered conditioned by the context of relative use of the information that either products or knowledge items are available and it agrees with the interest and/or users preferences. This leads to define users profiles, that are key pieces for the handling of "recommendations" from the system, since they allow manage an efficient filtrate of the information needs and users interests in order to obtain excellent and quality suggestions.

On this field, there are many papers related to user models [2], [3], [4], [5], [6], [7], [8], [9], context information [10], personalization [11], [12], [13], collaborative filtrate [14], [15], and others on holistic tendencies within Intelligence Web [16], [17]. In relation to recommendation systems and the agents that take part for the information filtrate there are several papers [15], [18], [19], [20] y [21].

In this way, Semantic Web environment or Intelligent Web become propitious, jointly with knowledge structures represented by the domain ontologies and user profile and intelligent agents as tools for information discovery, identification, relation, maintenance and selection, to conform the bases of a recommendation system that orients the users decisions in a prolific atmosphere of information and, generally, stressed by the uncertainly.

In this research, after present the previous and related works, the study case, and a summary of the involved theory, it is expose the domain ontological model as support for the student decision making for study opportunities of the Venezuelan's education University level synthesizing it in a model, suggested by the authors, described in four dimensions: Ontological Product, Development Process, User-Agent and Modeler-Agent.

This paper is structures as following: in section 2, Previous and Related Works are presented; in section 3, the Study Case is presented, where the origin of the problematic situation is considered; in section 4, the concept of Ontology and Semantic Web; in section 5, User Profiles; conforming these two last sections the theoretical sustentation of the research. In section 6, Analysis Dimensions of the Domain Ontology, methodological support. In section 7, the Domain Ontological Model to Supports Decision Making in Study Opportunities Selection is presented, exposing its elements and relations, in addition to the obtained Results. An Intelligent Agents development proposal is presented in section 8. Finally in section 9 the Conclusions and considered possible Future Works, followed by the References.

2 Previous and Related Works

There are some important previous and related works developed about the user profile and context ontology-based approach. [8] and others related with Decision Support for the same educational domain also [22], [23], [24]. Recently it has increased the importance of applying ontology as a key part of efficient filtering in recommendation systems [25] [26], [27].

The Recommendation system where this paper is move toward eventually, usually compares the collected data with similar data collected from others and calculate a List of Recommended items (particularly Career options) for the user. Regularly the filtering and method for Recommendation Systems could be "categorized into four ways: Rule-based filtering, Content-based filtering, Collaboration filtering and Hybrid Filtering" [22].

Recently paper as Ge [28] had proposed Cooperative Recommendation Systems based on Ontology Construction. They have suggested an algorithm to construct users` interest model (by ontologies), according user behaviors as Web search, browsing and others, (Web logs). After that, using a weighted Association Rule Mining algorithm they study the user interest ontology similarity measures versus Ontology Domain and it makes items recommendations to the users. The domain applied was Authoring Art-writer creations.

In the other hand, He [29], have suggested a Personalized Recommendation system on ontology-based inference in e-commerce domain. The main idea is an ontology inference mechanism used to infer not obvious interests. That could be means something user may feel interest but they don't represent it obviously. The proposal considers that user profile could be renewal or updated by the user manually. The domain applied was about e-commerce model using a kind of agent between Client (C) and Business (B), named by them as BAB. They explain shortly the System functionalities overall.

Also, Yu [30] have developed a hybrid Semantic Recommendation System ontology-based for e-learning domain to a Context-Aware proposes. The Recommender takes knowledge about learner (user profile), about content knowledge and domain being learned knowledge. The recommendation consists of four steps: Semantic relevance calculation, recommendation refining, learning path generation and recommendation argumentation. The three knowledge types previously cited with the recommender dealing, were modeled by Ontologies language (OWL). An interactive mechanism for Recommendation refining (step 2) was included and two algorithms were suggested for the steps 1 (Graph and Conceptual proximity inspired) and step 4, path generation, detecting and eliminating a DAG (Directed Acyclic Graph) in building the path.

In their paper Yang et al. [31] developed a master FAQ, integrating the Web as a centered intelligent system in the use of functions that offer a high quality of answer. In this system the use of intelligent searches can be observed using information with integration and classification, and tying the user's necessities (frequent questions) with results that approach which indeed they require. This work, allows reviewing how the domain ontologies and user consultations are used to give optimal answers.

Similarly, Hunyadi et al [32] bases their work on a social interaction collaborative model, which of some form is related to the present investigation, has much to do with the human interaction (students) with the intelligent systems. The relation of this one with this investigation is centered in the use that they give to of the software agents (*softbots*) providing a direction.

Finally, Gao´s work [22] has suggested a Recommendation System based in User Ontology and Spreading Activation Theory (SAT), to dealing, first with user preferences (user profile) and second one, with the domain semantic (network). They described graphically the System-Architecture's main components. This explained how it is applied to the spreading activation model to represent the "EXPO-2010" domain selected. The prototype elaborated was focus on the official website of World-Expo Shanghai 2010 and a couple of pages are showed in the Portal User Interface.

We are being suggesting in future work proposal a Hybrid filtering, using an arrangement of Content-based filtering, (users will be recommended items similar to the ones the users preferred in the past) with a Collaborative filtering (users will be recommended items that people with similar tastes and preferences liked in the past).

3 Study Case

About twenty years ago the information society was structure as natural consequence of the accelerated growth experienced by the Internet, since its creation at the beginning of the 60´s. This new structure raised a model that, according to Adell [33], promoted a set of economic and social transformations that changed the material base of our society; in such a way , that the way to work, to amuse, to relate and to learn has changed, demanding that the society has had to evolve to respond to these challenges efficiently. This development brings implicit the handling of an large amount of information, sometimes related to domains of very diverse nature, which constitutes an additional challenge for the user at the time of locating, filtering and selecting required information.

Under this context, the study case is presented where the student in order to begin a university career in a Venezuelan Institution must do a transcendental decision in uncertainly mood. The election that the students must do will be associated with the careers which are offered in an institution and the priority order that they have in the preference of the student; also it is related, among others, with the education quality, the academic services conditions and student welfare. Beside all

these factors, some aspects that are related with the vocational orientation: interest, labor aptitudes and preferences, as well as the influence of the family as far as their attitudes, feelings and opinions, or economic resources that they have to confront such decision.

In order to help the student to make this transcendental decision in Venezuela, the University Sector Planning Office (OPSU), it is the technical office to assist the Universities National Council (CNU), which depends of the Ministry of the Popular Power for the Higher Education, that has the responsibility to instrument the policies and strategies for the higher education established in the national plans, maintains an official publication in which list the institutions and careers officially recognized until year 2007 [34], called Study Opportunities Book (LOE: Libro de Oportunidades de Estudios in Spanish). On the other hand, the policies implemented by the CNU influence the final decision that the students have to make about university career o careers which are more attractive and vocational convenient for them.

According to the exposed, its can be appreciated how difficult it is for the students in general, and very specially for those of the last year of high school, the election of the career that they wish to follow, given the amount and complex variables that are necessary to consider in order to obtain an answer that comes near to the idea which they have preconceived. Figure 1 exposed a scheme showing the factors involved in the study case.

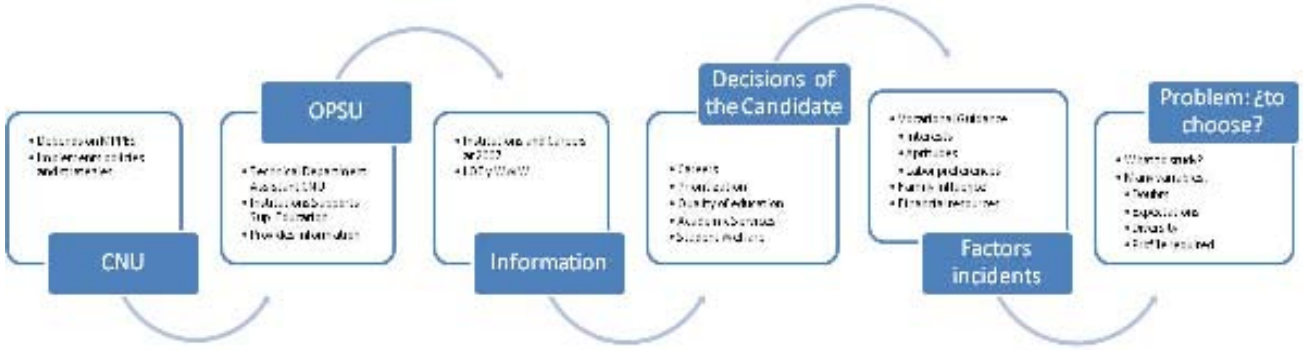

Figure 1. Factors involved in the case study: OPSU / CNU [Authors elaboration, 2008].

With the intention to make this task less tedious and help to do the best decision, the OPSU makes available an in line consultation tool, where the user can obtain data of all the identified options as Venezuelan study opportunities [35]. This tool can be described as a Web page of simple design and very basic functions, in which this office consolidates the information, provided by each institution and shows it linked by hyper connections. According to the exposed in the LOE, it is hoped that this mechanism provides opportune answer to the questions of the students.

Designed with this purpose, this tool does not provide expeditious answer to any of the questions that could be formulated and, far from helping the student to chose an option, by agreement with the identification to his/her personal characteristics and preferences, it creates doubts and uncertainly that make difficult the election, since the information in the current Website showed appears isolated, without meaning and dissociated of the general context in which it is related. Among the problems detected in the page it is possible to mention:

- It handles simple syntactic descriptions.
- Services use must be made manually.
- A content-semantic mark of the services is not made.
- It is only informational or centered on documents, constituted by static pages that are stored in a server, ready to be acceded and browsed. These pages are updated in a manual form using some tool of content administration.

The logic and immediate consequence that these problems generate in the student is the resistance to use this tool, with the direct influence to have to make elections without enough information. This situation could drive the student to initiate studies that, later, do not satisfy their expectations, could not choose the best option as far as cost/benefits or to choose study in institutions where the institutional requirements do not agree with their appropriated high school profile.

4 Ontology and Semantic Web

The cited complex relations map requires the formulation of an exhaustive and rigorous conceptual scheme, within a given domain, to generate a knowledge base, which can be represented by the ontological paradigm. It is valid to lean on this perspective to show meaningful information (semantic); this form of knowledge representation is denominated ontology and according to [36] is the intermediate representation of a conceptualization that is more formal and structured than the natural language, but less formal than a formal language, which allows to establish a common language which can be understood and capture the accumulated knowledge, in this case by educational institutions, reusing and improving it to ensure communication and information sharing, which is very advisable when it is required to increase the level of inquires and the search of pertinent information related to the study opportunities of higher education in Venezuela.

On the other hand, Pérez-Soltero et al. [37] define ontology using an incremental exhibition of the concept: "ontology is an explicit specification of a conceptualization (Gruber 1995)". The "explicit" is related to the concepts, the properties, functions and axioms, that are defined explicitly. The "conceptualization", talks about an abstract model of the real world. Later, the definition was expanded: "Ontology is a formal specification of a shared conceptualization (Borst 1997)", the key word "formal" is related to that which is interpretable in an automatic way, and "shared" implies, the consensus that occurs between the agents on the conceptualization, and it is necessary to have a consistent and coherent vocabulary.

The ontological paradigm essence is centered on turning the information in knowledge by formalized structures (ontologies) that references the data by metadata, under a standard normalized scheme of some knowledge domain, obtaining its capture and definition. Additionally, on these structures axioms can be settled down to be applied in the different dominions that are related with the stored knowledge. In this way, the searchers will be able to obtain data sharing such schemes of Web annotations and the software agents not only will find the precise information, but they will be able to make inferences automatically looking for related information in the Web pages and with the requirements of the inquiries made by the users; in addition, the producers of Web pages and services will be able to interchange data following these standard schemes and, even, they can be reused.

Of some way, the ontological structures break the standards of information location, since, as indicates [38], they make "… the systems interoperable,… the knowledge computable, the problem is that this challenge exceeds the capacity of standard paradigms used in knowledge representation and systems architecture". On the basis of this affirmation, it could be indicated that as complement to the challenge of this paradigm appears the semantic Web, which, in words of its creator [25]: "…it does not constitute an independent Web, but an extension of the present one; in which the information is equipped with affluent meaning defined, with the purpose of allowing a better work in cooperation between humans and computers". This novel system allows giving life to ontologies, providing advanced services to accede and to extract knowledge of Web documents. The semantic Web works thanks to the existence of the "semantic languages" or frameworks (RDF and RDF schema, topic maps with XML, XFML, OWL) that assure integration to share and to reuse data on the Web, based on the use of metadata and ontologies. The information retrieval can be made by *softbots*, this is, robots and software agents that make this work in an automated form; nevertheless, this process of recovery varies in function of the surrounding, if it is homogenous or heterogeneous.

In order to end this section, it is worth to indicate that ontological engineering contemplates a set of methodologies, techniques and tools for the ontologies development that stands out in the book of Gómez-Perez [1]. In this book, the approaches, tendency and recent evolution are detailed, demonstrating the potential that has this emergent conception of the knowledge science.

5 User Profiles

In the discipline of computation, computer science and systems, the concept of user profiles - also called user models - have many meanings and connotations. Its first and greater diffusion arise with the development and use of on-line systems, however, it has been increasing preponderance recently, not only to refer and/or to respond to the passive user that approaches to "the system", but for the possibility of taking care of an active user attracted by "the system".

Another definition of user profile is a proposal [39], which is centered in the modeled and consists of the classes' definition based on shared attributes, emphasizing on information needs, access conditions, experience and knowledge. In the study

case, it could define another attributes related to the candidate to follow a university career, such as: socioeconomic level, labor preferences, aptitudes, attitudes, inclinations, interest, among others, which can be fit to the model of user profile proposed by Golemati et al. [2], in order to obtain a user profile ontology. Of this form, as output it is obtained the following table (Table 1):

Class	Class Description	Values
Aspiring	Basic information of applicants, such as name and last name, identity card number, registration number, sex, age	Name: string; Identity: integer; Record: integer; Sex: female / male; age: integer.
Location	Address, home and mobile phones, email	Address: string, Telephone: string; Mail: string;
Academic Scale	The degree of student preference for long (4 or more years of study) or short careers (3 years or less)	Duration: integer
Education level	Represents the degree of inclination to continue college or entering the workforce	Licker Scale: integer;
General Grounds	It refers to those aspects that guide and maintain (energize, mobilize) the student's behavior towards achieving certain goals and valued by the individual (improvement, personal growth and progress)	Appearance: string;
Academic Motivation	Attitude and willingness to perform tasks or activities related to their academic training. Provision of channeling personal effort in the direction of a studio career. Interest in the work, activities and assignments that must be met in the course of university education	Attitude: string;
Vocational maturity	The degree of congruence between the student's vocational and vocational stage of its development according to their age, i.e. the student's level of development in relation to aspects of career choice	Licker Scale: integer;
Interests	Hobby or work-related interests, such as: sports, cooking, etc.	Interests: string;
Preferences	Taste or inclination toward something more subjective: pets, colors, music, cities, etc.	Preferences: string;
Fitness	Talents or skills that shows the candidate	Fitness: string;
Skills	Skills with which the candidate has	Skills: string;
Socioeconomic level	Rate attributes that measure the social and economic status of applicants, such as profession, income level, educational level of parents, family group, geographic location and tenure of housing, services, etc.	Licker Scale: integer;

Table 1. User Profiles Ontology [Authors elaboration, 2008].

By all means, it has to assume that a profile under these conditions would have to be able to register, to classify and to stimulate (supplies) the user to participate in agreement to his/her taste, interest and preferences (e-market). Obviously these partial innovations, beyond the one of the old-fashion information systems, are influenced by the new tendencies of the TIC and their recently applications in Internet, such as electronic commerce (EC), business intelligence (BI), social intelligence (SI), Web intelligence (WI) and knowledge communities (KC).

In all these scopes, the retrieval of useful and interesting information from the Web, agreed to the profile of each user will have to be supported in some intelligent form, as much by the customized

demand to the requirements of these, as by the emergent proposal that will offer new and flexible computerized systems known in literature like the recommendation systems.

Under this same perspective, the possibility of this "personal attention" and/or recommendations from "the system" will be obviously conditioned by the context of relative use of the information that either products or items are available and they agree with the interest and/or preferences of the user.

In this aspect, is possible to mention the paper by Eyharabide [40] that proposes the construction of semantically enriched user profiles, under the premise of optimizing the capacity that have the personal agents to apprehend on the preferences and habits of the users and with it nourish the profiles under a homogenous context. With that objective, in that paper the author displayed an algorithm that apprehends the type of information that is due to store in the user profile.

6 Ontology Development Dimensions Analysis.

Until now this paper authors have obtained some results product of previous investigations, not only as far as ontologies development, but and still more important, as far as the abstraction of the development process of such type of systems [24], [41], [42], [43], [44], [45], [46], [47], that for some authors impact the effectiveness and/or its "systemic quality" [48].

Such assertion of systemic quality will imply to involve in a holistic way the different elements related to the dimensions associated to the development problem (process/product).

In this paper an extrapolation of the total system quality assertion towards the ontological engineering and learning areas is made. In particular, it is important to consider the analytical dimensions, which have been focused throughout the following four elements:

- Development Product: The ontology or knowledge domain representation reached.
- Development Process: All ontology methodology, methods and tools.
- User-Agent: Owner(s) and final system user(s) who makes the key contribution with direct information for the domain-shared representation knowledge.
- Modeler-Agent: Active agent of the ontology formulation process and even as knowledge conception co-participant.

6.1 Development Product

The domain ontology as a product was obtained first from the scratch, taking the information available in the Study Opportunities Book (LOE) and working directly with the User-Agents involved. Those semantics were validated with cyclical interaction (feedback) with User-Agents to verify overall pertinence [49].

6.2 Development Process

The methodological approach as "Methontology" developed by Gómez-Perez [1], "Midle-Out" by Dori [50], and "On-To-Knowledge" by Sure and Staab [51] has been applied by the authors for "creative-base" interaction cycles allowing "ontology prototypes" generation.

In this case it was chosen to work with Methontology [1] since it offers the possibility of improving progressively the creation, capture and merge of the knowledge, its elements and relations, by a succession of prototypes that evolution in each new version. Its life cycle is determined by five phases: Specification, Conceptualization, Formalization, Implementation and Maintenance, with which different prototypes were developed.

For the ontology representation Protégé 3.1.1 [52] was used, based on the Ontological Language for the Web: OWL, which is defined as a language of markup to publish and to share data using ontologies in the WWW.

Starting with the information available in the Study Opportunities Book (LOE), in the phase of specification, the competitive questions to which must answer the ontology in this stage of tests were determined. In this phase [53] it was very useful, since it guided us toward the most sensible steps of the development on the base of the knowledge engineering.

During the conceptualization, activities to develop the conceptual model, it was made in order to create a semi-formal specification. This pattern turned as a slightly more formal model during the formalization and in the implementation a formal representation was made, for which the Protégé tool had been used, just as for the maintenance stage.

6.3 User-Agent

Representative "user sets" were selected for verifying the relevance and comprehension level of User-Agent and Modeler-Agent.

6.4 Modeler- Agent

Tree experts in system science and information management developed the ontology, with the advisory of two faculty members with expertise in the area that work in research and belong to the Development in Semantic Technology Group. Team members are Modeler-Agents, and they are working as team specialist in the ontologies development process [44].

7 Ontological Domain Model to Support Decisions about Study Opportunities

An ontological model for this study case is very useful, since it generates a storage system to share and reuse the knowledge; also, the model is very useful for the vocabulary standardization that is used in the domain. The prototype of Figure 2 shows the four essential elements and relations that settle down among them, which are defined next:

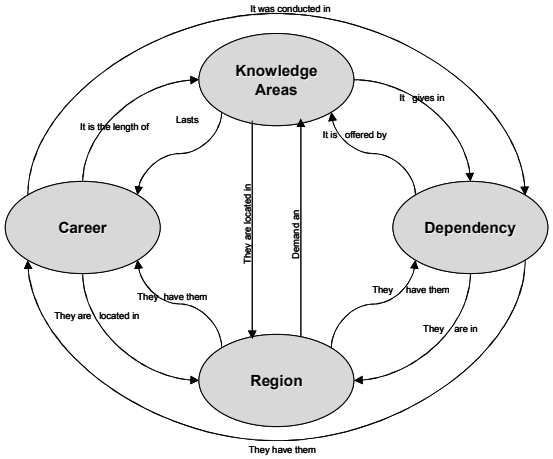

Figure 2. Ontological Model to Supports Decision Making in Study Opportunities Selection [Authors elaboration, 2008].

7.1 Elements and Relations Modeled

7.1.1 Elements

- Knowledge area. Grouping of career that offers the Higher Education Subsystem, according to the classification standardized by international organisms.
- Career. Professional formation that leads to a university degree. For the propose of the model, it is related to the duration of the training programs presents in different knowledge areas, which can be either long or short (5 or 3 years long).
- Dependency. It makes reference to the type of official subordination of the institution that offers the knowledge areas, which can be offered by public or private institutions.
- Region. In an operative way, the map of Venezuela locations is divided in eight great geographic regions.

7.1.2 Relations

- From the knowledge area (3 relations). A certain knowledge area can have careers of long or short duration; they can be taught in public or private institutions and, in addition, they can be located in one or more regions of the operational map.
- From the Career (3 relations). A career whose duration is long or short corresponds with a certain knowledge area and can be located within some geographic region, also it can be offered in a public or a private institution.
- From the Dependency (3 relations). A public or private institution can supply any knowledge area that is in any geographic region, and similarly the duration of the career can be long or short.
- From the Region (3 relations). The geographic regions demand different knowledge areas of long or short duration careers, in any public or private institutions.

7.2 Some Results

Part of the obtained results during the development of the mentioned ontology is in figure 3, where is a diagram expressed by the plug-ins Jambalaya, which works, simultaneously, as an application and a technique, being specially useful to visualize and explore the software architecture and any other information area; in this case it is possible to identify the main classes: knowledge area, career, region and dependency, as well as the relations that prevail on them.

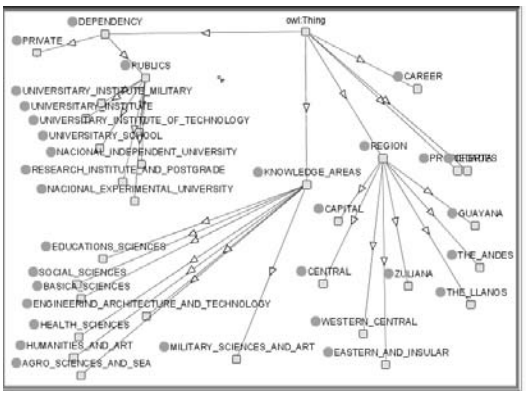

Figure 3. Representation of the Ontology using the plug-in Jambalaya of Protégé 3.1.1. [Authors elaboration, 2008].

Next, Table 2 is an extract of the concepts dictionary that are handled within Study Opportunities Book (LOE), being this one the main base of the natural language that allows ontology terminology develops.

Superclase	Class	Subclass	Request	Attributes class	Relations
Knowledge areas	Basic Sciences		long career: biology	Description, market occupational careers related supply	It is the length of have duration
			long career: mathematics	Description, market occupational careers related supply	
			long career: physics	Description, market occupational careers related supply	
			long career: chemistry	Description, market occupational careers related supply	
	Engineering, Architecture and Technology	Attends disasters	short career: emergency management and care in disasters	Description, market occupational careers related supply	It is the length of have duration
			Short Career: firefighter technology	Description, market occupational careers related supply	
			short career: fire technology	Description, market occupational careers related supply	
		civil design, industrial and textiles	long career: architecture	Description, market occupational careers related supply	It is the length of have duration
			long career: architecture (eus)	Description, market occupational careers related supply	
			long career: graphic design	Description, market occupational careers related supply	
			long career: industrial design	Description, market occupational careers related supply	
			long career: civil engineering	Description, market occupational careers related supply	
			long career: engineering in industrial design	Description, market occupational careers related supply	
			long career: urbanism	Description, market occupational careers related supply	
			short career: construction (technical)	Description, market occupational careers related supply	
			short career: environmental design	Description, market occupational careers related supply	
			short career: jewelry and fantasy design	Description, market occupational careers related supply	
			short career: fashion design	Description, market occupational careers related supply	
			short career: design of civil works	Description, market occupational careers related supply	
			short career: graphic design (technical)	Description, market occupational careers related supply	
			short career: graphic design advertising	Description, market occupational careers related supply	
			short career: industrial design (technical)	Description, market occupational careers related supply	
			short career: interior design	Description, market occupational careers related supply	
			short career: textile design	Description, market occupational careers related supply	
			short career: civil works	Description, market occupational careers related supply	
			short career: construction technology	Description, market occupational careers related supply	
			short career: textile technology	Description, market occupational careers related supply	
		electronic and mechanical maintenance			
		oil			
		systems			
		civil textiles and industrial design			
		material			
		chemical industry and production			
		soil and hydrometeorology			
	Agro and Sea Sciences				
	Health Sciences				
	Education Science				
	Social Science				
	Military Sciences and Arts				
	Humanities and Arts				

Table 2. Ontology Dictionary of Concepts [Authors elaboration, 2008].

8 Intelligent Agents.

After review some important technical papers about multi-agent develompent apporach [27], [54], [55], we are suggesting to addapt our Recommender System proposal to the Garcia-Ojeda´s prototyping [56] about dissemination selective of information in the Web based in multi-agents. The GAIA methodologies and AUML (UML) extensions were used by the authors to develop the multi-agent recommender system about information recovery, but we are being considering implement it as referent, because those are very similar in subsystems and main components. Perhap we must extend this vision for ontology consideration over the user-profile, domain-context and agents coordination also.

Following the GAIA methodology applied by those authors, it described in table 3 a synthesis of roles descriptions used in the prototype model. Main system roles explained, using the *Roles Model*.

In Figure 4 using the *Familiarity Model* the interaction between agents was described and finally, in Table 4, a short description is made specifically to illustrate the Recommender Role.

Organizational Departments	Roles	Short Description
Information Recovery. From OPSU, Universities Institutions and others sources. (IRD)	Searcher	Searching relevant Information from official Websites (Public & Authorized)
	Extractor	Recovery pertinent information about Career options, places, facilities and other conditions.
	Format Converter	Convert the Information into format standards to Show the Results
Selective Information Dissemination (SID)	Recommender	Set optimal relationship between information recovered with the User's –preference and –Interest.
	Disseminator	May send the (items) information recovery to the corresponding Users e-mail accounts
Users Management (UMD)	Users Assistant	Must receive the actions related with whatever user.
	User(s)	Persons or people who require selective dissemination support.
	User Support Manager	Person(s) responsible for set the system parameters and system support.
e-mail Management (EMD)	e-mail Manager	Up-to-date the items recommender versions
Website Management (WMD)	Website manager	Must be updated the different Institutions´ Website with current and new admissions information
Central Coordination (CCD)	Coordinator	Must coordinate the services under automatic way.

Table 3. Prototype Roles, adaptation of Garcia-Ojeda [56]

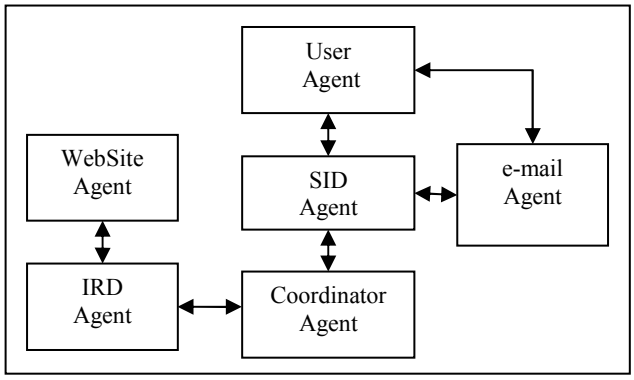

Figure 4. Interaction between Agents, adaptation from [56]

Recommender Role (REC)
Description: This Role has the task to set a similarity between Information Recovery and qualified data according the user interest and needs.
Protocols and Activities: Search-Information, Calculate-Similarities, Compare-With-User-Profile, Update-Recommendations.
Permissions /Grants: Search, Profiles, Webpage-Authorizations, etc.
Responsibilities: Executor Recommending, Searching, Updating, Format Converting.

Table 4. Recommender Roles, adaptation [56]

9 Conclusion and Futures Works

As a conclusion it is possible to indicate without any doubt that with the implementation of the ontology it will be able to enrich the existing model (LOE), in such a way that it is possible to present/display an information with greater meaning and better articulated to its context, which is expected to help the student in the search and recovery of the information domain, that orients his/hers decisions to choose studies that satisfy his/hers expectations, to choose the best option than optimizes the cost/benefit relation, to evaluate institutional requirements with his/her high school exit profile, among other estimations that could be considered. Similarly, the semantics incorporated in the application is an important foundation so that the software agents can infer knowledge from the axioms in the ontology.

On the other hand and, since technical literature grows vertiginously and more and more is specialized on each one of these subjects of the development and application of "intelligent information" for intelligent systems, the tendency to conjugate the new conceptions of the information, computer science, mass media in addition to the users profiles and their context is best known, playing a determining role on each one of these emergent perceptions.

The user information by its intrinsic nature is continuously redefining, relating to its changing expectations and interest which affects the specification registered in the systems, as well as the derived one from its registries based on its behavior patterns, usually responding to the interaction with its surroundings according to the different contexts. The computation and communications technologies help to support it, protecting the user personal information (profile) and those of their resemblances (collaborative), and recommend it through "system" products and services with agreed their interests and preferences. The ontologies in particular and the semantic technologies in general, are playing their roles when they attend as useful resources to increase so much the user profiles as those of their use context, with regard to improve the recommendation systems.

It is tried to propose to the future a Meta-ontology that integrates (ontology mapping/merging) the domain ontology with a user profiles ontology (figure 5 shows a user profile ontology proposed by Golemati et al. [2], that can be used, and figure 6 shows the merge to obtain the recommendation system), thus aiming towards a suggested Semantic Recommendation System under Agent-intelligent approach, that may be useful as support to the student decision making process of study opportunities selection of the Venezuelan University education level, trying to enrich the previous model.

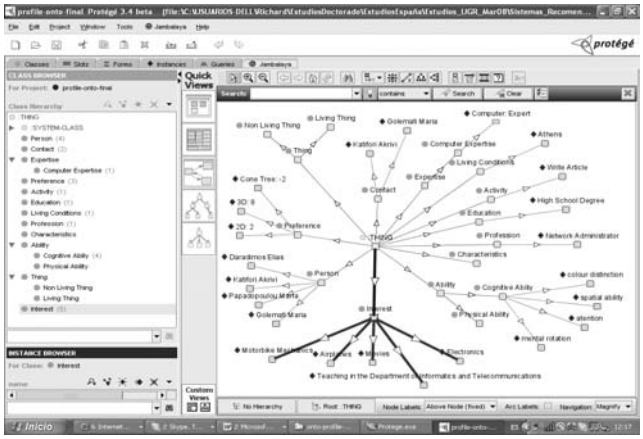

Figure 5. User Profile Ontology. Graph developed from proposal done in [2] using the plug-in Jambalaya of Protégé 3.1.1. [Authors elaboration, 2008].

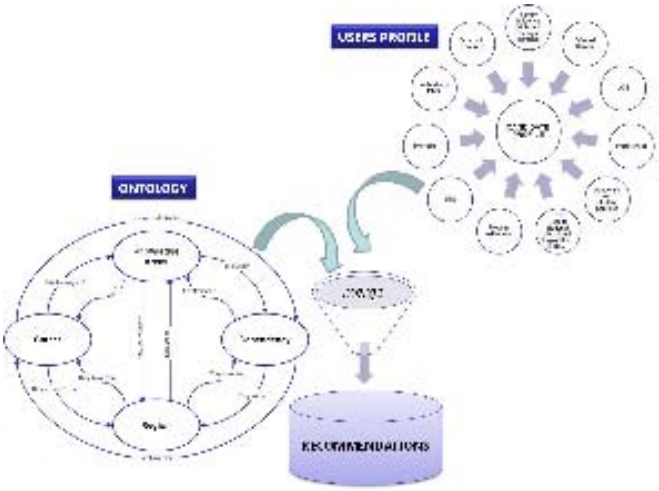

Figure 6. Integration of Domain Ontology with User Profile Ontology toward Recommendation System [Authors elaboration, 2008].

References:

[1] A. Gómez-Pérez A., M. Fernando-López, O. Corcho, *Ontology Engineering*, Springer-Verlag London 2004.

[2] M. Golemati, A. Katifori, C. Vassilakis, G. Lepouras, C. Halatsis, Creating an Ontology for the User Profile: Method and Applications, *First IEEE International Conferenc*e, 2007.

[3] C. Felden, M. Linden, Ontology-Based User Profiling, *Lecture Notes in Computer Science*, 2007, pp. 314–327
[4] P. Shoval, V. Maidel, B. Shapira, An ontology content-based filtering method, *International Journal of Information Theories and Applications*, 2008.
[5] H. Zhang, Y. Song, H. Song, Construction of Ontology-Based User Model for Web Personalization, *Lecture Notes in Computer Science*, 2007.
[6] L. Razmerita, A. Angehrn, A. Maedche, Ontology-Based User Modeling for Knowledge Management Systems, Vol. 27002/2003, 2003.
[7] Z. Jrad, M. Aufaure, M. Hadjouni, A Contextual User Model for Web Personalization, *Lecture Notes in Computer Science*, 2007.
[8] A. Sieg, B. Mobasher, R. Burke, Ontological user profiles for personalized web search, *5th Workshop on Intelligent Techniques. AAAI*, 2007.
[9] V. Schickel-Zuber, B. Faltings, Overcoming Incomplete User Models in Recommendation Systems via an Ontology, *Lecture Notes in Computer Science*, 2006.
[10] A. Sieg, B. Mobasher, R. Burke, G. Prabu, S. Lytinen, Representing user information context with ontologies, *HCI International Conference*, 2005.
[11] A. Sunikka, J. Bragge, What, Who Where: Insights into Personalization, *41st Hawaii International Conference on System Science*, 2008.
[12] R. Guttman, A. Moukas, P. Maes, Agent-mediated Electronic Commerce: A Survey, *The Knowledge Engineering Review*, Cambridge Univ. Press, 2001.
[13] H. Resnik, Varian - Recommender Systems, *Communications of the ACM*, special issue, 1997.
[14] T. Hofmann. Latent semantic model for collaborative filtering. *ACM Transactions on Information Systems (TOIS)*. Volume 22, Issue 1, 2004.
[15] E. Peis; J. Morales-del-Castillo; J. Delgado-López. Sistemas de Recomendación Semánticos. Un análisis del estado de la cuestión. [en linea]. *"Hipertext.net",* núm. 6, 2008. http://www.hipertext.net.
[16] F. De la Rosa, R. Martínez, Sistemas de Inteligencia Web Basados en Redes Sociales, *REDES-Revista Hispana para Análisis de Redes Sociales*, Vol. 12, Nro. 9, Junio 2007.
[17] Y. Yao, Zhong, Ning, J. Liu, S. Oshuga, Web Intelligence (WI) Research, Challenges and Trends In the New Information Age, *24th IEEE Computer Society International*, 2000.
[18] G. Adomavicius y A. Tuzhilin. Toward the next generation of recommender systems: A survey of the state-of-the-art and possible extensions. *IEEE*, Vol. 17, Nº 6, pp. 734-749. http://doi.ieeecomputersociety.org/10.1109/TKDE.2005. 99, 2005.
[19] M. Deshpande y G. Karypis. Item-based top-*N* recommendation algorithms. *ACM Transactions on Information Systems (TOIS)*. Volume 22, Issue 1. Pages: 143 – 177. ISSN: 1046-8188, 2004
[20] A. Saboya Vargas. Uso de Recomendadores, Asistentes y Ayudantes en sistemas Tutores. Depto. LSI – *Universidad Politécnica de Catalunya*. 2005.
[21] C-N. Ziegler. Towards Decentralized Recommender Systems. Albert-Ludwigs-Universität Freiburg, Fakultät für Angewandte Wissenschaften, Institut für Informatik. *Dissertation zur Erlangung des Doktorgrades*, 2005
[22]Q. Gao, J. Yan, M. Liu, A Semantic Approach to Recommendation System Based on User Ontology and Spreading Activation Model, *Network and Parallel Computing International Conference*, 2008.
[23] N. Bolaian et al, A Model for a Collaborative Recommender System for Multimedia Learning Material, *CRIWG 2004, Lecture Notes In Computer Science*, Vol. 3198, pp 281-288, 2004.
[24] L. Ramos, R. Gil, Propuesta de Sistema de Información para Apoyar la Gestión de la Educación a Distancia, *Conferencia Iberoamericana en Sistemas, Cibernética e Informática,* 2007.
[25] T. Berners-Lee, J. Hendler, O. Lassila, The Semantic Web, *Scientific American*, http://www.scientificamerican.com/2001/050lissue/0501berners-lee.html, 2001
[26] B. Mobasher , X. Jin, Y. Zhou, Semantically Enhanced Collaborative Filtering on the Web, *Lecture Notes in Computer Science*, 2004.
[27] J. Pan, B. Zhang, S. Wang, G Wu, D. Wei, Ontology Based User Profiling in Personalized Information Service Agent, *Computer and Information Technology, 2007, 7th IEEE International Conference*, 2007.
[28] J. Ge, Y. Qiu, Z. Chen, Cooperative Recommendation System Based on Ontology Construction, *Grid and Cooperative Computing, 2008, GCC '08, Seventh International Conference. IEEE*, 2008
[29] S. He, M. Fang, Personalized Recommendation Based on Ontology Inference in e-Commerce, *Management of e-Commerce and e-Government, 2008, ICMECG '08, International Conference IEEE*, 2008.
[30] Z. Yu, Y. Nakamura, S. Jang , S. Kajita S, K. Mase, Ontology-Based Semantic Recommendation for Context-Aware E-Learning, *Lecture Notes in Computer Science*, 2007.

[31] S. Yang, C. Hsu, D. Lee, L. Deng. FAQ-master: an ontological multi-agent system for web FAQ services. *WSEAS Transactions on Information Science and Applications,* Vol. 5, March, 2008.
[32] D. Hunyadi, J. Pah. Ontology used in an e-learning multi-agent architecture. *WSEAS Transactions on Information Science and Applications,* Vol. 5, August, 2008.
[33] J. Adell. Tendencias en educación en la sociedad de las tecnologías de la información. *Revista EDUTEC*. ISSN: 1135-9250. 1997
[34] Oficina de Planificación del Sector Universitario del Consejo Nacional de Universidades (CNU/ OPSU), *Libro de Oportunidades de Estudio en las Instituciones de Educación Superior en Venezuela*, Caracas, 2007
[35] Consejo Nacional de Universidades - Oficina de Planificación del Sector Universitario (CNU/ OPSU). *Libro de Oportunidades de Estudio*, http://www.loe.cnu.gov.ve
[36] M. Uschold, M. King, Towards a Methodology for Building Ontologies, *Workshop on Basic Ontological Issues in Knowledge Sharing*, 1995.
[37] A. Pérez-Soltero, M. Barceló-Valenzuela, G. Sánchez-Schmitz, R. Navarro-Hernández, Modelo Ontológico como Apoyo a la Asignación de Recursos (MOAR). Caso de Estudio: Programación de Cursos Escolares, *Conferencia Ibero-Americana IADIS/WWW Internet 2005 (CIAWI 2005)*, 2005, pp. 328-335.
[38] L. Ramos, R. Gil, Hacia un Sistema de Información para Apoyar la Gestión de la Educación a Distancia. *I Encuentro Venezolano sobre Tecnología de Información e Ingeniería de Software*. 2007
[39] Y. Hassan, F. Martín-Fernández y G. Iazza. Diseño Web Centrado en el Usuario: Usabilidad y Arquitectura de la Información [en linea]. "Hipertext.net", No.2 http://www.hipertext.net. 2004
[40] M. Eyharabide. Perfiles de Usuario Enriquecidos Semánticamente. Tesis Doctoral, *Universidad Nacional del Centro y CONICET* (Argentina). 2004.
[41] R. Gil, L. Contreras, El Producto y Proceso de Modelado de Sistemas de Información Basado en Ontologías: Revisión Bibliográfica, *Conferencia Iberoamericana en Sistemas, Cibernética e Informática*, 2006.
[42] R. Gil, L. Contreras, J. Ferrer, C. Rivas, Estrategias Ontológica Para Abordar Heterogeneidad de Dominios en Instituciones Universitarias, *Conferencia Iberoamericana en Sistemas, Cibernética e Informática, 2007,* pp.47-52.
[43] R. Gil Richard, A. Borges, L. Contreras Leonardo, Shared Ontologies to Increase Systems Interoperatibiliy in University, *International Multiconference on Computer Science and Information Technology*, 2007.
[44] R. Gil, Modelo de Sistemas Basados en Ontologías, Papel de trabajo (Tarea). Curso I2: Representación del Conocimiento y la Web Semántica. *Universidad de Granada, España*, 2008.
[45] R. Gil, A. Borges, L. Ramos, L. Contreras, Ontologies Integration for University Institutions: Approach to an Alignment, *19th Australian Software Engineering Conference ASWEC,* 2008.
[46] R. Gil, A. Borges, L. Contreras, L. Ramos, M. Martín-Bautista, Environment to Measure Ontology Learning Impact in Semantic Development Life Cycle: an Experimental Proposal, Papel de trabajo para artículo, *Universidad Simón Bolívar, Venezuela*, 2008.
[47] M. Corniel, L. Ramos, A. Borges, L. Contreras, R. Gil. Modelo Ontológico como apoyo a la Toma de en Oportunidades de Estudio. *II Congreso Venezolano de Enseñanza de Ingeniería*, Universidad Central de Venezuela. 2008.
[48] N. Callaos, B. Callaos, Designing with a System Total Quality, *International Conference on Information System Analysis and Synthesis*, 1996.
[49] N. Noy, M. Musen, The PROMPT Suite: Interactive Tools for Ontology Merging and Mapping, *International Journal of Human-Computer Studies*, 2003.
[50] D. Dori, *Object–Process Methodology*, Springer Verlag Berlin, 2002.
[51] Y. Sure, S. Staab, and R. Studer, On-To-Knowledge Methodology (OTKM), Institute AIFB, *University of Karlsruhe, Germany*, 2004.
[52] *The Protégé Proyect.* http://protege.stanford.edu/
[53] N. Noy, D. McGuiness, Ontology Development 101: A Guide to Creating your First Ontology, Stanford *Knowledge System Laboratory Technical Report and Stanford Medical Informatics Technical Reports*, 2001.
[54] F. Arias, J. Moreno, D. Ovalle, Integración de Ontologías y Capacidades de Razonamiento en Agentes de Software para la Simulación del Proceso de Negociación de Contratos de Energía Eléctrica. *Congreso Colombiano de Computación CCC-2007,*2007
[55] V. Iordan, A. Naaji, A.Circortas, Deriving Ontology Using Multi-Agent Systems, *WSEAS Transactions on Computer,*Vol. 7, June 2008.
[56] J. García, J. Pérez, A. Arenas, Laboratorio de Cómputo Especializado, *Universidad Autónoma de Bucaramanga, Colombia*, 2002.