MIRROS: Intermediary Model to Recovery Learning Objects
MIRROS: *Modelo Intermediario para la Recuperación de Objetos de Aprendizaje*

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Abstract
Techniques for recovery and reuse of learning objects in various learning management systems actually provide learning alternatives and services for online learning. One of these alternatives is the recovery of resources in the Learning Objects Repositories (LOR); this LOR hand out different services such as search for a specific resource by a user. From the perspective of artificial intelligence, it is possible to recover the digital resources based on metadata, with different possibilities for improving search mechanisms that satisfy a query according to the user profile with specific needs. The paper shows a proposal where searching services repositories of learning objects can be implemented by creating a reference model involving agents or elements implicated in learning or recommend learning objects based on the users requirement. From this perspective is proposed a reference model to recovery learning objects in a specific learning context.
Keywords: Learning Objects Repository, Metadata, Agents, Ontology.

Resumen
Las técnicas de recuperación y reutilización de objetos de aprendizaje en diversos sistemas de administración de aprendizaje brindan hoy nuevas alternativas y servicios para el aprendizaje en línea. Una de estas alternativas es la recuperación de los recursos en los repositorios de objetos de aprendizaje (ROA), estos atienden diversos servicios como la búsqueda de un recurso específico por un usuario. Desde la perspectiva de la inteligencia artificial, es posible recuperar los recursos digitales en base a metadatos, teniendo diversas posibilidades para mejorar mecanismos de búsqueda que cumplan una consulta conforme al perfil de un usuario con necesidades específicas. El articulo muestra una propuesta donde estos servicios de búsqueda en los repositorios de objetos de aprendizaje pueden implementarse creando un modelo de referencia, con intervención de agentes o sistemas recomendadores que sugieran al usuario objetos de aprendizaje a partir de sus requerimientos. Desde esta perspectiva se propone las un modelo de referencia para la recuperación de Objetos de Aprendizaje en un contexto de aprendizaje determinado.
Palabras Clave: Repositorio de Objetos de Aprendizaje, Metadato, Agente, Ontología.

1 Introduction

A repository for learning objects is a software system which stores educational resources and their metadata. Learning objects are stored in databases called learning object repositories (LOR). There are two types of repositories: those containing learning objects (LOs) and the metadata of the learning object. And those containing only metadata [Downes S.,2002]. Both types of interfaces and repositories can provide searching services. Repositories serve large collections of objects that can be interconnected with other repositories or with learning management system (LMS). As the increase in connections between the repository and the size of the data, the search mechanism increases the complexity. The web search mechanisms have evolved significantly the implementation of agents, recognized literature established that it´s promising extract information using a learning machine to have data related to natural disasters [Tellez, Montes & Villaseñor, 2009], based in this ideas furthermore is viable make recommend alternatives, for the reason that it can help reduce the complexity of the searching mechanism in the repositories, and search metadata and metadata relations. In recent research proposes solutions by designing schema ontology to provide more flexibility in the description of the entities in a semantic repository of learning objects, and allows automated functions or delegation of tasks to agents. [Soto J., 2007]. The development of learning objects has grown rapidly and online learning requires a search service to use and share resources. Different mechanisms have been proposed with the aim of retrieving the digital resources; however this paper proposes the implementation of a reference model to retrieve learning objectives. The model implements recommendation systems based on entry criteria as the user profile on which working the system, it is proposed in three layers which will undertake the necessary actions to form patterns of preference.

In one hand, in the context of the network, now you can find many interesting and repositories such as MERLOT2 (http://www.merlot.org) or CAREO3 (http://careo.ucalgary.ca). Access to these resources is free and open, which are designed primarily for teachers and students in higher education. It is well known that the storage of didactics materials in repositories has grown linearly, renowned researchers as Ochoa Duval (2008) documented a detailed analysis of the fast growth of these. Furthermore, the repository benefits are diverse. For example, to have a repository implemented properly structured with existing searches knowledge. They also allow revisions cooperative learning objects ensuring quality in content and presentation. Repositories provide access to objects and their metadata with the aim not only to consult and seek information, also linked to learning platforms.

However, in support of accessing data, is necessary to generate information with the use and access to metadata standards of quality (such as IEEE LOM). According to J. Bartolome (2008) and colleagues, create mechanisms to search for information to transform data in information and information in knowledge is one of the challenges actually, as well as search and retrieval from distributed repositories for the composition of new teaching materials that meet the needs of a particular user in a specific context.

Tim Berners-Lee precursor of the idea of the World Wide Web trying from the beginning of creation includes semantic information, however for various reasons this was not possible. Today one of the challenges of the Web aims is to add semantic metadata and ontology to the World Wide Web [Bernerns, 2001].

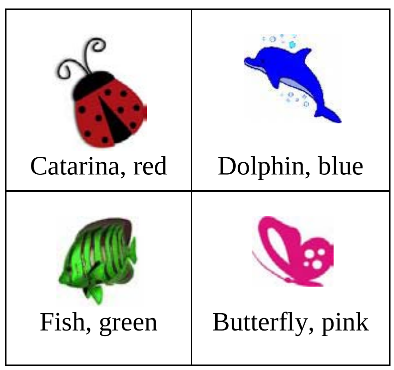

Fig. 1. Labeled data (metadata)

According to Figure 1, the metadata describes the content and semantic meaning. Why must be provided in a formal way to facilitate the automatic evaluation of machine processing and ensure that not only humans, also machines that are able to "understand" the contents of documents or metadata. The property of re-usability of resources and their exploitation on the web, and the interconnection between these resources may increase the use of semantic web through language's metadata (Ontologies) and maps that allow to understand how to be labeled, resources for the purpose can be retrieved using the information contained in the metadata. Metadata is simply a fact a fact, and contains a keyword. Metadata describe data and retrieve through search and navigation mechanisms.

1.1 Metadata in Learning Objects

Metadata are data sets that can be stored, locate and retrieve. It can also be represented by a commonly accepted semantics tries to represent electronic information, as well as the bibliographic description of electronic resources. The use of metadata by the need arises to retrieve electronic information scattered. They mainly describe the content and location of the object, among other features. The literature has documented several metadata models, such as bibliographical source, as the "Dublin Core" (http://dublincore.org/) or Circle of Dublin, created by the initiatives of the librarians associations. Metadata format is based on the semantic maps association and sets super enlaces similar to the elements and structures in metadata standards. Currently there are different standards as IEEE LOM (Learning Object Metadata), which proposes nine categories of metadata. IMS (www.imsglobal.org) a detailed set of specifications that comprise a framework for sharing educational elements in e-learning environments that covers different aspects and SCORM (Shareable Content Object Reference Model), for its acronym in English, is a collection of technical specifications for e-learning. The SCORM standards are governed and published by the Advanced Distributed Learning Initiative (ADL). SCORM defines a reference model or application profiles based on specifications and standards defined.

In this way we find different types of metadata description, Allow find, identify and select a learning object. Management, Give information on the management of a learning object, when it was created, the author's name, etc. and structural, facilitates the identification of an object. So it is necessary for learning objects are equipped with appropriate metadata with the next purpose: First, out of recovery mechanisms according to the needs of users, enhance the personalization of the educational content, then facilitate storage and reuse in repositories, predominant structure of educational learning objects giving meaning pedagogic and finally, strengthen social partnership. This proposal, offers a set of solutions to the first two points, regarding the mechanisms of recovery according to the needs of users is proposed by implementing agents to recover the information and information retrieval to enhance the customization of proposed a content recommendation system based on profile-preferences- needs user through ontologies.

1.2 Learning Agents and systems recommended in the recovery process

First, for the implementation of recovery a mechanism is necessary to identify the difference between a searcher and an intelligent agent. The first uses the semantics of Web resources for information retrieval based on indexing of all the recoverable resources. By contrast, the agent navigates to the web covering the links between resources with the aims to search for information and communication resource, to interact with the resource. The agent also found the resort, with the current.

Artificial intelligence has been revived from the implementation of algorithms and techniques of learning agents. At present, the agents are assigned certain tasks that can be evaluated with the aim of knowing if the task is optimized and amend its rules of behavior. This leads to achieving the desire to develop software with an intelligent behavior. An agent can be defined as a piece of software or hardware that is capable of acting independently to complete tasks the user is also characterized by storing knowledge about themselves and their environment [Jenings, 1998 en Camargo, 2007].

Table 1. Characteristics of agents

Capacity	Description
Independently	There are no direct human intervention, have control over their own actions.
Sociability / Communicative	Ability to communicate through a common language with other agents and humans.
Response capability	Perceive their environment and react to adapt to it.
Initiative	Initiate the necessary action to solve a problem.
Reasoning	Interpret, solve problems, make decisions and determine actions.
Learning	Learns, adapts and improves with experience.
Mobility	Change of platform in a distributed system.

Table 1 explains the characteristics agents according to the laws of artificial intelligence. Learning point is focused to adapt and improves with experience. This idea is introduced in the MIRROR model, because the agent could gain knowledge of user requirements based on his own experience.

Since this perspective, ratings, to enhance the personalization of content that must be recognized prior to the service-oriented architecture (SOA), any information residing in static web pages. Today requires not only access to static documents using information retrieval techniques, to services that provide new ways of providing information. Technology for recovery of services also is taking importance to provide tools to customize the learning is to find those materials or services that meet the criteria for personalized search.

This type of technology today opens new alternatives which are services that can identify learning objects that can be recommended. In the literature different applications based recommendation systems appear. “A qualitative MDP-based recommender system for power plant operation” [Reyes, Sucar & Morales, 2009], “Restaurant recommendation system based on fuzzy techniques” [M.J. Barranco, et al., 2008]. These systems are attractive because propose novel and practical model learning approach, although specifically will deepen in those where the recommendation is directed to the user, we analyze three types:

- *Collaborative Recommendation Systems:* Building the recommendation as a probabilistic statistics from other users with similar preferences. Designed a model to generate preference user patterns and user groups with similar preferences. The techniques used are data extraction or data mining. Refer to the monitoring of user behavior, ratings services, history, etc., Are generated patterns of social behavior. Its disadvantage is that it requires a large number of users to generate patterns of behavior.
- *Based Systems for Content Filtering*: This type is constructed according to the recommendation of the similarity of an item with other items purchased in the past. These systems use technologies based on machine learning and establish the degree of interest of a user in a given article. Can be implemented with artificial intelligence techniques as neural networks, Bayesian, decision trees and reasoning systems based on semantic features that describe the specifics of the items in context.
- *Systems-based Knowledge Recommendation:* Generate recommendations from the information provided by the user, usually through examples. In the case of learning objects may be examples of content. Also recommended to help the situations in which historical information about the user is given, those objects or contents that historically have been reviewed by users. Thus the system recommends that types of objects are useful once the user has declared its need. This will collect and store the metadata related to the learning object in a format allowing further inference on them. To make such an inference is necessary to generate a knowledge based on ontologies so that the information is processed and based on interpretable definitions.

1.3 Recommender System and Metadata

Each learning object contains descriptive metadata; this metadata is used to locate objects in preference according to user requirements, profile and learning requests. To accomplish this, we can construct a system which can recover recommended web resources, specifically in learning repositories. As a consequence, the recommended system needs to be built on an architecture where agents are involved to assist the recovery of resources. Nowadays, the usefulness of recommender systems has been recognized by different researchers in different applications because it helps the user to find what he needed to search in the Web, one application example is the Avatar System - Personalized Recommendation System television content based on semantic information- (Ramos, Blanco & Gil, 2007). These agents help to filter in a more efficient search according to user requirements.

Detected the need to retrieve digital resources (learning objects) in the field of education, is encouraging the development of models to facilitate the learning of the users and integrating material recommended. The model MIRROS is proposed for the recovery of learning objects, used within the recommended system multi-agent with hybrid architecture.

2 Intermediary Model to Recovery LO (MIRROS)

The model names is due to literary translation in Spanish -***M**odelo **I**ntemediario para la **R**ecuperación de **O**bjeto**s** de Aprendizaje*-. MIRROS Model is oriented to involved agents; they will learn and interact with a Hybrid Recommendation System (HRS). The main goal to incorporate the ideas from systems of recommendations based on knowledge (Ontologies) and collaborative recommendation systems (generating patterns of preference). The model is generated by recommendations of learning objects from the information provided by the user, which represent the learning objects proprieties and relations. The system may recommend based on historical information, not existing or new. It is necessary that the user needs to start shooting recommendation. Finally, a recommendation system will be made:

1. Introduce an example that reflects the user need.
2. Setting the search parameters.
3. Setting preferences for a given set of contents.

After this, appears a "triggers recommendation" of other objects and the user can select from a list of objects.
MIRROS is composed of three layers: *Requirement* makes the main recompilation of user, retrieves the user profile and needs to send it a LOR. *Filtering* organize the conceptualization of the learning domain. The LOR returns alternatives, in this layer the ontology is processing. Finally, *Suggestion* produces an option of learning object. The general framework of MIRROS is exposed.

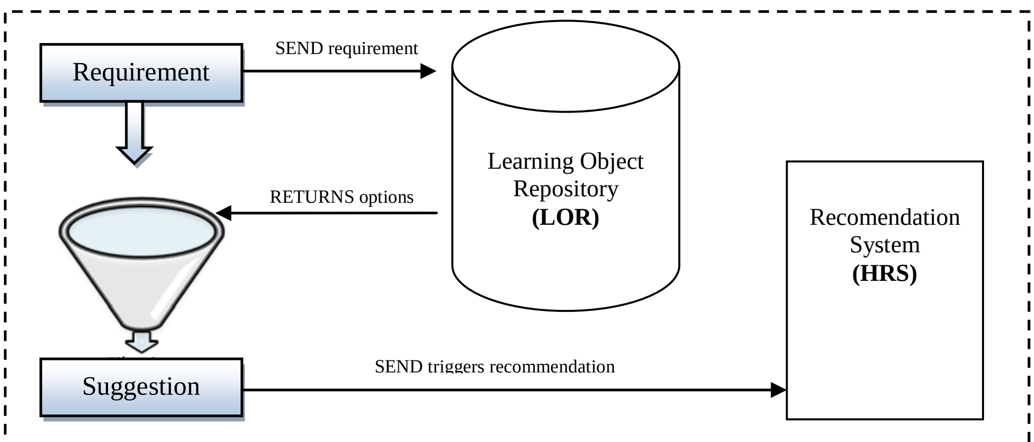

Fig. 2. Framework of Intermediary Model to Recovery LO (MIRROS)

According to Figure 2, the theoretical composition proposed for the MIRROS Model considers the following layers:

a) Requirement: This layer gives the user profile and the system collects information on user needs. The user provides his needs and a set of examples.

b) Filtering: We meet the objects stored in the repository of objects; those objects are discriminated not meet user needs and therefore may not be recommended.

c)Suggestion: The results of the previous layer, the system HRS finds and recommends the items that best integrate the needs and preferences of the user.

In the model MIRROS will be involved an agent to witch is assigned a task that can be subsequently evaluated with the aim of knowing if the task is to optimize and modify its rules of behavior. In this Model the agent in addition takes the necessary actions to display patterns of preference. The concept of pattern has been previously used in studies related to the production of learning objects [Margain, 2008]. On this occasion it is proposed to contribute to the solution, to identify user preferences. The agent must interpret the preferences to assist in the resolution of user needs, make decisions and determine actions for the purpose of learning object recommended (LOR).

2.1 Hybrid Recommender System (HRS)

The recommended system is established as a hybrid system because it is composed of three types of agents:

- Interface Agent (I_Agt): Capture requirements and sets the user profile. This agent is located in the layer of requirements.
- Agent Finder (F_Agt): Find, discriminate and integrate resources. This agent is located in the layer of filtering.
- Recommender Agent (R_Agt): Recommends learning objects. This agent is located in the layer of suggestion.
- Feedback Agent (B_Agt): This agent offers feedback of the recommended learning objects

The figure 3a suggests that recommender agent acts principally in terms of two patterns:

- **User Pattern:** Capture the objects based on the descriptive characteristics of a learning object which are expressed in metadata. For example, object name, size, etc. Also capture a set of rules for how these features can be used to meet user requirements.
- **Preference Pattern:** Capture the objects based on user requirements, also expressed in the metadata. For example, language, specialty, etc. This pattern also takes into account what is not wanted, as the objects to be discriminated.

The figure 3b show that the recommendation is based strategy to recommend items based on the ontology of related objects, taking into account user preferences based on user pattern and preference pattern.

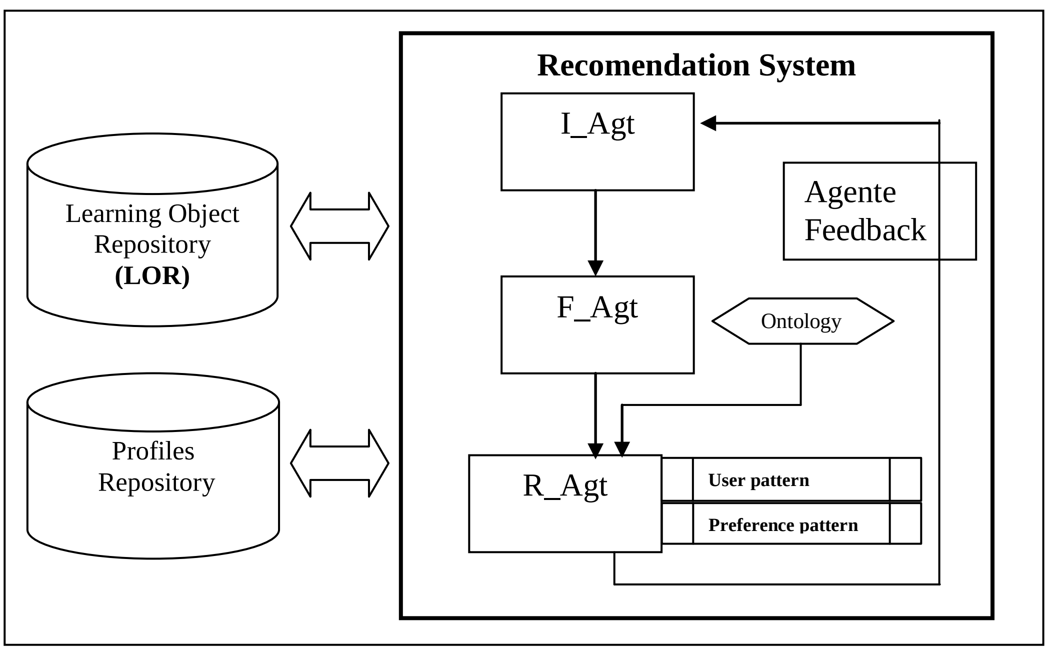

Fig. 3a. Recommended Hybrid System Architecture

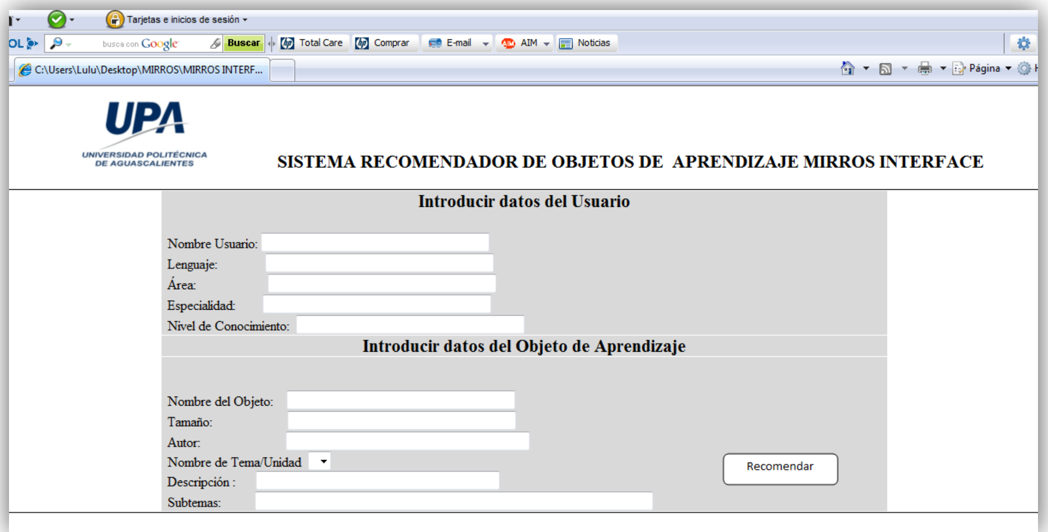

Fig. 3b. Recommended Hybrid System Interface

3 Application

To exemplify the MIRROR model, let us consider some learning objects that belong or "*is part of*" engineering systems curriculum (see figure 4) of the Politecnic University of Aguascalientes. Although it is known that we can reach a depth such that any concept linked to a learning activity can be considered a learning object, this representation assumes that there is a matter for each learning object and the ontology is simulated.

a) Requirement: This layer gives the user profile and the system collects information on user needs and examples. The User Profile is determined as a student who "is part of" to the engineering systems curriculum and the student belongs at one specialization. This layer helps to represent a set of elements that are used to make the user requirement. To do this we have defined a small set of binary relationships. The Relation R1 contains four relations expressed in the next equation.

R1 = {belong, is, take, has}

The *"belong"* relationship means an area inclusion, the *"is"* relationship means an identity with specialization area, the *"take"* relations ship means the first course association and the *"has"* relationship means the serial course association with the first one.

{Student belong engineering systems}, {Student is specialization area of software engineering},
{Student take software engineering}, {Student has software engineering II}

Student Profile = (area inclusion, specialization area, fist association, serial association)

R1 = (engineering systems, software engineering, software engineering I, software engineering II)

b) Filtering: In this layer objects belonging to the preferences of the learner, which discriminate those objects which do not meet their needs, these may not be recommended. The relation R2 will be subjects discriminated. It could have one o more discriminated relationships.

R2 = {[not] belong, [not] is, [not] take, [not] has}

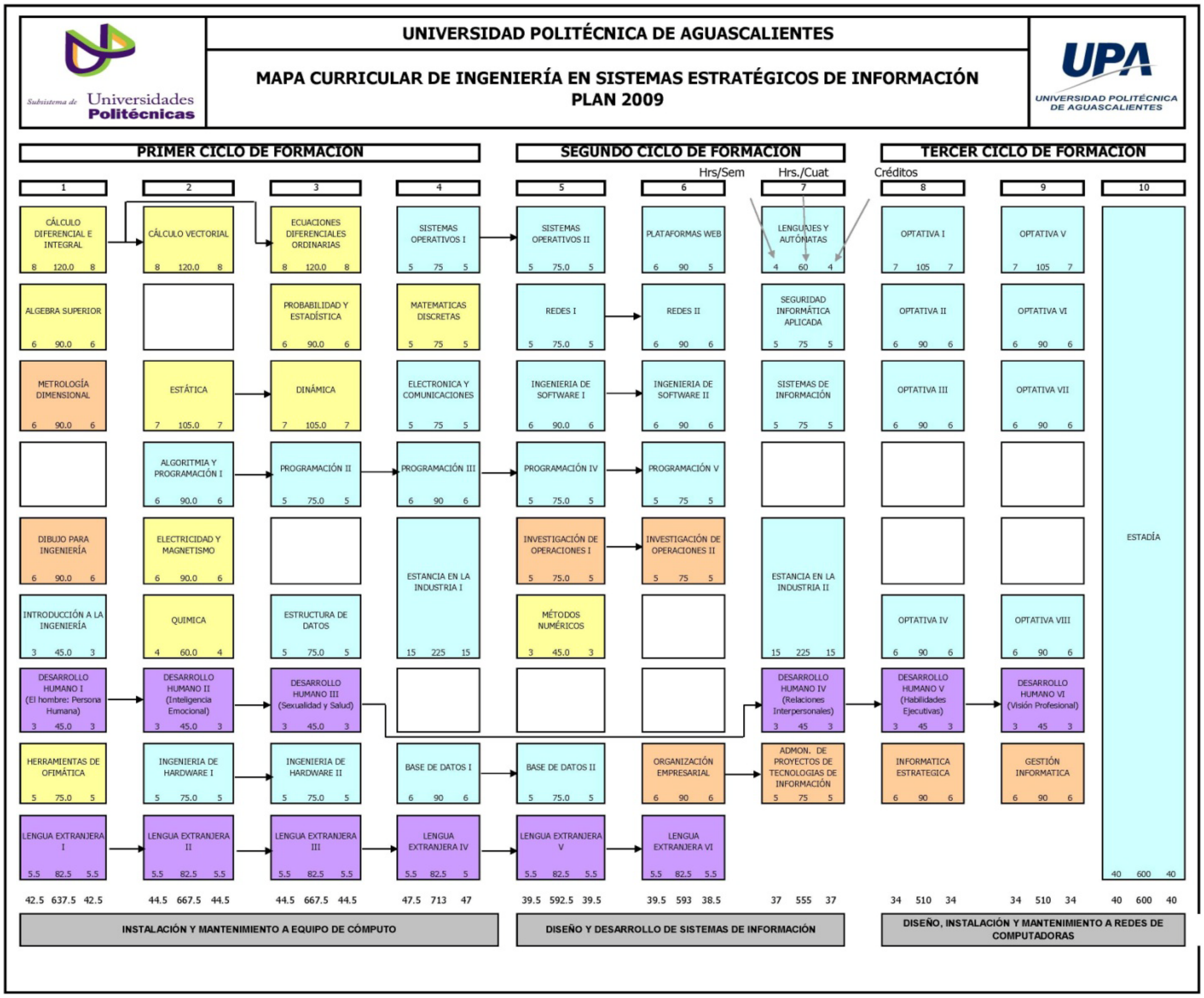

Fig. 4. Strategic Systems Curriculum

The *"not belong"* relationship means an area exclusion, the *"is"* relationship means a difference with specialization area, the *"not take"* relations ship means the no course association and the *"has"* relationship means the no serial course association.

{Student belong engineering systems}, {Student is specialization area of software engineering},
{Student <u>no take</u> network specialization}, {Student <u>not has</u> all network specialization topic]}

R2 (Subjects_discriminated) = (Network specialization, Common Core Networks)

Ontologies allow us to conceptualize an application domain using concepts and relationships. The new knowledge base will be comprised of objects that correspond only to the materials together. It is represented in figure 5.

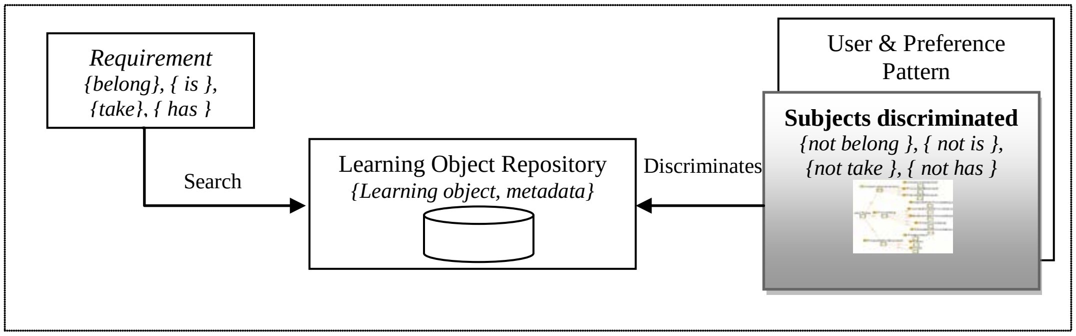

Fig. 5. Framework to filtering the learning objects

c) Suggestion: The system finds and recommends the items or objects that best integrate the needs and preferences of the user. The results show a recommendation from the ontology of objects based on the Curriculum, they related user preferences. In this case the system built a partnership based on the user's profile (See figure 6.)

R1 = (engineering systems, software engineering, software engineering I, software engineering II)
R2 = (Network specialization, Common Core Networks)

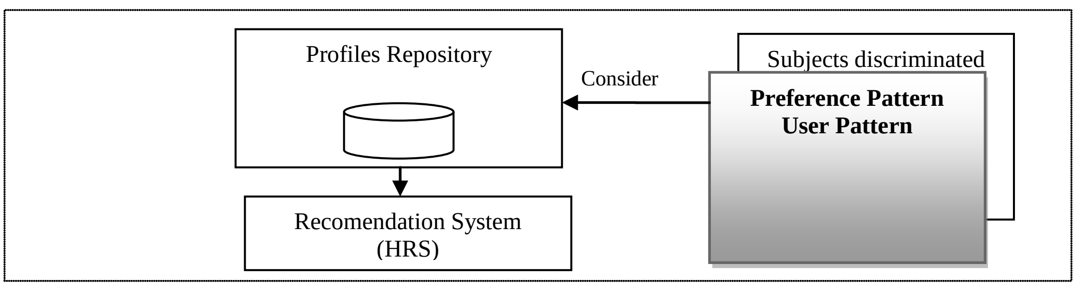

Fig. 6. Framework to suggest the learning objects

The partnerships will be inferred: P*reference Pattern = Historical user preferences (hp)*
R3 = (hp1, hp2, hp-n…..)
R3=(Spanish, software engineering, 0.5 Gb)
Learning Object recommended: *R1 = (software engineering I)*

Finally, the figure 7 depicts an ontological description of the curriculum considered for the learning domain. This diagram could be implemented for any curriculum. We can put into service another curriculum instance, for example Mechanics, Informatics, Medicine, etc. It is achievable because the conceptualization provides us the ontological diagram to recovery and reuse of learning objects according the user´s requirements.

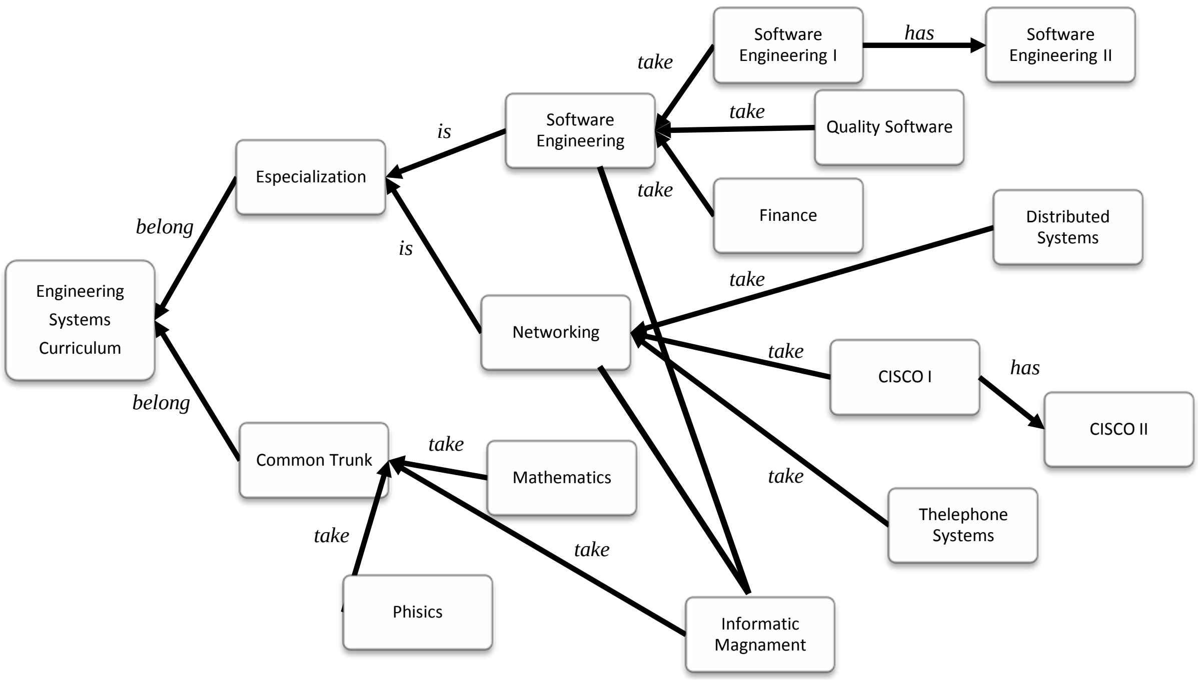

Fig. 7. Ontological description of the curriculum engineering systems

4 Conclusions and Future Work

This paper presents a proposed model for recover Learning Objects. They are established through recommendation systems based on entry criteria as the user profile on the system that works representing these elements and their relation with ontology. It has shown that meaningful partnerships can discover the needs of users and also to provide personalized learning objects is based on the profile and needs of a particular user under a specific context.

The model has been planned with general vision of knowledge representation. MIRROS model achieves a first look at techniques for making use of knowledge about the domain of metadata by ontology. It is necessary to do more tests with more relations an more test in order to determine its use in other domain. In addition, for the personalization of objects is necessary to establish these complex relationships and are not considered in existing approaches.

The recommended systems are strongly related to the needs and preferences of the user. As future work the authors should expand the ontology and even simulate with more metadata, various preferences and user needs. One more idea for future work is considered this model to processing metadata with a semantic focus.

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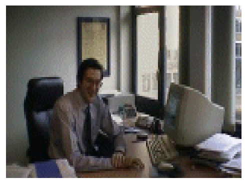

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