INTELLIGENT RETRIEVAL
Open Journal

Review

An Intelligent e-learning Scenario for Knowledge Retrieval

Antonio Martín*; Carlos León
Departamento de Tecnología Electrónica Seville University, Sevilla 41004, Spain

Corresponding author
Antonio Martín
Departamento de Tecnología Electrónica Seville University, Sevilla 41004, Spain

Article information
Received: January 1st, 2023; **Revised:** February 21st, 2023; **Accepted:** March 31st, 2023; **Published:** April 20th, 2023

Cite this article
Martín A, León C. An intelligent e-learning scenario for knowledge retrieval. 2023; 1(1). doi: https://doi.org/10.70705/ppp.ir.2023.v01.i01.pp17-22

ABSTRACT
Electronic learning (E-Learning) is an invaluable tool for businesses looking to boost employee productivity and academic achievement, as well as for schools looking to improve the quality of its student body and faculty. Educational institutions rely on effective information retrieval as a tool to help students improve their abilities and throughout the learning process. When dealing with information retrieval in the classroom, both students and teachers encounter several challenges. Research shows that there is still a need for a more effective strategy. Technologies like Semantic and Artificial Intelligence hold great promise for meeting the demands of e-Learning. Problems with storage resources and information retrieval are both exacerbated by the merging of e-Learning and digital libraries. Digital libraries are now far more flexible places to study and gain knowledge because to readily available infrastructure, time flexibility, learning materials, and ways to share them. Our research aims to create a broad platform for learning environments via the presentation of an e-learning management system for the Digital Library at Seville University. Possible intelligent infrastructures for building decentralized digital libraries with a global semantic schema are explored from a search viewpoint. We propose a framework for an intelligent search engine that is both semantic and built on concepts. In this group effort, we provide an innovative way for engineering students to engage with an online learning platform that takes into account each learner's unique characteristics and physical environment. By analyzing recorded semantic metadata and using AI technology, we provide a thorough method for finding information items in massive digital collections.

Keywords
e-learning systems; Ontology; Retrieval; Case-based reasoning; Digital library; Knowledge management; Intelligent agents.

INTRODUCTION

While the present Digital Library (DL) is an excellent resource for learning and research, its usefulness is limited since users have a hard time locating credible E-Learning materials. Classical search engines handle learned information like any other database, controlling both the contents and the locations. A reliable method of retrieval is required. Alphabetical indexing and keyword-based searching are the conventional approaches to managing and retrieving Learning Objects (LOs) [1]. Searching using more superficial criteria such as title, location, publication date, and document number is another option [2]. Unfortunately, neither one of these options offers a solution, since they either fail to produce any relevant examples or return a large number of cases that are irrelevant.

Lots of issues remain unresolved, even though a lot of money and effort have gone into this [3]. While many studies have focused on incorporating these new technologies into existing digital library information retrieval systems, very little has examined the architectural and life cycle perspectives of semantic and intelligent artificial challenges. Overwhelming amounts of data make it difficult to conduct targeted searches, even as search engines have become more efficient. In contrast to similar initiatives, we provide methods that make use of information in ontology search and expert systems, and we construct contextual profiles based on ontologies [4]. The characteristics of LO usage and user attitudes suggest that case-based retrieval, an ontology application, might be a suitable option.

Our research focuses on developing more effective search algorithms for use in dispersed data spaces, such as digital libraries. In the field of digital libraries, the goal has been to provide technologically advanced learning and teaching environments. An innovative method for placing a search engine in context was introduced by us. Both automated or semi-automatic learning and the accurate localization of digital library materials are made possible by the integration of semantic Web and artificial intelligence technology [5]. In order to help users find information from many diverse LOs, the search engine uses E-learning classification expertise and the provided class lattice to provide results that are hierarchically arranged and easy to navigate, rather than the usual flat ranked document list. That is why we are working to enhance representation by bringing in additional information-based metadata. We provide an overview of the application's technological components and center our discussion on case indexing and retrieval procedures. Case-Based Reasoning

(CBR) technology is an integral part of our strategy for achieving content-based search and retrieval information [6].

The paper is structured as a fallow document. An introduction to our prototype architecture is given in the first part. The procedure for creating an ontology is the subject of the second part. Next, we'll provide a brief overview of its key features and explain how AI and the Semantic Web may work together to improve search engines. We will now examine the CBR. application framework jColibri and its capabilities for executing reasoning over ontologies [7]. We conclude by outlining next works and presenting the outcomes of our continuing efforts to adjust the framework.

II. ONTOFAMA ARCHITECTURE

We create an E-Learning model for novel intelligent retrieval LOs to aid with knowledge management in digital libraries, specifically for semantic retrieval. Using ontologies and expert systems as a foundation, we create a prototype called OntoFAMA. The three primary components of our system's architecture—the intelligent user interface, the search engine, and the ontology knowledge base—are shown in figure 1.

The OntoFAMA platform is a web-enabled environment where software agents may be run to obtain LOs. Learners may utilize agents to narrow their search for LOs based on their own criteria. Web service activities that retrieve metadata from Los

With OntoFAMA, you may manage your various knowledge in a regulated and orderly way by accessing a database of learning experiences—or any situation—that is conceived of at a more abstract level. By sorting and filtering information according to its applicability, it enables knowledge to endure. You may change and modify the stored learning information to new scenarios. It's like a database of prior experiences that can solve new problems you meet by linking new experiences to old ones. To facilitate the sharing and reuse of learning objects (LOs) necessary for acquiring information in a particular search area, ontologies will be seen as knowledge structures that define ideas, concept properties, resources, and connections among them. The case base stores the abstracted metadata descriptions of resources and LOs (cases), which are separated from the specifics of their physical representation [8].

The Case-Based Reasoning (CBR) engine is used by OntoFAMA. By comparing them to comparable scenarios that have been experienced before, CBR may give OLs for novel situations [9]. For Case Base to function, the memory organization interface must be able to read the whole case base into memory. Various LOs provide semantic categorization information that the knowledge acquisition process automatically learns. A CBR In order to sort freshly acquired information from the DL's information sources, the classifier uses the learnt taxonomy.

The quality of this part of the user interface has a significant impact on how well a system is received [10]. A new interface that can retrieve enough cases to fulfill a query has been introduced. For our system to get the correct situations, the user must engage with it in order to fill in the blanks. The user interfaces allow users to navigate the web, search for specific information, and access various services and content. One user profile, consumer search agent components, and the consolidation of various user resources' essential data make up this system. The creation of user profiles—Staff, Alumni, Administrator, and Visitor—has been the primary emphasis of profile intelligence. In order to better explore the digital library's collection, the user interface allows the user to create a profile that reflects his interests.

III. CASE-BASED REASONING

Knowledge management information systems that employ metadata descriptions to characterize knowledge objects are often referred to in the literature as CBR. Metadata describing desirable features of a library resource describes LOs in our CBR application, and the search result is a reference to a learning resource with the same description [11]. The cases are these descriptions that are kept in a case database. An OntoFama object's CBR case data might be thought of as part of its knowledge (metadata). An LOs link and a description of a reusable learning resource are both included in each instance for the purpose of doing a similarity assessment:

An explanation of a learning resource that is based on a framework. The potential LOs shown by activities taken during framework initialization. These objectives will be used for case indexing and will be officially defined in relation to framework domain taxonomy.

- The answer. These procedures are supported by more data. We will use execution graphs to depict the solutions in our basic situations since, from our experience creating, they are a useful way for representing the set of activities that the user should perform to achieve a LO.

Even for a basic Case-Based Reasoning application, there are a lot of moving parts: gathering case and background information, modeling an appropriate case representation, defining an accurate similarity measure, building retrieval functionality, and designing user interfaces. One of the main reasons CBR applications have been commercially successful is that they allow for a large reduction in the effort needed for knowledge collection and representation compared to other AI methodologies. Still, developing a CBR app from the ground up is a laborious software engineering process that calls for a wide range of expertise beyond basic programming.

A case type is a collection of cases that have a common structure. One or more similarity functions are linked to each case type. Figure 2 shows how these tools are used to depict the process of comparing new instances to current ones and to determine which examples are most similar.

The features that OntoFAMA CBR offers are the following:

- Retrieving the past education experience which is the most similar with a new experience.
- Manipulate already stored learning experiences in order to allow knowledge to adapt.
- Specify the way by which similar teaching experiences are compared.

- Apply a CBR cycle that allows to process information based on Case-Based Reasoning principles.

For this purpose we can used a Case-Based Reasoning (CBR) shell, software that can be utilized to develop several applications that require cased-based reasoning methodology. In this study we used the CBR object-oriented framework development environments JColibri. This framework work as open software development environment and facilitate the reuse of their design as well as implementations. Our motivation for choosing this framework is based on a comparative analysis between it and other frameworks, designed to facilitate the development of CBR applications.

IV. ONTOLOGY DESIGN AND DEVELOMENT INTERFACE

To define the links between objects of discourse and their qualities, we need a vocabulary of ideas, resources, and services for our information system, as shown in the scenario [12]. Improving users' capacity to appropriately access tacit legal knowledge is a key objective of knowledge learning management. One way to do this is by creating a knowledge representation model for intelligent retrieval of learning objects. Using ontology as a data model, OntoFAMA contributes to a very excellent representation of knowledge. E-Learning objects and the relationships between them and user profiles are described using ontology, which is a well-defined language used to explain knowledge domain. For a given domain, a grammar makes use of the words in the vocabulary that may convey meaning. With the help of the ontology idea, OntoFAMA can reason over the learned information and deduce new knowledge from the existing one.

Instead of returning a flat ranked document list in response to user queries, the search engine uses ontologies in learning knowledge classification and the given class lattice to create hierarchically structured navigable results. This makes it much easier for users to find information from many different LOs. The system's three primary sources were the library's catalogue, personal database, and learning electronic resources. Ontology design may be aided by the standards defined by the W3C [13]. We used RDF semantic markup language to describe these classes and their characteristics. As an ontology editor that helps with both building knowledge bases and acquiring new information, we've decided to use Protégé [14]. It is an open-architectured, strong tool for development and knowledge modeling. The ontology languages used by Protégé to create semantic relations are OWL and RDF [15].

In a case structure, ontology classes and particular properties are translated. Using a so-called case structure, cases are grouped. The case structure also uses an XML format to describe the structure of the information, much as cases [16]. The sophisticated semantic web framework known as JENA and the Web Ontology Language (OWL) allow for the incorporation of ontology-based information into case structures. Our well-defined ontology for the OntoFAMA project was established using the RDF language. The project includes a collection of codes, visualization tools, computational resources, and data sets that are dispersed throughout the grids. Metadata pertaining to digital library materials may be structured according to RDF specifications. We might think of our ontology as a quaternion with the following structure: OntoSearch:={profile, collection, source) where profiles stand for the many types of users, resources include all the digital library's services and resources, and matter encompasses various information sources such as catalogs, archives, intranets, the web, etc.

We need to construct a case knowledge base with an inheritance structure to make ontology-based intelligent retrieval a reality. The taxonomies profile is used to build the ontology and its sub-classes, as seen in figure 3. This demonstrates the overarching categorization of classes used to categorize OntoFAMA resources and everything connected to them.

Several properties, such as E-learning_Resources, Digital_Collections, Catalogue, Science_Resources, etc., are included in profile ontology, as shown in the picture. Once the ontology is in place, we must populate it with sufficient starting instances and items.

cases to the database of information. Following these procedures has helped us achieve our goal. To begin, we choose an object and then make a new instance of it. Afterwards, the librarian, who is a domain expert, uses their expertise to fill in the blanks of the instance units.

V. CONVERSATION INTERFACE

Building a customized intelligent search engine that can be adjusted to suit various user profiles is a more concrete objective of the project. Advanced search capabilities and the ability to execute in an online DL environment are prerequisites for the engine [18]. We employ profile users for distributed retrieval of learning materials; these users may then have their searches tailored to their exact needs. In the profile agent, a Web service encases an environment where software agents may be run to access e-learning content. Using the criteria the students have provided, profile agents aid students in their quest.

We provide a method for tailored retrieval inside the e-learning search engine. This method leverages semantic approaches to form ontologies that hold the learning information and user/learner profiles. Queries are ranked according to how their words translate to this ontology system. An intuitive graphical user interface is included into our system to help users identify their first search needs, as we have seen in earlier sections. Contextual systems aim to adjust to the user's present search rather than creating static profiles. OntoFAMA keeps tabs on what users are doing, figures out what kind of information they could need based on searches, and then gives it to them before they ever ask. The user's criteria, as shown in figure 4, include their respective demands, tasks, and objectives for a certain search.

The process of using precedents for making arguments and giving learning opinions employs the tacit knowledge contained in the precedents. Past reusable LOs searches can be seen as sources of new object searches because they contain the tacit knowledge about how query terms were once applied in a specific user profile. The purpose of the study was the implementation of e-learning management system from different user perspectives.

In an intelligence profile setting, people are surrounded by intelligent interfaces merged, thus creating a computing- capable environment with intelligent communication and processing available to the user by means of a simple, natural, and effortless human-system interaction. The engineering student enters query commands and the system asks questions during the inference process. Besides, the user will be able to solve new searches for which he has not been instructed, because the user profiles what he has learnt during the previous searchers [19]. We have developed a graphical selection interface as illustrated in figure 5. The easiest to implement interfaces communicate with the user through a scrolling dialog.

In the user profile interface, the user enters the keywords. Say a patron of Seville's digital domain library is seeking a "Computer Science electronic resource" or similar item. There need to be some "Computer Science" and related information in the mandatory learning materials. In order to help users find information from many diverse LOs, the search engine uses E-learnig classification expertise and the provided class lattice to provide results that are hierarchically arranged and easy to navigate, rather than the usual flat ranked document list. The conduct search sorts the classes in decreasing order according to rating after inspecting the subclasses of the designate class in the hierarchical tree, determining the category significance. For each set of query phrases, the search engine retrieves items from the designated class, determines the relevant importance of each object, and then sorts them in decreasing order based on the ranking. Figure 6 displays some of the resources that were retrieved as a consequence of the search.

Figure 6. Search engine results page

In the end, you'll get a list of LOs along with their names, a repository link, and a brief description of the places in the LO where the keywords were found.

A. Getting comparable instances back

Usually, CBR systems use a database of previous search-result pairs as input for retrieval and matching algorithms. The core principle of CBR is the assumption that new searches are often very similar to old ones, and that earlier results may be either directly reused or adapted to fit the present context. The establishment of an intelligent retrieval ontology is primarily driven by the need to provide knowledge retrieval with consistent and clear information. We provide retrieval techniques with several layers in our system:

1. Intelligent profiles interface: low-level query profile option selection, primarily including four user types: teachers, staff, students, and visitors. As a first step in doing a search, users have the option to define specific parameters.

2. Cases that meet the query may be returned via ontology semantic search, which can query on classes, subclasses, or properties of the knowledge base.

Step three of the retrieval procedure is to find the case's characteristics that are most comparable to the query. The CBR part of our inference engine uses the information the system retrieved from the question text to find more query-answer combinations that are similar [20]. To choose the most appropriate matching scenario, the system employs similarity criteria. Knowledge retrieval may make direct use of the expanded query conditions generated by similarity retrieval, which broaden the initial query criteria. When retrieving knowledge items for a new query, the similarity metrics utilized in CBR play a crucial role. The current school of thought holds that, in contrast to the original CBR methods, similarity is often not only a meaningless distance metric but rather a function that roughly reflects usefulness.

For this retrieval, we turned to a computational method that ranks results according to numerical similarity functions applied to the query. Our system employs the nearest-neighbor technique [21] as its retrieval strategy. This method compares the new input case to previously stored instances by weighing the total of their attributes to determine how similar they are. What follows is an example of a common method for determining closest neighbor matching:

for similarity assessment that allow to compares two differently structured objects, in particular, objects belonging to different object classes.

VI. EXPERIMENTAL EVALUATION

The efficacy of Artificial Intelligence and Ontologies in retrieving reusable learning information from a digital library has been tested via experiments. To find out how well run-time ontology mapping works, several tests are executed. The primary objective has been to determine if the agent-assisted query formulation process provides a viable means of increasing the quantity of important LOs retrieved from the Digital Library and subsequently saved in the CBR. Fifty engineering students from a range of demographics were chosen for the experiments. The users were requested to begin their essay before submitting any inquiries to OntoFAMA in order for us to provide context for them. Additionally, they were instructed to carefully peruse all of the results that OntoFAMA provided before to selecting any result. For every keyword phrase, we compared the top ten results from each search engine. We included a kind of implicit user relevance into our research by keeping track of which results they clicked on in our application. We need to keep in mind that the relevance of the recovered LOs is subjective. In other words, the same LO might have multiple meanings to different persons. Excellent, good, acceptable, and bad are the values that have been agreed upon in our research to quantify the quality of the learning materials that have been retrieved.

We had a log of inquiries after data collection, with an average of 5 searches per user. We had to exclude some of these searches because we couldn't find any relevant results, there were too many clicks, or the query just didn't exist. All of the remaining questions were examined and assessed (figure 7).

In each experiment we report the average rank of the user- clicked result for our baseline system, Google and for our

VII. CONCLUTIONS AND FUTURE WORK

An E-learning domain intelligent search system and automated classifier are introduced in this study. Which employ CBR and ontology approaches to organize and retrieve LOs. A CBR search engine, an object semantic classifier, and a knowledge acquisition mechanism make up our platform. Our method involves enclosing the material in a tuple (object, attribute, valor) so that it cannot be directly accessed in the database. Extracting information from DL is a necessary step in the search process so that it may be matched with the learner's needs. This may be handled covertly by an agent. For a more comprehensive review of agents' potential in K-12 settings, we suggest reading. For each user, we have created a unique profile that is suggested, relevant, and based on their preferences using all of the profile agents. Learning outcomes (LOs) may be recommended by the learner based on their viewpoint, and the model has strong features in delivering a preference to the learner using a unique way to determining close meaning of question. An individual's capacity to learn from group experiences will be enhanced by this feature of the model.

Lastly, the research assesses the feasibility of our methods for allowing search in digital libraries that are based on intelligent systems by analyzing the outcomes of implementation. A more successful LO retrieval is achieved, according to the findings, by enhancing representation and adding more metadata from the information and the ontology into the retrieval process. When compared to experienced users, OntoFAMA achieves comparable or higher results in learning knowledge acquisition and learning knowledge categorization, according to the experiment. Looking forward, our focus will be on improving the recommended queries, expanding the system to provide more help, doing user testing to identify areas for improvement, and using learning expertise from other libraries and services. There has to be an authoring tool for authenticating users, quick ontology parsing, and practical implementations.

REFERENCES

[1] Z. Jianfeng, "Research on Web-Integration-Based E-Learning Education Model," in e-Education, e-Business, e-Management, and e-Learning, 2010. IC4E '10. International Conference on, dates: 22–24 January 2010, volume, issue, pages 554-557.

[2] In the 2010 Second International Conference on E-Learning and E-Teaching (ICELET), A.P. Ali, H. Dehghan, and J. Gholampour presented "An agent based multilayered architecture for E-learning system" on December 1-2, 2010.

Reference:

[3] Govedarova, D., Stoyanov, S., Popchev, I. "An Ontology Based CBR Architecture for Knowledge Management in BULCHINO Catalogue." (2014).

Conference on Computer Systems and Technologies, 2008, International.

[4] "A case study of applying semantic technologies to a digital library" published in the 2005 edition of the Library Management Journal by Emerald, written by P. Warren.

[5] "Ontology-based metadata generation from semi-structured information" by H. Stuckenschmidt and F. Harmelen. ACM, 2001, K-CAP, pp. 163-170.

In their paper titled "Semantic web technologies for digital libraries," Sure and Studer (Y.) discuss

[6]. Vol. 26, 2005, Library Management Journal, Emerald.

A group that works on AI applications; its name is GAIA. http://gaia.fdi.ucm.es/grupo/projects/ provides information on the "jCOLIBRI project" and its distribution of the development environment with LGPL. University of Madrid's Complutense. 2009.

The article "Towards the metadata integration issues in peer-to-peer based digital libraries" was written by H. Ding. Volume 3251 of Springer's Lecture Notes in Computer Science, edited by H. Jin, Y. Pan, N. Xiao, and J. Sun, covers GCC in 2004.

As a tool for tooling selection, web-based case-based reasoning (CBR) was proposed by J. Toussaint and K. Cheng [9]. Advanced Manufacturing Technology: An International Journal. 2006.

As stated in the 2003 Proceedings of WWW, "Semantic search" was written by R. Guha, R. McCool, and E. Miller. that year 2003.

The article "Artificial Intelligence, Structures and Strategies for Complex Problem Solving" was written by G.F. Luger. fourth edition. Published by Pearson Education Limited in 2002.

12. "Web semantics and ontology" by D. Taniar and J. Wenny Rahayu. Published in 2006 by Idea Group Pub in Hershey, Pennsylvania.

[13] RDF Vocabulary Description Language 1.0: RDF Schema. World Wide Web Consortium. The RDF description schema is available at http://www.w3.org/TR/rdf-schema/.

The Protégé Ontology Editor and Knowledge Acquisition System was developed by PROTÉGÉ in 2009 and may be accessed at http://protege.stanford.edu/.

J. Heflin's "OWL Web Ontology Language Use Cases and Requirements" [15] is a reference. Web Consortium Recommendation. 2004

A. Gomez-Perez, A.O. Corcho, and M. Fernandez-Lopez published a paper titled "Ontological Engineering" in 2016. Springer Berlin: "Advanced Information and Knowledge Processing" (2003). 40 pages.

[17] "A Practical Guide To Building OWL Ontologies Using The Protégé-OWL Plugin and CO-ODE Tools" (M. Horridge, H. Knublauch). Manchester University, United Kingdom, 2004.

In their article "How to Build a Digital Library," I.H. Witten and D. Bainbridge discuss this particular topic (18). In 2003, Morgan Kaufmann published the book.

[19] “Case-based recommender systems” by M. Bridge, H. G¨oker, and L. McGinty. Expertise in Engineering Journal. 2006.

[20] “Handbook on Ontologies” by S. Staab and R. Studer. Berlin: Springer, 2005. International Handbooks on Information Systems.

“Constructing CBR systems with jColibri” was written by B. Díaz-Agudo, P.A. González-Calero, J. Recio-García, and A. Sánchez-Ruiz. Journal of Scientific Computing, 2007.