An Approach to Construct Learner Profile using Ontology

T. Sheeba, Reshmy Krishnan

Abstract*: E-Learning is the use of technology to enable people to learn anytime and anywhere. E-Learning depends on learner profile for the retrieval of relevant learning content to the learner. Learner profile describes the way in which a student learns best. It includes information on learner's knowledge, interest, learning preferences and styles, goals, background etc. One of the main issues in constructing learner profile is semantic web. Ontology is used as a standard knowledge representation for the semantic web. This paper suggests an approach to construct ontology based learner profile including static and dynamic characteristics of the learner and update it automatically. Finally an efficient fuzzy semantic retrieval process is proposed for the efficient retrieval of information from learner profile.

***Index Terms*— E-Learning, Semantic Web, Learner Profile, Ontology, Fuzzy Semantic Retrieval.**

I. INTRODUCTION

Comparing with the traditional face-to-face style teaching and learning, E-Learning is indeed a revolutionary way to provide education in life long term. Nowadays, E-Learning systems are widely used for education and training in universities and companies because of their electronic course content access and virtual classroom participation. Due to the rapid increase of learning content on web, it is time consuming for learners to find content what they really want to and need to study. Without knowing anything about the learner, a system would perform in exactly the same way for all learners. The success of any E-Learning system depends on the retrieval of relevant learning contents according to the requirement and understanding ability of the Learner.

In order to satisfy the requirements of the learner, learner profile is needed to reflect the true learner needs. Learner profile is a structure containing information both directly and indirectly pertaining to user's preferences, behaviour and context. It represents learner's interest as well as information and knowledge about domain that is relevant for a Learner. Learner profiles can form a good representation of the learning context, which promises to enhance the usage of learning content. It is a necessary factor for building an effective and accurate adaptive system. One of the main issues to take into account in the process of constructing learner profiles is the notions of the Semantic Web. Semantic Web relies heavily on formal ontologies to structure data for comprehensive and transportable machine understanding. The ontological representation of the user profile enhances the performance in tasks such as filtering, information retrieval, classification, information management etc. Various research studies were encountered in the process of creation of user profile. User profile can be created from both static and dynamic characteristics of the user. A user profile model is created by acquiring profile properties of individual user using questionnaire and focused more on static user characteristics. Dynamic and temporal characteristics are not incorporated.

Dynamic characteristics learner interest is considered in the following user profile construction: A user profile is created in "music" domain using user's current interests and new interests by analyzing user web logs. User profile is updated with the new interest using a newly introduced concept of ontology based semantic similarity. Interested terms of the learner are extracted by analyzing the web log. Vector Space Model (VSM) used to extract feature from document. A fuzzy clustering method classifies the learners for their interests which recommends using ontology based user profiles to maintain sophisticated representations of personal interest profiles. Each user profile is built from learning objects published by the user himself. Automatically generated fuzzy ontology is used to represent the user profile based on the user's interests and preferences. User profile is built from the learning objects published by the user into a learning object repository. It uses fuzzy ontology to represent user profile into a recommender engine and enhances the user's activities into e-learning environments. An ontology based user profile is constructed using fuzzy clustering technique. The method allows some information to belong to several user profiles simultaneously with different degrees of accuracy. User profile is created by collecting information using meta search in user's blog, personal/organization, web page, and any other sites. WordNet and Lexico-Syntactic pattern for hyponyms were used to extract feature from document. This profile is further improved by applying an ontology matching approach to learn the profile with other similar user.

Learner Interest and Learning style are considered in user profile construction by analyzing the web log. Ontology-based representation using WordNet is used to extract features from documents which solve the semantic inadequacy of VSM model. Fuzzy technique is used to classify the learners for their

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interests and Felder-Silverman Learning style model is used to reflect the intrinsic style of the learners. Fuzzy semantic retrieval is proposed in Electronic Commerce and Traffic Information Service domain using the concept of fuzzy linguistic variable. Query expansion done in SPARQL query language by semantic relations between fuzzy concepts and achieved semantic retrieval of e-commerce and traffic information through fuzzy concepts on the Semantic Web.

The proposed work is to develop an ontology based semantic learner profile which includes both static and dynamic information of the learner such as age, gender, education, interest, learning style etc. The created ontology is then updated automatically to incorporate dynamic characteristics of the learner when new documents are selected by the learner. Finally provide an efficient fuzzy semantic retrieval of information from learner profile by taking advantage of the concept of fuzzy linguistic variable which improves the efficiency of information retrieval and filtering.

II. SYSTEM MODEL

The proposed approach can provide learner profile according to the learner's individual differences which enhance the process of locating precise learning resources.

The system intervenes at four stages during the process of learner profile construction as shown in Fig 1. First stage is data collection which controls the process of collecting static and dynamic data of the learner. Second stage is learner profile construction which uses ontology to construct learner profile based on the collected information. Third stage is the learner profile updation which updates the learner profile automatically during the adaptation process. Final stage is the fuzzy semantic retrieval which performs retrieval of semantic information from learner profile with the help of fuzzy linguistic variable.

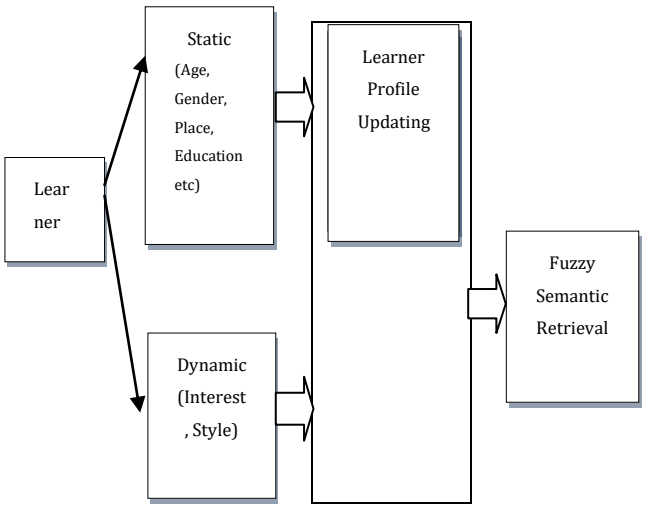

Fig 1. Learner Profile Construction Process

III. PROPOSED METHODS

A. Data Collection

There are two types of data about the learner. They are knowledge based i.e., explicit and behavior based i.e., implicit. Knowledge Based Information: Otherwise called as static. It includes personal Information of learner such as gender, age, place (city, state, and country), education etc. It can be obtained when the learner fill the registration form of the site and this profile is stored in the database. This method is time consuming for users. Behavior Based Information: Otherwise called as dynamic. It includes information such as learner interest, learning style, learner preferences etc. It can be obtained by analyzing the web pages that the learner visits (i.e., web access patterns) in web server logs. Learner Interest and Learning style are considered in the proposed system as it of particular importance for most learner profiles.

Acquiring Learner Interest: Learner Interest can be obtained from the documents visited by the learner by performing web log analysis. Fig 2 shows the basic steps used for acquiring learner interest. Weblog from learner are first preprocessed as data in its raw form is not suitable for the application of data mining algorithms. Data preprocessing process includes steps like data cleaning, learner identification, session identification, path completion, formatting etc.

Next step is the effective representation of documents selected by the learner. Various methods are used to extract features from the documents. The Vector Space Model (VSM) is adapted to achieve effective representations of documents which extract interested items in the web page. In VSM, each document is identified by n-dimensional feature vector in which each dimension corresponds to a distinct term. The term frequency used to reveal the importance of term within a particular document. Ontology-based representation using Word Net is used to identify Word Net concepts related to document terms. This method improves the performance of traditional VSM model by providing semantics to the terms. WordNet and Lexico-Syntactic pattern for hyponyms were used to extract feature from document.

Domain concept filtering is used to compare extracted concepts with the domain ontology to check the relevant items and the most relevant ones update the learner profile. The items relevance is based on ontology-based semantic similarity where browsed items by a learner on the web are compared to the items from domain ontology and learner profile.

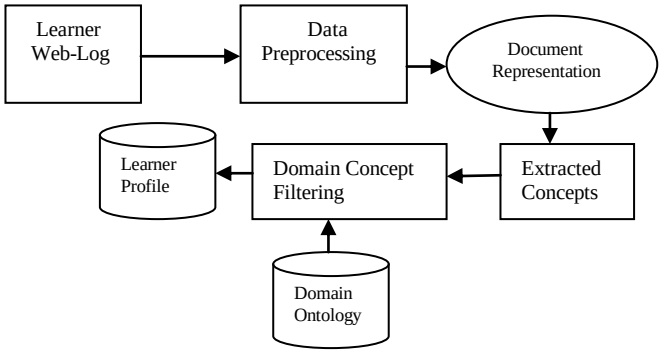

Fig 2. Acquiring Learner Interest

Acquiring Learning Style: Learning style is typically defined as the way the learner prefers to learn. Everyone has his/her own style on learning which can also vary from one situation to another. This learning style can be identified by the learner action on the site.

More profound models used for learning style are: Kolb's learning style model and Felder-Silverman learning style model.

The Kolb Learning Style Inventory (LSI) has a forced-choice ranking method to assess students' preferred modes of learning. The students complete twelve sentences about their preferred way of learning. Each sentence has four endings and the individuals are asked to rank the endings according to what best describes how they learn (4 = most like you; 1 = least like you).

Felder-Silverman learning style model defines four dimensions on learning style such as active/reflective, sensing/intuitive, verbal/visual, sequential/global. The analysis of the log files provides a summary of what content items the learner chose to use. The learning styles proposed by Felder-Silverman learning style model are matched to the learner actions as shown in Table 1.

Table 1. Relationship between Learner Actions and (FSLSM) category.

Parameter	Value	FSLSM Category
No. of visits/postings in forum/chat	High	Active, Verbal
No. of visits and time spent on exercises	High	Active, Intuitive
Amount of time dealt with reading material	High	Reflective
Performance on questions regarding theories	High	Intuitive
Performance on questions regarding facts	High	Sensing
Amount of time spent on a Test	High	Sensing
No. of revisions before handing in a test	High	Sensing
No. of performed tests	High	Sensing
No. of visits and time spent on examples	High	Sensing
Amount of time spent on contents with graphics	High	Visual
Performance in questions related to graphics	High	Visual
Performance on questions related to overview of concepts and connections between concepts	High	Global

B. Learner Profile Construction

Ontology is used for the learner profile construction. Ontology represents the knowledge in a domain in a structured way. It is a conceptualization of a domain into a human understandable, machine-readable format consisting of entities, attributes, relationships, and axioms. It is used as a standard knowledge representation for the semantic web. The main steps used in the ontology construction are (Fig 3): Enumerate important concepts and terms which collect terms related to learner, Define concepts, slots and relation of concepts which create preliminary concepts and sub concepts and create relationships between the concept, Implementation which is performed with the help of software and Evaluation which check whether the created ontology is accurate or not.

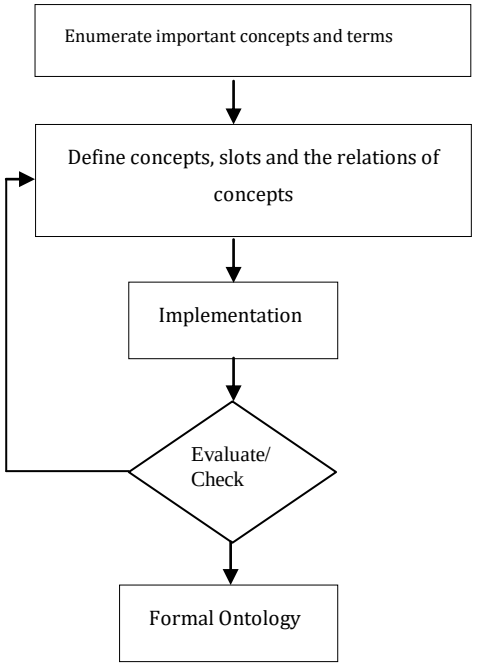

Fig 3. Steps of Ontology Construction

C. Learner Profile Updating

Learner profile updating allows the inclusion of new concepts into the learner profile when new concepts are selected by learners. Semantic Similarity is the general method used for the learner profile updation. It is used to quantify concept similarities in a given ontology. It compares new concepts with concepts from a learner profile based on the following condition: If the concept does not exist in the learner relevant terms set, then it is incorporated, and its weight value does not change. If the concept already exists, then the concept weight is updated with the new value.

There are multiple ways of calculating similarity of concepts/individuals in ontology. The most efficient method that matches with the human intuition is based on ontology nodes (classes). In the node-based approach similarity is just a distance between the nodes that are being compared. In the edge-based approach similarity is defined as the minimum number of edges between two concept nodes. The main problem with these approaches is the assumption that links in the ontology is uniform. This can be addressed by a notion of weighted edges. Different methods of assigning weights are introduced such as network density, node depth, type of link and strength of each specific child link. A similarity function approach used to calculate the similarity defines the weighted sum of three different similarities. Ontology-based semantic similarity is used to compare items browsed by a user on the web with the items from a user's profile.

D.Fuzzy Semantic Information Retrieval

Fuzzy ontology contains fuzzy concepts and fuzzy memberships which allow easy determination of the precise meaning of a word as it relates to a document collection. It can be used in information retrieval to locate precise information, which may be contained in a document content collection. Fuzzy ontology based retrieval system is a system that typically measures the relevance of documents to learner's query based on meaning of dominant words in each document. It determines semantic equivalence between terms in a query and terms in a document by relating the synonyms of query terms with those of document terms.

In the proposed system, fuzzy semantic retrieval is performed with the help of fuzzy linguistic variable. This variable is used for the classification and retrieval of learner profile. It uses three main steps: Define Linguistic Variable, Define Membership Functions, and Define Semantic Relation between Fuzzy Concepts

Define Linguistic Variable: Linguistic variables are the input or output variables of the system whose values are words or sentences from a natural language, instead of numerical values. A linguistic variable is generally decomposed into a set of linguistic terms. Example: Age (a) is the linguistic variable. Linguistic terms A(a) = {old, middle-aged, midlife, youth, youngster, adult , …} covers overall values of the age.

Define Membership Functions: A membership function is used to quantify a linguistic term. Different forms of membership functions are triangular, trapezoidal, piecewise linear, Gaussian, or singleton. Membership function can be context dependent and generally chosen arbitrarily according to the user experience. Example: Linguistic terms "youngster" ≤ "midlife" ≤ "old".

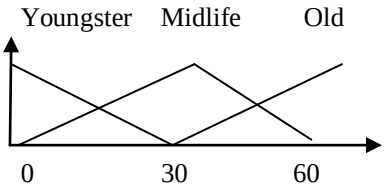

Fig 4. Triangular Membership function

Define Semantic Relation between Fuzzy Concepts: Semantic relation between fuzzy concepts is defined such as equal to (=), less than or equal (≤) and greater than or equal (≥), subset of (⊆) etc. Example: "middle-aged" = "midlife", "old" ⊆ "adult", "middle-aged" ⊆ "adult", "youth" ⊆ "adult".

IV. CONCLUSION

The proposed system is an attempt to implement an ontology based learner profiles that incorporates sophisticated representation of static and dynamic characteristics of a learner which can be utilized for effective information retrieval.

The system will provide personalized learning process to the learner based on their individual characteristic such as age, education, interest, learning style etc. It helps staffs to understand the learning process of learners, and adjust the pedagogical activities, and support the course development. It also supports self directed learning and collaborative learning. Ontology-based semantic information retrieval is one of the motivations of the Semantic Web. The system proposes an efficient fuzzy semantic retrieval which enhances the performance of tasks such as filtering and information retrieval by using the concept of fuzzy linguistic variable.

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