Inculcating Intelligence into E-Learning

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ABSTRACT

E-Learning is a critical support mechanism for educational institutions to know the performance of their students, teachers, as well as useful for organizations to enhance the performance of their employees. There is a need to enrich the available information with machine-processable semantics since there is considerable difficulty in finding, accessing, presenting and maintaining the information required by a wide variety of users on World Wide Web. With the techniques like semantic web technologies supported by semantic E-learning, there is a chance to move from content-focused learning services to semantic-aware and personalized learning services. The purpose of this paper therefore is fivefolds. Firstly, it focuses on the Semantic Web and Semantic E-learning approach as a potential technology for realizing E-learning requirements. Secondly, it focuses on knowledge representation techniques in Semantic E-learning. Thirdly, its major stress is to discuss the architecture of Semantic E-learning framework and various stages in intelligent Semantic E-learning scenario. The paper also focuses on Semantic Web technologies-based intelligent information retrieval methods. Lastly, this paper shows the analysis of various semantic mark up languages based on certain criteria.

Keywords

Semantic web , Semantic E-Learning , RDF, Ontologies, E-Learning Agents.

1. INTRODUCTION

E-learning is electronic base training which is just-in time education integrated with high velocity value chain [1]. It has various benefits over traditional class room study and also reduces the cost of education training in institutions. But along with all the benefits provided by E-learning, it is expected that E-learning should provide experiential active learning i.e. learning from experience by providing personalized environment i.e. user can customize their learning environment according to their requirement and create appropriate learning context dynamically and also it should be socio constructivist i.e. provide support for group work. Learning process needs to be efficient and just-in-time. E-learning lacks in learner-centric usability and interactive involvement and the lack of understanding of multimedia-aided learning and teaching [2]. To overcome these lacking points , there is a need for E-learning at some advanced level which is known as semantic E-learning.

So, this transition from E-learning to semantic E-learning (Intelligent/Adaptive e-learning) which will also fulfill the demand for shifting E-learning solutions from pure web-based content provision to instructional and learner-centric learning and teaching environments[2].

It can be viewed as an intersection of three components: E-learning, semantic web and end-user programming (customized learning) as shown in figure 1.

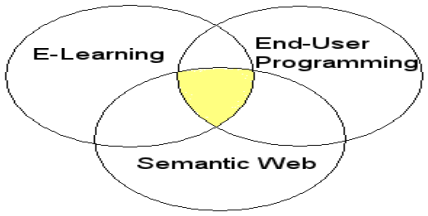

Figure 1: Components of Semantic E-learning

Semantic E-learning helps in integration of content provision, learning process and learner personality and develops an integrated semantic E-learning framework. With the techniques like semantic web technologies supported by semantic E-learning, there has been a move from content-focused learning services to semantic-aware and personalized learning services.

2. SEMANTIC WEB

Semantic web i.e. meaningful web is the next generation of World Wide Web (WWW) which will make E-learning more intelligent as shown in figure2. Semantic web uses ontology-based technologies and intelligent agents for semantic information processing. This new e-learning system integrated with semantic web technologies in the educational domain is called as semantic E-learning approach.

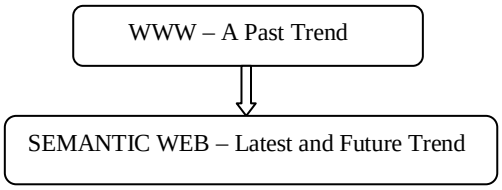

Figure 2: From WWW to Semantic Web

ıat provides intelligent access to heterogeneous, distributed information, enabling software products (agents) to mediate between user needs and information sources available [2]. It also represents a promising technology for realizing E-learning requirements. Semantic web will enhance content with formal semantics and make it suitable for machine consumption.

3. SEMANTIC E-LEARNING

With the help of semantic web, there is a possibility to develop an adaptive E-learning system. As given below,

figure 3 shows the learner control strategy comprising of three components.

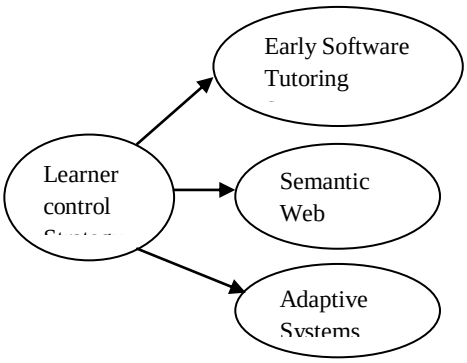

Figure 3: Components of Learner Control Strategy

First component being early software tutoring systems i.e. existing E-learning system and WWW. Second component is semantic web which helps in context awareness and is supported by technologies like Ontology and RDF (Resource Description Framework).Third component on adaptive system comprises of intelligent agent and learner personality. Intelligent agent will act upon semantic web and extract appropriate information required by the learner and make E-learning into an intelligent E-learning. This addition of two new components to existing E-learning system will not increase the complexity as generic context model will lower the knowledge barrier of semantic annotation of learning resources which improves the usability of semantic E-learning systems. Therefore, job of common instructors and learners become easy and the requirement to understand the concepts like ontology, technologies related to semantic web is not a compulsion.

4. COMPONENTS OF SEMANTIC E-LEARNING

Three main components of semantic

E-learning has been identified as:

1) Learning Content Description
2) Semantic Management
3) Learning Process and Pedagogy Support

First component is learning content description having two components semantic web and semantic description. Semantic description is supported by ontologies and semantic mark up languages. Third component is learning process and pedagogy support which comprises of learning styles and learner personality. But, there is a need to map between these two components. So, semantic management acts as a middle component of semantic E-learning by providing the link between learning content description and learning process.

4.1 Semantic Description

Earlier learning content description is majorly supported by learning object metadata(LOM). Also, various LOM editors are available like the LOM Javaeditor , the treeLOM etc. LOM is adopted by most learning management systems(LMS) but some systems still use their own framework for learning content description rather than adopting LOM as the main standard[2].It has been identified that this method of describing learning content description face the heterogeneity problem as same learning content could end up with a number of incompatible descriptions in different LMSs. Also, it takes extra effort while resolving these issues in practice. Modern E-learning solutions need the solution to represent multimedia resources, which requires complex semantics. So, semantic description is much more than metadata which are used to describe learning objects. Semantic description include one component as metadata along with other information like literal statements, learning processes, mind maps , etc.

So, there is a need to move from learning content description to semantic description in modern E-learning solutions. Now learning content description has two components which are semantic web and semantic description. Semantic description is supported by ontologies and semantic markup languages. But context should be described as a combination of predicate and objects in a context aware system which is also suitable for context model. In traditional E-learning system, it is described with keyword based metadata description.

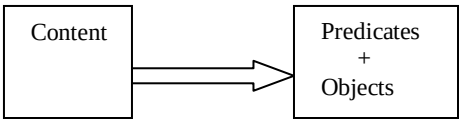

Figure 4: Elements of Semantic statements

In semantic statements, information is structured in <predicate, object> pairs as described in above figure 4.

4.1.1 Ontologies

One of the primary characteristic of semantic web is shared understanding and also it needs awareness of context in application like user context or working context [3]. It is based on ontologies, which enables the organization of learning materials around small pieces of semantically annotated (enriched) learning objects. Ontologies are specification of the conceptualization and could be used to present semantics of course content and student information.

4.1.2 Semantic Mark up Languages

Various languages like XML, RDF, DAML, Topic maps, XQUERY are proposed for the semantic web development. Information can be made available to the agents by providing mark-up annotations attached to data sources [4]. This paper mainly focuses on RDF (Resource description language) and DAML (The DARPA Agent Markup Language). XML is also considered because of the widespread adoption of XML and the many commercial tools that make it attractive for practical use.

4.2 Semantic Management

One of the main issues in semantic management is the problems of heterogeneity. This issue becomes more

challenging when it emerges with multiple ontologies and schemas. Semantic description needs various levels of 'bridge' for semantic translation and interoperation [2].

Following are the two main approaches which have been analyzed to resolve this issue:

1) Ontology Mapping
2) Semantic Integration

Various semantic services are there which are using these above two approaches i.e. ontology mapping and semantic integration and acts as an interface between semantic web and semantic application.

4.3 Learning Process and Pedagogy Support

One of the main expected features from today's E-learning system i.e. semantic E-learning system is to become adaptive in nature. This Adaptive feature can be achieved by incorporating learning process and pedagogy support in the existing system. This task is performed by intelligent agent. Also, it is necessary to implement pedagogy support irrespective of pedagogy framework used. Learner personality plays an important role and also it is essential to be aware of the learner's aptitude and personality in context [2]. Learner's personality traits are expressed in learning styles and provide various learning strategies as an outcome. To meet the needs of individuals, modification of learning process and the learning content is performed accordingly. Following are the two factors which are used to enable personalization:

1) User modeling
2) Personal Profiling

Learner ability aspect in web based learning is also important along with user profiling aspects such as learner preferences, interests and browsing behaviors [2].

4.3.1 Intelligent Agents

An agent perceives its environment through sensors and acting upon that environment through effectors [5]. Two main properties of agents are autonomous and intelligent. In Semantic E-learning framework we will use the following hierarchy of agents among the vast categorization of agents as shown in figure 5.

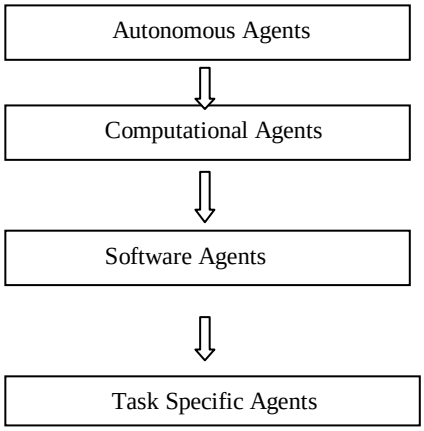

Figure 5: Hierarchy of agents used in Semantic E-Learning

There are various roles of intelligent agent which will help in making adaptive e-learning system. Main five roles of intelligent agent which have been identified are:

1) Hide complexity
2) Assist end-users
3) Intelligent search engines
4) Support instructional design
5) Perception of dynamic conditions

5. ROLE OF SEMANTIC WEB – AS AN INTERFACE

Traditional web based E-learning systems use a web browser as an interface between the user and run time learning environment as shown below in figure 6.

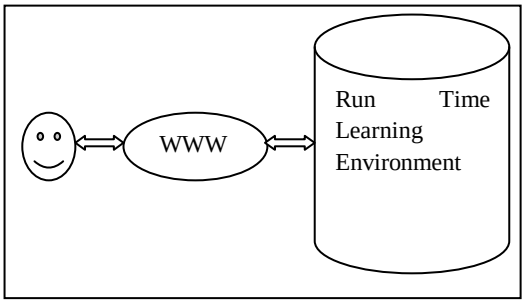

Figure 6: WWW as an interface in traditional E-learning.

In semantic E-learning system, two new components are added as discussed above in section 4. Here, semantic web act as an interface between user and run time learning environment which is also linked to the context model (first newly added component) which act as a core component of complete semantic E-learning system shown in figure 7.

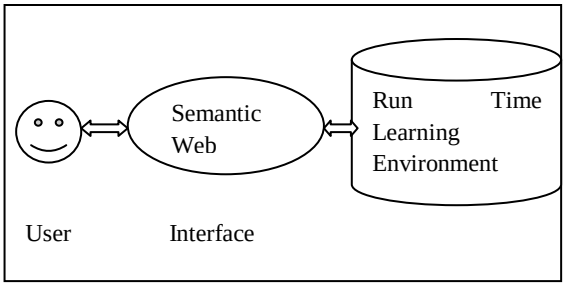

Figure7: Semantic web as an interface in Semantic E-learning

5.1 Semantic aware context model

Semantic context aware includes both static and dynamic information related to the entity they are describing. Context model designed for semantic representation should have following three properties:

1) Generic
2) Scalable

3) Layered

The context model should be generic and scalable enough to work across HTML-based WWW and XML/RDF based semantic web and to interoperate with various learning content description specifications.

Also, the model should be layered so that semantics can be described as a set of statements based on statement model which is part of every layer of context model. Each statement has some weight i.e. semantic weight to show its impact in that semantic context. Lengthy description is allowed (i.e. no limit on the number of semantic statements) due to iterative mathematical model in each layer.

The context model is more than just representation as it also captures the semantic relations among concepts and statements.

To make the system adaptive in nature, personal agents (second newly added component) are added which will interact with the user and act accordingly in an adaptive manner. Through run time learning environment user can access the learning objects which are directly linked to the multimedia based resources, presentation slides and reference documents. Also teachers can learn various learning styles and share them among their colleagues.

6. STAGES IN SEMANTIC E-LEARNING SYSTEM

Figure 8 given below shows the three stages in semantic E-learning system i.e. pre- learning stage, learning stage and post- learning stage. These stages are based on plan, process and analyze.

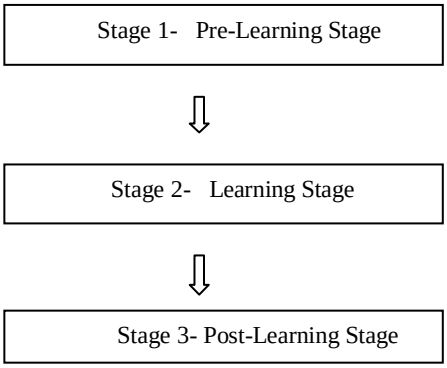

Figure 8: Stages in Semantic E-learning

6.1 Stage 1: Pre-Learning Stage

This stage involves the preparation of work from both the learner and instructor side. Mainly there are two main tasks on the learner side. First is to define learning goals and learning preferences. Second task is to get assistance from intelligent agents in identifying learner personality and learning style. Instructor is also involved in two main tasks. Firstly, to prepare multimedia learning resources. Secondly, to design learning paths for different types of learners. This gathered information is stored in a knowledge base.

6.2 Stage 2: Learning Stage

Second stage involves various kinds of learning activities such as locating appropriate learning material, discussing with peers, self evaluation and revision. Also, basic knowledge material retrieval service is carried out based on the context model. It also uses learning signals to communicate with peer agents of other learners in order to get adequate learning advice.

6.3 Stage 3: Post-Learning Stage

This stage involves reporting and evaluation results on both the learner and instructor side. Agents could generate a learning progress report against the predefined goals and outcomes. Two factors mainly to be considered in report are :

1) Learning Efficiency

2) Time(effort) spent in learning activity

Future guidance is also mentioned in reports if required.

7.SEMANTIC INFORMATION RETRIEVAL

There are three methods for semantic information retrieval. First is the traditional method based on keyword based retrieval mechanism. Existing solutions using this traditional approach are literal based and there is no sense of real semantics. Second method is RDF based search for semantic web. It is in early development stage, still not practical and mature enough to be widely used in practice. Third and the mostly used method is context-based query process. In this, <predicate, object> search mechanism is used. It provides semantic search which is compatible with RDF. This pair query model can be implemented as a single text field search as the most common web search interface.

The user can choose either of the above methods. Once the query context is specified, the system will pass the context information to the search engine to retrieve matched results. In retrieval process, there might be duplicated results shown in relation to the same physical object. Auto completion feature is also added to the pair based on the context of personal interest.

8. RESEARCH OBJECTIVE

The objective of this research is to analyze the semantic mark up languages and adopt a language for the further semantic web development, which will act as a vehicle for knowledge representation. So, the selection of appropriate semantic mark-up language is important, as this selected language will enable agents to communicate with each other. The semantic mark-up language will act as the medium of communication between the agents.

9.RESEARCH METHODOLOGY

The research study should focus on three semantic mark-up languages XML, RDF and DAML. Out of these, RDF and DAML are most important. XML is supported due to its expressive set of constructs and availability of commercial support. These three languages in view are analyzed on certain criteria. Criteria are chosen by keeping in mind semantic web development. In today's distributed environment and object oriented approach, there is a need to focus on concepts like classes, properties, inheritance, and data types etc. Table 1 given below shows the comparison of semantic mark-up languages XML, RDF and DAML on the certain criteria. This table helps us in

finalizing the semantic mark-up language which will be used for future semantic web development.

10. ANALYSIS OF MARK UP LANGUAGES

XML stands for Extensible markup language and this generation of web made the step to machine generated and often active HTML pages. RDF is the W3C standard on top of XML for encoding knowledge (metadata). It is used to breakdown knowledge into discrete pieces. These discrete pieces are called triples or RDF statements. The complete database of information is represented with the help of RDF statements.

It can be viewed as a labeled directed graph where each edge in the graph can be thought of as a fact or a relation between two things. A fact represented with the help of directed edge is shown in figure 10 given below. It consists of three parts: a subject (start node of the edge), a predicate (i.e. verb) (type of edge), and an object (end node of the edge).

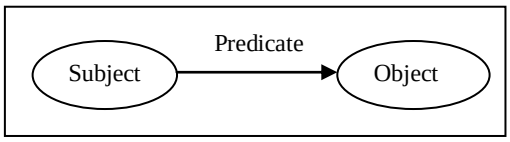

Figure 10: RDF Triple

It provides a means for adding semantics to a document and information is stored in the form of RDF statements which are machine understandable. It is popularly known for its RDF/XML syntax. So, everything in semantic web should be represented as [7]:

1. A fact which is expressed as a triple (Subject, Predicate, Object).
2. Subjects, predicates, and objects are given as names for entities, whether concrete or abstract, in the real world.
3. Names are in the format of URIs, which are opaque and global.

The DARPA Agent Markup Language (DAML) program is also aimed for making more of the content on the web machine-understandable and enabling more agent based communication.

DAML language provides logical language embedded on the web. This mark-up language ties the information on a page to machine readable semantics. Meanings and specifications of the terms associated with the page are stored in ontologies.

Following table1 shows the comparison of XML, RDF and DAML as semantic markup languages for semantic web development.

This comparison is based on many dimensions like contexts, object & class properties, inheritance, element range and domain, data types, property value enumeration, ordered data sets and bounded lists. Element range specifies the kinds of values (elements / classes / data types) the property can have Element Domain specifies which elements / classes can have the particular property. An Enumeration restricts the value space of a property to a certain set of values.

S.NO.	CRITERIA	XML	RDF	DAML
1.	Modularity	No	Yes	Yes
2.	Classes and Properties	No	Yes	Yes
3.	Inheritance	No	Yes	Yes
4.	Cyclic Hierarchy	No	Yes	Yes
5.	Interoperability	syntactic	semantic	semantic
6.	Namespace	Default Namespace	Uses XML Namespace	Uses XML Namespace
7.	Property Specification	Local as well as Global	Global only	Local as well as Global
8.	Enumeration of Property Values	Yes	No	Yes
9.	Ordered Data Sets	By default	Use <rdf:Seq..> tag	Use <daml:list> tag
10.	Bounded lists	Not Possible	Not Possible	Possible
11.	Data Types Supported	Numerical , Temporal and string	Literals i.e. set of all strings	Use XML schema
12.	Element Domain	No explicit declaration of the domain of the element.	Multiple domain statements imply conjunction (i.e. all of them should be satisfied) and can only be specified globally	Multiple domain statements imply conjunction (i.e. all of them should be satisfied) and can be specified globally
13.	Element Range	Yes, Local as well as global	Yes, Local Only	Yes, Local as well as global
14.	Element Cardinality	Yes, Local Only	No	Yes, Local as well as global

11. RESEARCH ANALYSIS

From the above comparison, it can be seen that XML is used as syntax for RDF. RDF is not only used as a syntax for DAML, but also as a sublanguage since some expressions are written in RDF (e.g. instances) [8]. Out of these, the most important semantic mark-up languages for semantic web development are XML and RDF. XML is supported due to its expressive set of constructs and availability of commercial support. XML is a foundation for dealing with hierarchical, self-contained documents but actual implementation of these object oriented concepts which are the foundation for developing distributed environment are supported by RDF. XML is also more than a file format. It itself is not very much concerned with meaning. But, it has been identified that to exchange the data on the web, web format should posses universal expressive power and provide support for syntactic interoperability and semantic interoperability [9]. Because of this reason, this research analysis concludes that RDF i.e. resource description framework is an appropriate vehicle to represent knowledge for the development of semantic web. RDF can be stored in various formats and is also not limited to metadata but can be used to encode information about and relations between things in the real world: people, places, concepts, etc.

12. CONCLUSION

The major purpose of education cannot remain the inculcation of knowledge and skills, but should become the development of intellectual and psychological capacities which enable people to learn continuously for rest of their lives. Semantic web is the emerging technology aiming at web-based information and services that would be understandable and reusable by both humans and machines. Thus, we can say the current Web is a decentralized platform for distributed presentations while the Semantic Web is a decentralized platform for distributed knowledge. An important objective of semantic web is to hand over most of the important information to software agents that we are doing ourselves now days on the web. Intelligent learning system can be considered as a

intersection of adaptive web i.e. semantic web and adaptive education system.

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