

# Mapping Provenance Model to e-learning Ontology

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*Abstract* The Semantic Web (SW) may be represented as it is advancement of the web; it is specifically conspired to describe information in a specific manner, which machine can understand easily. In this context the 'object' or "resource" derived from web must be a unique as Uniform Resource Identifier (URI). Ontologies are used to establish the relationships between objects. Trust or provenance plays important role in the semantic web. Trust defines the merit by which a user considers authenticity of the documents. Semantic web refers the credibility, reliability and tustability of the data in the given context. It is necessary to observe and differentiate trusted data points from entrusted ones. [8]. User has to take decision regarding selection of the documents based on considering all the parameters of trust, whether given information is reliable or not. The documents available in the web in which users put a new set of problems every time and need to obtain the solution exactly trustworthy.

## I. INTRODUCTION

In present scenario available e-learning system are not fulfilling the need of users and are insufficient. For the actual need of learners, educational development and as per demand it is not sufficient to impart education among the entire segment of the society in time and place. Now with the help of I.T. technology a gap may be reduced between learners and quality oriented resources. However, in conventional e-learning model, a system with specific network, In the mean time a problem may be overcome above issues using Cloud computing which helps learners in terms of its dynamic approach and usage of resources accurately and reliable. All future e-learning models are bound to be cloud based for its advantage of availability, reliability with accuracy, scalability and cost [2] [12].

In order to enrich resources e.g study material, extensive use of audio/ video a system must be capable to reaches learners with aspect that data returns to users are accurate and trustable. By making use of multiple delivery systems. Such a delivery mechanism must provide the learners with the more flexibility to search data from designated cloud as well as other network also. Technologies are to be applied to make efficient way for supporting learners to be able to achieve the desired and reliable results. It is needed to develop such system which provides new dimensions of learning and openness of education [3].

Revised Manuscript Received on July 01, 2019.

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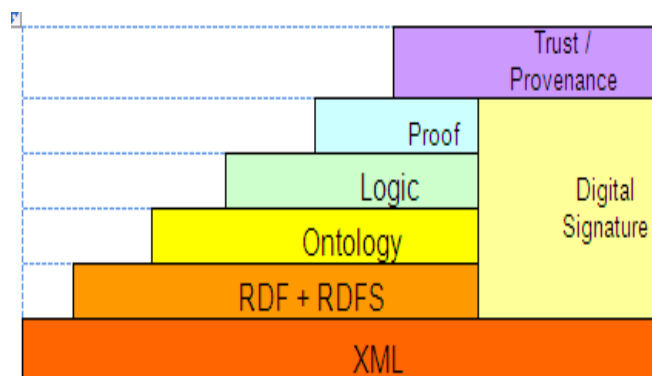


Figure 1: Semantic Web Cake [36].

- 1) The XML Layer gives the application full access to and control over the content of message.
- 2) The RDF Layer is a method for representing data by defining relationships between data objects.
- 3) The Ontology Layer is the infrastructure for the semantic ontology. Inference layer is based on concepts delivered in description logic (DL), and is compatible with RDF.
- 4) The Logic & Proof layer has set of rules that enable inference to decide courses of action and answer the questions.
- 5) Trust / Provenance ensure and check all the aspect of originality, trustability of the data.

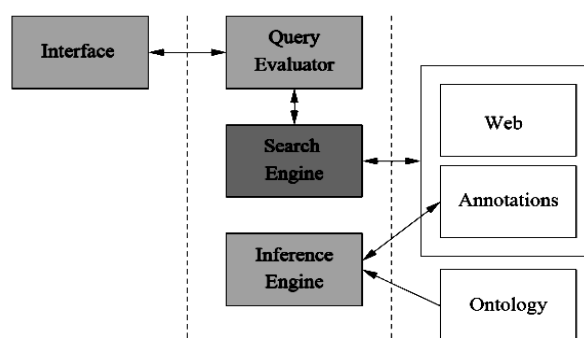


Figure 2: Architecture of Semantic Web search system [13]

With respect to it an e-learning model of the cloud provides the learner a facility of accessing the database e.g. e-gyankosh and software packages relevant to the syllabus already available with its official website. The following issues of search engines are observed during the study and further analyzed as [3].

- 1) In the present e-learning model in which resources are available for the users as a web services. By which user are bound to learn the contents available on the designated cloud only.
- 2) The available e-learning models do not provide semantically structured knowledge representation and thus returns non relevant data when search upon.
- 3) It is very challenging for any e-learning model, which is based on web content or any other source. Until unless we look the concept of meaningful data? Originality of data? Thus significantly missing the provenance component.
- 4) Sometimes users access data, available on the web and use that data without knowing the facts.

The problems of present search engines may be resolved by adapting the following:

- Incorporating various AI techniques to impose intelligent agents to resolve the problems and Leave the existing web documents as they are without restructuring.
- Restructure the existing web documents by annotating them so that the browsers/machines may understand the relationship between the various documents and return the semantic based results.

The real purpose of the semantic web will be attained by incorporating the merger of the web documents needs to incorporate context definition about self and also the software agents which can explore context definition attached to the Web resources.

### II. ONTOLOGY AND SEMANTIC WEB

A such environment of Web where machine agents and users will communicate semantically is said to be Semantic web. According to user's requirement implementing the exact query, its purpose of to make available of the content accurately. Once the machine will be able to return answer for every doubt, the exact answer will be returned along with a list of hyperlinks [14, 15].

A Concept of Ontology is "a specification of a conceptualization of a specific domain" [4]. Ontology is a definition of the concepts and relationships. It is consistent with the usage of ontology as set-of-concept definitions, but more significantly we need to explore, what ontology is for. The purpose of drawing ontology is sharing knowledge and further utilization. In that context, ontology is a stipulation used for making ontological assurance. First design ontology's so it can share knowledge with and among the learners. [16]

Ontology defines e-learning system; the first step of the development procedure carries to capture and documentation as user's point of view. The steps are:

- Scope of ontology as well as identification of the objective
- Re-use existing vocabulary.
- Elaborating.

- Classes with their hierarchy.
- Properties of the classes.
- Properties' features
- Defining instances.

The xml source code for focusing the protégé ontology is given below:

```
<?xml version="1.0"?> // define the semantic version of the
                                xml
<!DOCTYPE Ontology [
<!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
// to create Schema
```

It explores the schema for XML.

```
<!ENTITY xml // define entity
"http://www.w3.org/XML/2019/namespace" >
```

A unique name is given each element of the class, although it may be shared with elements in other classes.

```
<!ENTITY rdfs "http://www.w3.org/2019/rdf-schema#" >
```

It is a collection of classes with certain properties using the rdf extensible. Rdf: It is a recursive class of classes. This language is used for declaration of basic classes and their types and exploration of the terms which is used in rdf. Also used for determining characteristics of other resources, like the ranges of properties and domains.

```
<! ENTITY rdf
"http://www.w3.org/1999/02/22-rdf-syntax-ns#" >]
```

Typed literals are allowed by rdf. Literals are denoted as the object node of a predicate. These are written in RDF/XML with the same literal syntax for string nodes in the property element form but with an additional rdf: data type "data type URI" attribute on the element of property.

```
<Ontology xmlns="http://www.w3.org/2002/07/owl#" //
presentation of xml syntax for OWL
```

Above syntax defines XML notation syntax for OWL, which is depicted as a dialect Abstract Syntax as OWL Semantics. The web ontology syntax expresses through sublanguages: OWL Lite, OWL DL, and OWL Full.

```
xml:base="http://www.semanticweb.org/amit/ontologies/2019/0/untitled-ontology-10
```

The base URL of an element can be queried from a script using node base of the parents elements denoted to the document entity or external entity, if one exists, otherwise.

```
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
```

```
xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:xml="http://www.w3.org/XML/1998/namespace
```

Here ontology is explored with a sample ontology named Amit

ontology IRI="http://www.semanticweb.org/Amit/ontologies/2019/0/untitled-ontology-10">

<Prefix name="rdf"  
IRI="http://www.w3.org/2019/02/22-rdf-syntax-ns#" />

<Prefix name="rdfs"  
IRI="http://www.w3.org/2000/01/rdf-schema#" />

<Prefix name="xsd"  
IRI="http://www.w3.org/2001/XMLSchema#" />

<Prefix name="owl"  
IRI="http://www.w3.org/2002/07/owl#" />

Two sub classes are defined for the super class university. Person and Module are the two subclasses. Person class further consists of two subclasses. Lecturer and Student are two subclasses of Person class. Module class also consists of two subclasses: CS Module and Math module.

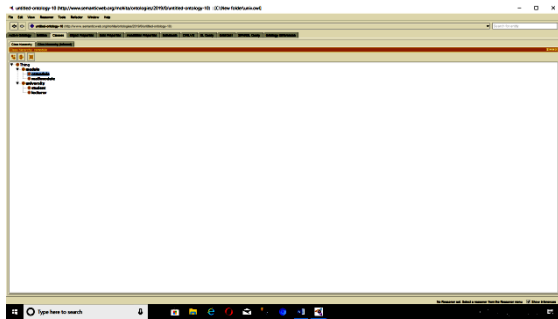


Figure 3: Sub Classes

Here cs module declaration is given.

<Declaration>  
<Class IRI="#cs module" />  
</Declaration>

Now this paper also focuses on the object property of the subclasses Lecturer and Student. "Teaches" object property is for lecturer and "Studies" object property is for student.

Lecturer → teaches → Module  
Student → studies → Module

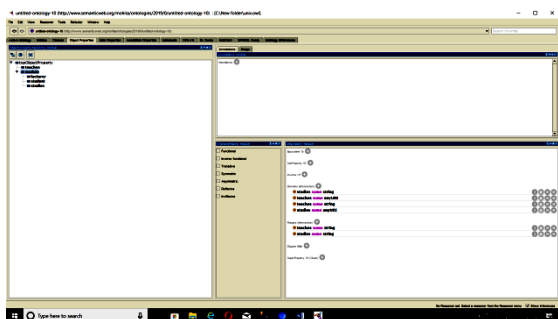


Figure 4: Object Property of the Class

Here for example lecturer

<Declaration>  
<Object Property IRI="#lecturer" />  
</Declaration>

The data properties are also explored in this paper. f\_name, id\_no., l\_name, staff\_number are the data properties for Lecturer. f\_name and l\_name are defined string type and id\_no. and staff\_number are defined as integer type

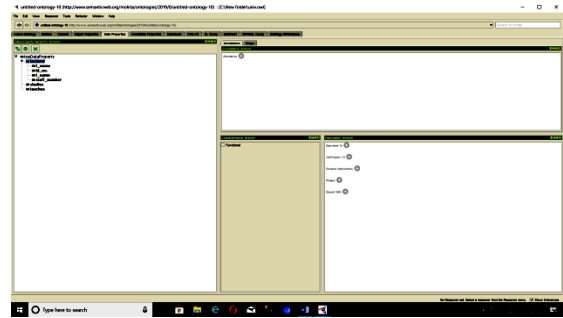


Figure 5: Object Property of the Class

<Declaration>  
<Data Property IRI="#f\_name" />  
</Declaration>

<Sub Class Of>  
<Class IRI="#cs module" />  
<Class IRI="#module" />  
</Sub Class Of>

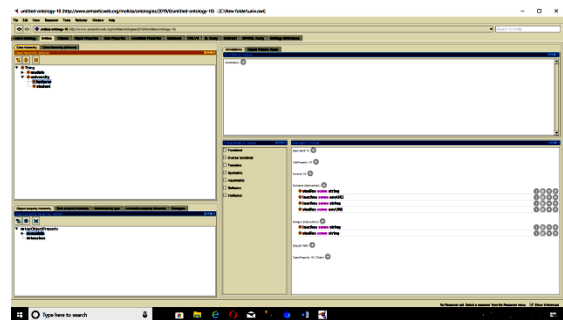


Figure 6: Object Property of the Class

<Sub Class Of> // define of sub class  
<Class IRI="#module" />  
<Data Some Values From>  
<Data Property IRI="#studies" />  
<Data type abbreviated IRI="xsd:string" />  
</Data Some Values From>  
</Sub Class Of>

These are the data properties of module class.

<Functional Object Property>  
<Object Property IRI="#teaches" />  
</Functional Object Property>  
It is a functional object property of teacher class.

<Object Property Domain> // define object property domain  
<Object Property IRI="#module" />  
<Data Some Values From>  
<Data Property IRI="#studies" />  
<Data type abbreviated

IRI="xsd:anyURI"/>

</Data Some Values From>

</Object Property Domain>

It is a domain object property and data property for module class.

<Object Property Range>

<Object Property IRI="#module"/>

<Data Some Values From>

<Data Property IRI="#studies"/> // describes the data property of studies

<Data type abbreviated IRI="xsd: string"/>

</Data Some Values From> //

</Object Property Range>

It is a range object property and data property for module class.

<Sub Data Property Of> // define sub data property

<Data Property IRI="#f\_name"/>

<Data Property IRI="#lecturer"/>

</Sub Data Property Of>

It is a sub data property for module class. for example : data property of f\_name for lecturer sub class

</Ontology>

### III. TRUSTABILITY / PROVENANCE

Security & privacy of data is must since users are depending upon the data available in the proposed system. In present scenario users has limited choice to access resources from various sources as Facebook, You Tube and Twitter etc. But problem is data received from above sources may or may not be reliable in following context:

- 1) Obtained data used in research work may prove to be wrong.
- 2) Users are unable to find out the modified data available in above resources.
- 3) Provenance chain is not available in terms of Date & time.
- 4) Difficult to find out root level author of recourses thereafter complete chain up to current edition. E.g. A is the author of Book consequently B, C, D has put up some modification. in this context due to non availability of Complete chain data is not reliable.

To procure trustworthiness provenance, it is needed to ensure that any suggested explication handles under mentioned facts smoothly [6]

- Integrity
- Availability
- Confidentiality

PROV data model [7] is a recommended standard of W3C. Which has published a set of documents to enforce provenance in all future data sets and thus data sources. The prescribed set of documents shall be a major source of information in our research.

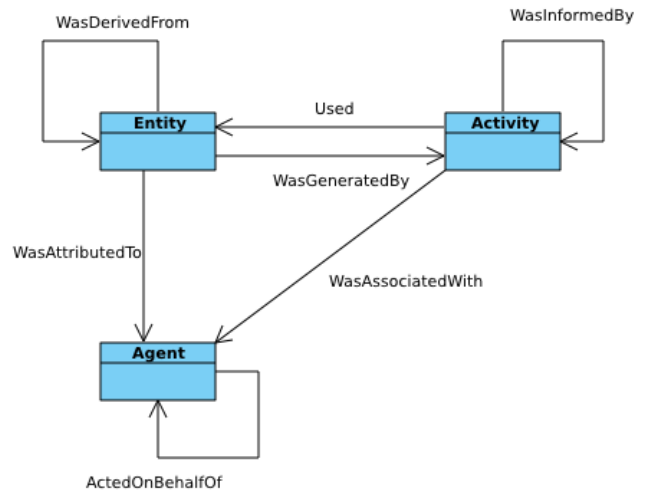


Figure 7: Role of Entity, Activity and Agent in Provenance

This paper explores and describes the provenance as *entities*. Entities may be Object like Course or module. "Things" denotes a notion's type, rather than digital objects such as web pages or files, Online Books, Module, offline books, and their abstract concepts & Ideas.

### IV. THE NEED & MODEL OF PROVENANCE

Provenance in context of E-Learning paradigm

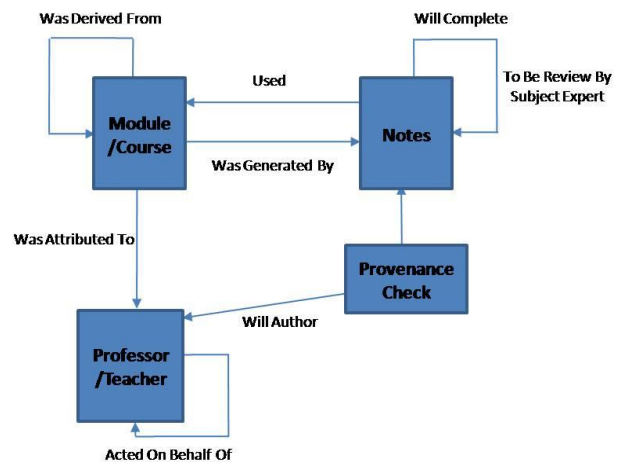


Figure 8: Define of Entity, Activity & Agent in provenance

Fig.8 Teacher is teaching Subject as Math and simultaneously that subject is taught by many teachers. Notes and module/courses are associated in two other ways: a note uses different courses and entities that will be produced by activities. Teacher who is act as an agent has responsibility to prepare notes and delivered with provenance. For the existence of an entity as Course or module, in this case teacher may represent as activity or entity. For example in deliver of the contents for monitoring the grammar used in a documents. Here an agent towards activity for the preparation of document; in this context the concept of provenance will also define, including as for source creator and the series of history.

Teacher can also be related to notes, course or module as well as other courses also. For example notes are the documents on the Web. If message send by twitter, extracting meta data in a file, grouping a data set which is based on statistical and analytical analysis on a data set, extracting query as per define criteria, and editing a file. There is association between Notes or Books and courses or module two ways: notes utilize courses or modules and notes produce courses. The way of tackling or producing courses may take times. When the act is completed it refers as term 'generation'. Similarly the way of utilizing courses or module refers the term as 'usage'. Hence, the concepts of generation and their usage are defined as following. The Generation is the conclusion of introduction of courses or modules and the activity which is producing the notes. The courses or module was not in existence before generation and after generation it is available for users. The use of that notes is the beginning of utilizing courses. Before usage, it is difficult to use the notes.

## V. AGENTS AND RESPONSIBILITY

### A. Attribution

When module or course id is attributed to Teacher as ag, module e was initiated by undesignated activity that mean it was associated to Teacher ag. Hence, these types of relation are meaningful when it is unknown about the activity as notes, or irrelevant.

- id: an *OPTIONAL* identifier for the relation;
- Module as entity: it is an entity identifier (e);
- Teacher: the identifier (ag) of the Teacher whom the course or module is ascribed to, and therefore possesses some responsibility for its existence;
- Attributes: an *OPTIONAL* set (attrs) imparting some other information for the attribution.

```
teacher(ex:Amit, [ prov:type='prov:Person' ])
teacher(ex:Rajiv, [ teacher:type='prov:Person' ])
module(tr:WD-prov
[ prov: type='rec54:WD' ])
```

```
Was Attributed To(tr:WD-prov-dm, ex:Amit,
[prov:type="producer ship" ])
```

```
Was Attributed To(tr:WD-prov-dm-20111215, ex:Rajiv,
[prov:type="Writer ship" ])
```

### B. Association

A notes or Books *association* is the task of responsibility to teachers for producing notes, indicates that a teacher had a role to produce modules or Books as activity. It further gives permission to teacher for the planning or achieve goals towards producing notes or Books as activity.

Associated With (id; a, ag, pl, attrs) in PROV-N, has denoted as An *association*.

- For an Notes or Books and teacher as an agent denotes id: an *OPTIONAL* identifier for the association;
- Books or notes as activity: an identifier (a) for the activity;

- Teacher as an agent: an *OPTIONAL* identifier (ag) for the teacher associated with the books or notes;
- plan: an *OPTIONAL* identifier (pl) for the teacher relied on in the matter of this activity as preparing notes or Books;
- attributes: an *OPTIONAL* set (attrs) depicting extra information for this association of the activity as producing Books or notes with this agent as teacher.

Trustability or trustworthiness of information produce:

- 1) Authenticity of the data.
- 2) Author or Source of the data.
- 3) Obtain the source of the data and data chain.
- 4) Data testing record.
- 5) Chain of modification.
- 6) Know the updation of Data as per new technology.
- 7) Return semantically structured knowledge representation

Data provenance describes the study and keeps record of the source creator of the item along with history. There are some resources where ownership and finding history of objects are big question for the trust point of view. In a view of extracting information, Provenance, know about history of ownership is required and called fundamental principal of archival [18, 19]. Provenance defines the path of ownership along with history of data objects. For example a person 'A' is the original creator of documents, processes thereof and forward it to person 'B', who is processed, modified something and forwards it to person 'C'. Now the provenance of the documents contain the complete details of chain as ('A', 'B', 'C') along with other information e.g detail of processes done in each steps operated upon documents

## VI. RESULT ANALYSIS

The methodology used is automatic tracing and Capture of provenance in the models. The aim of this paper to provide the solution to return data is semantic and trustable.

- 1) Obtain semantically structured documents that are scalable to other Semantic environments.
- 2) Extended E-Learning ontology to successfully map with the proposed E-Learning framework.
- 3) Validate the semantic E-Learning ontology by help of the reasoner thus ensuring the consistency of the dataset in use.
- 4) The semantic description of the E-Learning ontology will be rendered the trust ability aspect by effectively embedding the provenance metadata.
- 5) Thus it can represent a Chain A->B->C->D-> with all relevant details so that Users may easily found Complete details of Author A,B,C,D in terms Date of publication, modifications, any changes etc..

## VII. CONCLUSION AND FUTURE SCOPE

In this paper it is defined that provenance contains the original creator as source of data and also keep the details of various operations or processing done upon data. For future data quality and proposed ontology / semantic web is reliable and trustable. This is the fact until unless proper ownership history in each steps of a document which is maintained through secure provenances it cannot be proved reliable evidence. The proposed model will address most of the issues however some issues will always remain open for future metadata description research such as developing software agents which can extract the provenance, verify it and if needed reject the same for failing to be a valid and trustable document.

## ACKNOWLEDGMENTS

This paper is based on discussions and use of various e-learning models in which there is a big question mark on use of data obtained from designated cloud or portal. It is necessary to develop such kind of model which returns a reasonable meaningful data with a concept of provenance & trustability upon data.

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