

Role Of RDF In Distributed Learning Environment

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Abstract- In today's decentralized platform, the content on the current web is in the form of distributed presentations and the knowledge conveyed by these files is opaque to the computer. Through semantic web, content can be considered as the distributed information on the decentralized platform which will help in faster and efficient retrieval of required information. Resource description framework (RDF) assists semantic web in manipulation of logical pieces of meaning by a machine to useful ends[1]. This paper has threefold objective. Firstly, paper throws light on RDF along with its responsibilities and available formats. Secondly, paper concentrates on distributed learning environment and its association with RDF .Thirdly, paper highlights the role of uniform resource identifiers (URI's) in RDF and mapping of databases with RDF.

Keywords - RDF, XML, Semantic Web, URI, Distributed Learning Environment (DLE)

I. INTRODUCTION

Information on the web can be encoded with the help of many languages like XML, RDF etc. [1]. 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) [2]. XML is not suited for distributed, extensible information unless that XML looks a lot like RDF. RDF excels when every document is thought of as a part of the bigger picture, part of a huge graph of knowledge spread throughout the internet otherwise the information could be written simply on XML.

II. RDF MODEL

RDF stands for resource description framework. It is a general method to decompose knowledge into small pieces, with some rules about semantics or meaning of those pieces. The point is to have a method so simple that it can express any fact, and yet so structured that computer applications can do useful things with knowledge expressed in RDF. Earlier RDF was there to represent Metadata i.e. data about data. But it has evolved

now days and is used to represent two things. Both the information about and relations between things in the real world: people, places, concepts etc can be represented through RDF. This metadata i.e. data about data represented with the help of RDF can play the role of provenance information which will assist in the process of verifying the authenticity of the data.RDF is designed to represent knowledge in a distributed world which is its key difference from XML.

RDF model is used to breakdown knowledge into discrete pieces [2]. These discrete pieces are called triples or RDF statements. The complete database of information is represented with the help of RDF statements. Database means mostly relational databases i.e. Neat tables or hierarchies in XML. But everything cannot be packed neatly in tables.

Mostly, Real life situations are best described with the help of graphs. 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. Consider the information about companies and universities which can best described in graphical form as shown below in figure 1.

A fact represented with the help of directed edge as shown in figure 1 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) which forms the RDF triples as shown in figure 2 below.

Subject(Starting node of the edge)	Predicate (Label of the edge)	Object(End node of the edge)
All RDF Triples of the graph		

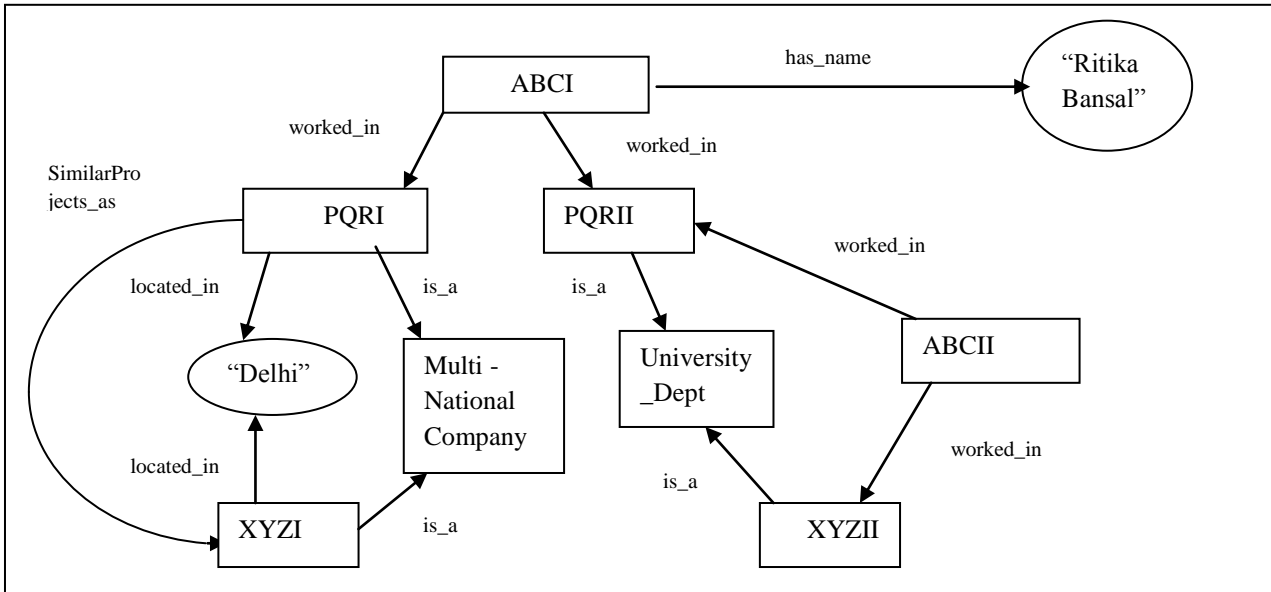


Figure 1: Knowledge as a graph

Information expressed either in tabular form or in graphical form is almost the same thing as tabular form can be generated from the graph easily. By considering one complete edge including both the end nodes as one complete row of a table as shown in figure 3.

Everything at all mentioned in RDF means something. It may be reference to something in the world, like a person or movie, or it may be an abstract concept like state of being friends with someone else.

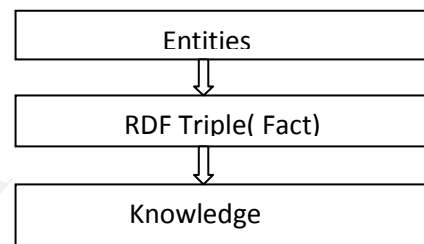


Figure 4: Working of RDF Model

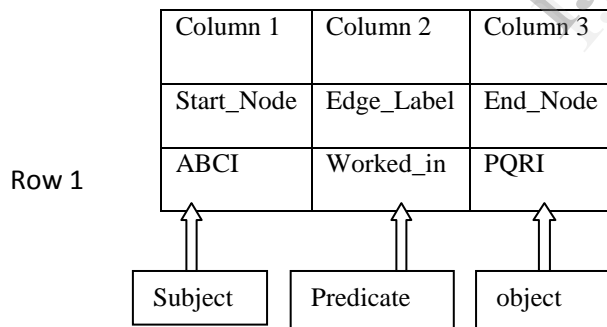


Figure 3: From Graphical to Tabular Form

By combining three related entities, fact can be developed. This fact is a RDF triple consisting of three main entities where first entity plays the role of a subject, second entity act as a predicate describing relation between the first and third entity and third entity act as an object as shown in figure 4 below.

III. RDF FORMATS

Triples are the core element of RDF. When RDF applications use RDF in any of the available formats, they see the triples. To represent the fact with the help of RDF, following two formats are mainly used[2]:

- 1) Notation3(N3) Format
- 2) RDF/XML Format

N3 format is not a W3C standard but it is widely used and deployed in e-mail discussions between semantic web developers. Its wide usage is due to its ability to capture the abstract graph and closely follows the tabular encoding of the underlying graph. Global identifiers are used to represent subject, predicate and object of all the RDF triples. These global identifiers are uniform resource identifiers (URI's) which resolve the problem of ambiguity when various RDF triples from different RDF files are accessed for useful information retrieval. This N3 format use the URI's in abbreviated form with the help of namespace. Extension of N3 format is NTriple format which uses full URI's, which are assembled from

the abbreviated notation i.e. N3. As RDF is the W3C standard on top of XML for encoding knowledge (metadata). So, another format for RDF which is also a W3C standard is RDF/XML format.

Mostly, applications use RDF/XML format as it is W3C standard and is based on XML. But due to the little complex syntax, it is not easy to capture the underlying graph and RDF triples clearly. So, converting RDF/XML to N3 or better yet N-Triples is a good way to get a clear view of what triples are encoded by the XML. As the main task is to understand the triples, the underlying graph and its relationships, RDF supports a tool known as RDF validator which can be used to convert RDF /XML format into a table of RDF triples[2]. This conversion tool can also be used for checking of RDF/XML syntax whether proper and accurate triples are formed or not. Both the formats use blank nodes to develop RDF triples. This is required due to the constraint that RDF Triples can express binary relationships only.

IV. RESEARCH ANALYSIS I: USING URI's in RDF FORMATS

As discussed in section III, Global identifiers are used to represent subject, predicate and object of all the RDF triples. These global identifiers are uniform resource identifiers (URI's). It is a string of characters used to identify a name or a resource over a distributed environment [3]. The use of URI's in RDF triples resolves the problem of ambiguity when various RDF triples from different RDF files distributed over the network are accessed for useful information retrieval. In RDF notations, URI's are usually abbreviated using the concept of Namespaces of XML. Namespaces have no significant status in RDF. They are merely a tool to abbreviate long URI's. These namespaces are generally declared at the top of RDF file and then used in abbreviated form later on.

N3 Format- Abbreviations of URI's are used
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>. @prefix ex: <http://www.example.org/>.
ex:ABCI ex:worked_in ex:PQRI. ex:PQRI rdf:is_a ex:Multi-NationalCompany.

Figure 5: Illustrating of N3 Format

In NTriple format which is similar to tabular form of the RDF Triple, use complete URI's instead of abbreviations.

This format gives the clear understanding of all the Triples in the information described in the graph.

NTriple Format(Tabular Form) - Full URI's are used
<http://www.example.org/ABCI> <http://www.example.org/worked_in > <http://www.example.org/PQRI>.
<http://www.example.org/PQRI> <http://www.w3.org/1999/02/22-rdf-syntax-ns#is_a> <http://www.example.org/Multi-NationalCompany>.

Figure 6: Illustrating of NTriple(Tabular) Format

RDF/XML Format – A W3C Standard
<rdf:RDF xmlns:rdf="http://www.w3.org/1999.02/22-rdf-syntax-ns#" xmlns:ex="http://www.example.org/">
<rdf:Description rdf:about="http://www.example.org/ABCI"> <ex:worked_in <ex:PQRI rdf:about="http://www.example.org/Multi-NationalCompany"/> </ex:worked_in> </rdf:Description>
<rdf:Description rdf:about="http://www.example.org/PQRI"> <ex:SimilarProjects_as rdf:resource="http://www.example.org/XYZI"/> </rdf:Description>
</rdf:RDF>

Figure 7: Illustrating of RDF/XML Format

V. RESEARCH ANALYSIS II: RDF's SUPPORT for BINARY RELATIONSHIPS

RDF supports binary relationship only. So, it is necessary to express many-way relations using intermediate nodes and these nodes are often anonymous. As mentioned in 3.0, both the formats supported by RDF i.e. N3 and RDF/XML format use blank nodes to fulfill the constraint of binary relationship. To express any relationship involving more than two entities, RDF use blank nodes to break that relation until it is easily expressed through binary relationships which is supported by RDF Triples. These blank nodes are also known as anonymous nodes which are used to represent more complex relations. These are the nodes in a graph without a name, either

because the author of the document does not know or does not want to or need to provide a name. These blank nodes in documents may be given “local” identifiers so that they may be referred to multiple times within a document. It is only that these local identifiers are explicitly not global, and have no meaning outside of the document in which they occur. These blank nodes are often considered as existentially bound variables.

Suppose following statement “ABCI worked in one of the university departments” states that there is some department of university which is not known. But this department must have some name so that it can be referred in the file in which it is used. To solve this problem, unknown department is given some local identifier called anonymous name so that it can be referred locally in the file in which it is used. The above statement can be divided into two statements expressing binary relationship with the help of blank node used to identify department locally.

- ABCI worked in Blank Node.
- Blank Node is a university department.

In RDF format, blank nodes (anonymous nodes) are expressed using unnamed namespaces (underscores) and some local identifier like anon123 as shown in figure 8.

Blank Nodes (Anonymous Nodes) : N3 Format	
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.	
@prefix ex: <http://www.example.org/>.	
ex:ABCI ex:worked_in _:anon123.	
_:anon123 rdf:is_a	ex:Multi-NationalCompany.

Figure 8: Blank Nodes in RDF/XML Format

VI. AUTHENTICITY of RDF TRIPLES

Along with the ability of providing meaningful data by doing semantic search, semantic web technologies such as RDF are also enabled with the feature which helps in providing trustworthy and authenticated data. This capability of RDF is possible as it is capable of storing provenance information through the process of Reification[4]. Information such as who is responsible for the data or how the data came to be is known as provenance information[5]. This information assists in the process of verifying the authenticity of the data.

Reification is an important RDF concept that provides the ability to make assertions about statements represented by RDF Triples. Reification enables the association of a level of trust and confidence with RDF Triples, thereby enabling the Ranking/Validation of the authenticity of the Triples.

VII. FLOWCHART REPRESENTING SEMANTIC INFORMATION RETRIEVAL

Queries in RDF application are also posted in RDF Triple format. The query part of the RDF triple is considered as a wild card in a program.

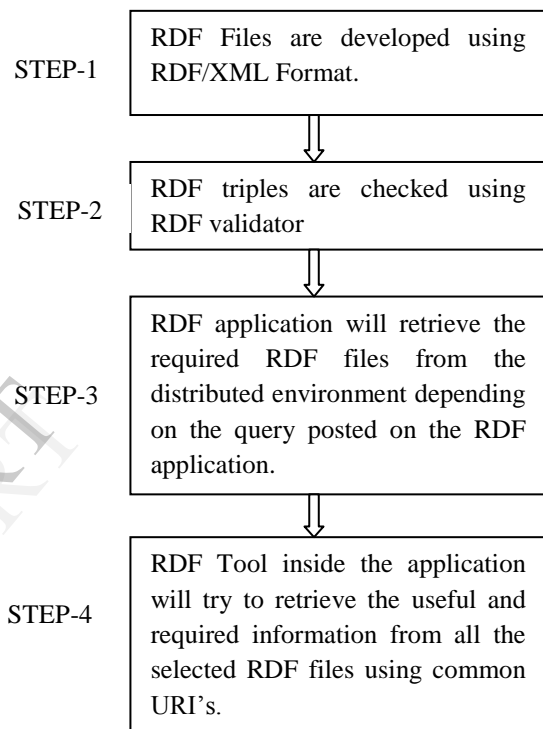


Figure 9: Flow diagram showing Steps for Semantic Information retrieval

VIII. INTEGRATING RELATIONAL SYSTEM with RDF

Stable technologies like relational systems can be integrated with semantic web technology like RDF. This new integrated system is called as R2D [2].

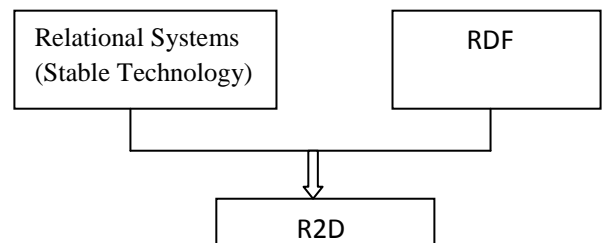


Figure 10: Integrating RDF and Relational System

IX. CONCLUSION

As RDF query is considered in Triple format, it means RDF query consists of only three parts i.e. subject, predicate or object. If any one of these three parts is not known, RDF query can be posted as shown in figure 11. Then RDF The missing part can be considered as a wild card in context of programming application will try to answer that query by analyzing all the retrieved RDF files having data in the form of RDF triple format i.e. expressing all the binary relationships.

RDF Query	<u>Wild card</u>	Predicate	Object
RDF Query	Subject	<u>Wild card</u>	Object
RDF Query	Subject	Predicate	<u>Wildcard</u>

Figure 11: Various forms of RDF query

The concept of using blank nodes to form RDF triples can also be used in forming RDF queries. Mostly data is available in the graphical form, RDF triples are formed from the graph using the one complete edge of the graph including both the nodes. Similar to the data, query can also be in complex form expressing many way relationships. Using blank nodes, query can be divided into binary relationships and triggered in the one of the forms shown in figure 11. When all the RDF queries expressing binary relationships are answered, then all these are combined to answer the main query triggered at the RDF application.

X. FUTURE WORK

Resource Description Framework (RDF), a domain-independent data model enables interoperability between applications that exchange machine-comprehensible information. Also, RDF's popularity as a semantic web technology and its capability can be merged with adaptive E-Learning as adaptive E-Learning is associated with semantic web. RDF is limited to express binary relationships. In future, it can be extended to support many way relationships.

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