ISSN No. 0976-5697

Volume 2, No. 4, July-August 2011

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

Enhancing Semantic web Image Search Precision Using Annotated RDF Model

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Abstract **-** Over the past decade the number of images being captured and shared has grown enormously with the advent of the Internet as a medium of sharing resources like images, audio, video, documents *etc*., the Web users made it a way to interchange the knowledge as well. This behavior of the Web users over the Internet phenomenally turned the WWW into a huge repository of unstructured data inducing a need of the standard based representation of the data over the Internet. This need made itself more demanding because the searching or extraction of the knowledge from the unorganized data was becoming impossible, giving rise to the concept of Semantic Web. The use of XML for representing the data made the situation at the rest in the meanwhile. But, only the syntactical exploitation of the data could not help the situation because the process like searching of the images on the Web demanded the inclusion of the supplement of semantic structures into the list of standards. The Resource Description Framework (RDF) standard, a base technology of the Semantic Web, appeared as an intuitive solution of this problem as it employs the concept of annotation to describe the images and keeps all pieces of information pertaining to the images in the RDF documents, making the search process semantic rather than the traditional. In this paper, the intent is to generate annotated RDF model for semantic retrieval of images using RDF editor for annotation. This RDF model is validated
through online W3C RDF validation service. SPARQL, RDF query engine, is used to query the validated RDF model to check the efficiency of image search.

Key words: Resource description framework, RDF triples, RDF specification, semantic web

I. INTRODUCTION

The Internet revolutionized the way in which our society disseminates and uses information. With the growth of multimedia the huge amount of images are increasing daily on the internet. A consequence of this popularity is an overload of information available on almost any topic which in turn has created several new problems for users. How to find required information from the vast ocean of information in such a short time has become the key constraint. In simple search user gets many irrelevant images and to retrieve the accurate images from the Web according to user query is a challenging task. To find the proper result from the web we have to enrich the annotation process as much as possible and move toward the semantic image search. In addition, it is also difficult to verify that the information or even the source of the information is truthful. To present more precise result to each user with different occupations, hobbies, and some other background profiles; there is a need to modify search method and involve some factors of user's background information. The ultimate goal is to enable computers to do more useful work and to develop systems that can support trusted interactions over the network.

A. Resource Description Framework (RDF)

The Resource Description Framework (RDF) [28] is a W3C recommendation that attempts to address XML's semantic limitations. It presents a simple model that can be used to represent any kind of data. This data model consists of nodes connected by labeled arcs, where the nodes represent Web resources and the arcs represent properties of these resources.

RDF Schema is a simple type modeling language for describing classes of resources and properties between them in the basic RDF model. It provides a simple reasoning framework for inferring types of resources.

The Semantic Web contains the standards and tools of XML, XML Schema, RDF, RDF Schema and OWL.

The Resource Description Framework (RDF) is a W3C standard for describing Web resources, such as the title, author, modification date, content, and copyright information of a Web page [8]. RDF is designed to be read and understood by computers and it is not designed for being displayed to people. It is written in XML and it is a part of the W3C's Semantic Web Activity.

Resource Description Framework Define metadata vocabularies and use them to make statements. Resource can be anything identifiable with a URI, Description is a statement about properties of resources and Framework means a common model for statements using diverse vocabularies. RDF is a model and XML syntax for representing information in a way that allows programs to understand the intended meaning. It's built on the concept of a statement, a triple of the form {predicate, subject, and object}. The analysis of a triple is that <subject> has a property <predicate> whose value is <object>. In RDF a <subject> is always a resource named by a URI with an optional anchor id, <predicate> is a property of the resource,

and the <object> is the value of the property for the resource [9]. Consider the following triples (figure 1):

{dc: Publisher, http://www.w3.org, "World Wide Web Consortium"}
{dc: Title, http://www.w3.org, "W3C Home Page"}

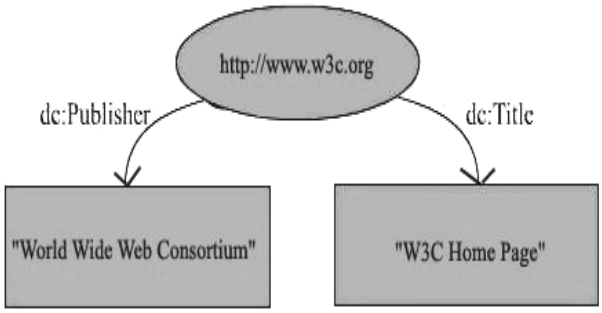


Figure .1 RDF triples

B. Role of Annotations in Semantic Web

The process of associating metadata with resources (audio, video, structured text, unstructured text, web pages, images etc) is called annotation and semantic annotation is the process of annotating resources with semantic metadata. Semantic annotations can be coarsely classified as being formal or informal. Formal semantic annotations, unlike informal semantic annotations follow representation mechanisms, drawing on conceptual models represented using well-defined knowledge representation languages. Such machine process able formal annotations on web resources can result in vastly improved and automated search capabilities, unambiguous resource discoveries, information analytics etc. The annotation of Web based resources like text files or digital content is very different from the annotation of Web services [11].

Semantic Annotation moves one level deeper:

a. It enriches the unstructured or semi-structured data with a context that is further linked to the structured knowledge of a domain.
b. It allows results that are not explicitly linked to the original search. So, if tagging is about promptly finding the most relevant result, semantic annotation adds diversity and richness to the process [12].

II. RESOURCE DESCRIPTION FRAMEWORK (RDF)

The Resource Description Framework (RDF) is an extremely flexible technology, capable of addressing a wide variety of problems as it is a language designed to support the Semantic Web, in much the same way that HTML is the language that helped initiate the original Web. RDF is a framework for supporting resource description, or metadata (data about data), for the Web and it provides common structures that can be used for interoperable XML data exchange. As a result of many communities coming jointly and approving on basic principles of metadata representation and transport, RDF has drawn influence from several different sources. The main influence have arrived from the Web standardization community itself in the form of HTML metadata and PICS, the library community, the structured document community in the form of SGML and more importantly XML, and also the knowledge representation (KR) community. There are also other areas of technology that contributed to the its design; these include object oriented programming and modeling languages, as well as databases. Although RDF draws from the KR community, it does not specify a mechanism for reasoning [19].

A. RDF Triples

A simple model for "statements"
Subject: what the statement is about
Predicate: a property of the subject
Object: the value of the property
A natural way to describe the vast majority of the data processed by machines.
In figure 2, the subject is http://doc, predicate is dc:creater and the object is
Joe Smith.

Figure .2 A simple RDF assertion

RDF is a general method to decompose information into pieces. The emphasis is on general here because the same method can be used for any type of information. In
RDF information is expressed as a list of statements in the form SUBJECT, PREDICATE, OBJECT. The subject and object are names for two things in the world, and the predicate is the name of a relation between the two. In short, predicates can be considered as verbs.

B. RDF Specifications

The broad goal of RDF is to define a mechanism for describing resources that makes no assumptions about a particular application domain, nor defines (a priori) the semantics of any application domain [21].The RDF updated specification released six new documents: RDF Concepts and Abstract Syntax, RDF Semantics, RDF/XML Syntax Specification, RDF Vocabulary Description Language 1.0: RDF Schema, the RDF Primer, and the RDF Test Cases. The RDF Concepts and Abstract Syntax and the RDF Semantics documents provide the fundamental framework behind RDF: the underlying assumptions and structures that makes RDF unique from other metadata models (such as the relational data model). These documents provide both validity and consistency to RDF - a way of verifying that data structured in a certain way will always be compatible with other data using the same structures. The RDF model exists independent of any representation of RDF, including RDF/XML [20].

C. Basic RDF Model

RDF is model and XML syntax for representing information in a way that allows programs to understand the intended meaning. It represents information about resources on the Web, i.e., metadata about resources. A resource in RDF is mapped to a Uniform Resource Identifier (URI) and is described in terms of its properties. The purpose is to make statements about resources, which can be viewed as labeled edge (property) between two nodes (object and property value).The foundation of RDF is a model for representing named properties and property values. Its properties may be thought of as attributes of resources hence correspond to traditional attribute-value pairs. Its properties represent relationships between resources and an RDF model can therefore resemble an entity-relationship diagram. In object-oriented design terminology, resources

correspond to objects and properties correspond to instance variables [22].

The RDF data model is a syntax-neutral way of representing RDF expressions. Two RDF expressions are equivalent if and only if their data model representations are the same. The basic data model consists of three object types:

a. Resource

All things being described by RDF expressions are called resources. A resource may be an entire Web page; such as the HTML document "http://www.w3.org/Overview.html" for example. A resource may be a part of a Web page; e.g. a specific HTML or XML element within the document source. A resource may also be a whole collection of pages; e.g. an entire Web site.

b. Property

A property is a specific aspect, characteristic, attribute, or relation used to describe a resource. Each property has a specific meaning, defines its permitted values, the types of resources it can describe, and its relationship with other properties. This object type does not address how the characteristics of properties are expressed.

c. Statement

A specific resource together with a named property plus the value of that property for that resource is an RDF statement. As mentioned earlier, these three individual parts of a statement are called, the subject, the predicate, and the object respectively.

Example:

In RDF resources are identified by a resource identifier. A resource identifier is a URI plus an optional anchor id. Consider as a simple example the sentence: Ora Lassila is the creator of the resource http://www.w3.org/Home/Lassila.
{Creator, http://www.w3.org/Home/Lassila, Ora Lassila}
This sentence has the following parts:

Table.I RDF Frmat [19]

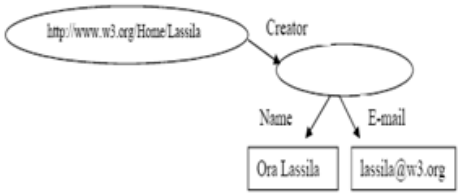
Subject (Resource)	http://www.w3.org/Home/Lassila
Predicate (Property)	Creator
Object (literal)	"Ora Lassila"

Figure 3 shows the diagram of this RDF statement using directed labeled graphs (also called "nodes and arcs diagrams"). In this diagram, the nodes (drawn as ovals) represent resources and arcs represent named properties. Nodes that represent string literals are drawn as rectangles.

Figure.3 Simple node and arc diagram [19]

Thus, such a sentence would be: The individual whose name is Ora Lassila, email<lassila@w3.org> is the creator of http://www.w3.org/Home/Lassila.

The intention of this sentence is to make the value of the Creator property a structured entity. In RDF such an entity is represented as another resource. The sentence above does not give a name to that resource; it is anonymous, so in the diagram below we represent it with an empty oval:



Figur.4 property and structured value [19]

RDF general format:

```
<? xml version="1.0"?>
<Class rdf:ID="Resource"
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns="uri">
<property>value</property>
<property>value</property>
</Class>
```

D. Advantages of using RDF:

a. The RDF format, if widely used, will help to make XML more interoperable:
   Tools can instantly characterize the structure, "this element is a type (class), and here are its properties".
   RDF promotes the use of standardized vocabularies, standardized types (classes) and standardized properties.
b. The RDF format gives a structured approach to design XML documents. The RDF format is a regular, recurring pattern.
c. It enables quick identification of weaknesses and inconsistencies of non-RDF compliant XML designs, providing better understanding of the data.
d. RDFS gives the benefits of both worlds:
   Standard XML editors and validations to create, edit, and validate XML file.

Use the RDF tools to apply inferencing to the data.

e. It positions the data for the Semantic Web.

III. ANNOTATING IMAGES USING RDF

Images are not structured documents like text information; at the same time, the current mechanism is too rigid to make some modification and always ineffectively use information provided by users except keywords. Before the emergence of the RDF, the keywords for the image search were based on the filename of the image, the link text pointing to the image, and text adjacent to the image. To enhance and optimize search results, RDF standard is used now to describe the image resource with attributes as its weight for such content descriptive phrase, which would help user in providing new content description to images by adding new self-defined tags into resource description.Consider images of cars with all the possible specifications i.e. brand, model, color, wheelbase, kerbweight *etc*. If user's query is for car of brand 'Honda' or 'Maruti, all the images of car will be displayed, irrespective of the brand mentioned by the user.

A simple RDF for figure 5 (a)

```
<? xml version="1.0"?>
```

<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:car="http://www.flickr.com/search/?q=honda+city+car#">
<rdf:Description
rdf:about="http://www.flickr.com/photos/marcusvieira/3839909947/">
<car: brand>Honda</car: brand>
</rdf: Description>
</rdf: RDF>

When the user searches Honda City car with 'red' color and/or wheelbase=2300

And/or kerbweight=1350, the search engine will not be able to provide the desired result as there is no annotation for these attributes in the above RDF; instead, the information returned is of all 'Honda' cars regardless of its 'color', 'wheelbase' and 'kerbweight'.

To make the image retrieval more accurate and precise and to make machine more understandable RDF document are augmented with self defined tags. The image annotation process will be improved by using such tags. In RDF document, we can give as much as possible information about any image.

Examples:

(a) Honda City 'red' Car (b) Maruti Suzuki SX4 White Car

Figure.5 Cars Images with different brand, model and color

Resource description framework for Figure 5(a) with semantic annotations

<? xml version="1.0"?>
<rdf: RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:car="http://www.flickr.com/search/?q=honda+city+car#">
<rdf: Description
rdf:about="http://www.flickr.com/photos/marcusvieira/3839909947/">
<car: brand>Honda</car: brand>
<car: model>Honda City</car: model>
<car: color>red</car: color>
<car: wheelbase>2300</car: wheelbase>
<car: kerbweight>1350</car: kerbweight>
<car: weight>10</car: weight>
</rdf: Description>
</rdf: RDF>

Resource description framework for Figure 5(b) with semantic

<? xml version="1.0"?>
<rdf: RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:car="http://www.flickr.com/search/?q=maruti Suzuki+sx4+car#">
<rdf: Description rdf: about="http://www.flickr.com/photos/labeebxaman/2528477801/">
<car: brand>Maruti Suzuki</car: brand>
<car: model>SX4</car: model>
<car: color>white</car: color>
<car: wheelbase>2250</car: wheelbase>
<car: Kerbweight>1100</car:kerbweight>
<car: weight>9</car:weight>
</rdf: Description>
</rdf:RDF>

When user searches Honda City 'red' car or car with wheelbase=2300 or kerbweight= 1350, the search engine will make inference based on the corresponding RDF document and finally provide the set of images (given in figure 5(a)) fulfilling the user demand. Similarly, when the user searches Maruti Suzuki SX4 white car with wheelbase=2250 and kerbweight=1100, the search engine will make inference based on the respective RDF document and finally provide the desired image (given in figure5 (b)). Hence, by creating the RDF document for any image or resource and providing maximum content description to that image or resource, we have enhanced the searching process and the images retrieved are more semantic in comparison to traditional search.

Second enhancement proposed in this thesis for semantic retrieval is to add weight tag in RDF document. As the number of users of any image increases, the weight corresponding to the searched keyword will increase and therefore increasing the ranking of that image with respect to that searched keyword. By injecting the Web 2.0 features we can obtain more semantic image content description in the following ways:

The third idea [23] proposed for increasing the semantic image search is to add category tag which can further increase the accuracy and precision of search. While performing search operation, the user's background information is added in the related RDF document as additional semantic information for keywords to overcome from the situation where that keyword has several various meaning in different contexts.

To present more precise result to the users with different occupations, hobbies, and some other background profiles, we need to modify ranking algorithm for accommodating the factor of user interaction in order to present individual ranked result for various individuals even they use the same keyword to perform search operation. New evaluation method is:

For each image, except content description, add category description:

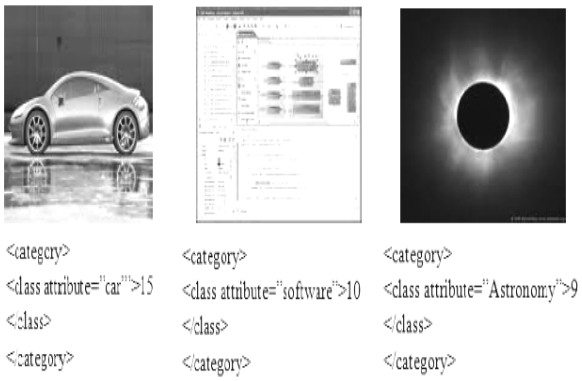


Figure .6 Image search result for eclipse keyword RDF for adding category tag

<category>
<class attribute=' '>weight</class>

…
<class attribute=' '>weight</class>
</category>
<class> tag's attribute corresponds to users' background info description terms like occupation: 'software engineer', hobby: 'cars', 'astronomy', *etc*.

Figure.6 shows the example of using user background information for describing the category of images. As some people searching for images of cars would probably choose the first image. As soon as, the car fans choose the first image as the result for the search after keyword of 'eclipse', this image would add value car to the attribute '*attribute*' of <class> tag to the category description section and with other car fans 'confirmations, the value of weight for <class> tag will be increased for that particular value of '*attribute*' attribute. The similar procedure will be followed in case of software and astronomy.

Rank Grade = Class Weight + keyword Weight

The Rank Grade will decide the search result of images. If one image has highest Rank Grade, it will come on the top level of the result and other images with the lowest Rank Grade will come in the last page. The Rank Grade totally depends upon appropriate semantic annotation of images and semantically searches of those images.

IV. TOOLS AND BROWSERS

The following tools have been used in solving the problem stated in problem
statement section.

A. RDF Editor

RDF Editor is used to write and edit RDF documents. It generates and saves N-Triple reports on any platform.
RDF Editor Interface:
Available Menus

File Menu

File -> New - Creates a New RDF File.
File -> Open - Opens a current existing RDF File.
File -> Save - Saves the currently open RDF File.
File -> Save Report - Saves the report that you have generated. (Report area is the text area in the bottom half. Whatever you see there will be saved).
File -> Exit - Exit the application.

Edit Menu

Edit -> Copy All - Copy the whole RDF document that is currently open and put it in clipboard.
Edit -> Undo - 1-level down implementation of undo. If someone accidentally add or remove any component from the file, you can use undo to undo the previous action. Pressing undo twice will bring back the change done.

Tools Menu

Tools -> Generate N-Triple report - Generate N-Triple report from the currently open RDF file and show it in the Report area (bottom half).

B. Twinkle: Sparql Tools

Twinkle is a simple GUI interface that wraps the ARQ SPARQL query engine. The tool should be useful both for people wanting to learn the SPARQL query language, as well as those doing Semantic Web development.

Features:

Load, edit and save SPARQL queries.
Insert PREFIX statements into queries.
Configure custom namespaces so they can be quickly inserted into queries.
Cancel long running queries.
Save results to file.

Query local files and remote RDF documents. Query RDF data held in relational databases. Query online SPARQL endpoints, such as DBpedia, reyvu.com and GovTrack.Query using standard SPARQL, or the ARQ extended syntax which supports COUNT, etc. Use ARQ extension functions and property functions. Apply inferencing (e.g. Jena rules, RDF Schema, OWL ontology) when running queries.Configure commonly used data sources for quick access.

V. RESULTS AND DISCUSSION

A. RDF document creation

RDF Editor is used to make the RDF document for cars image repository. Self defined tags are used to annotate the images. Figure.7 shows RDF document created using RDF Editor.

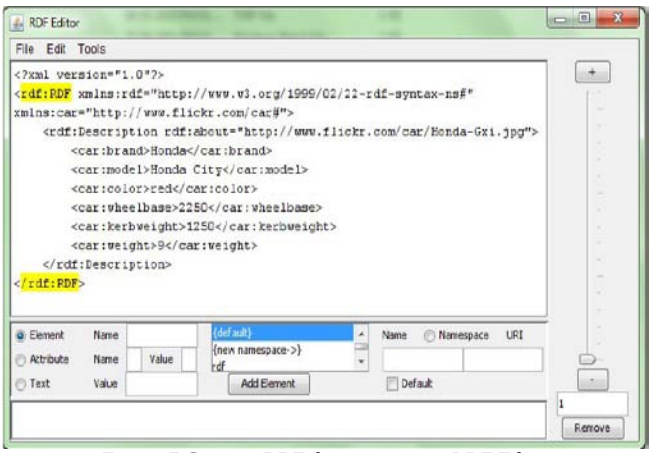


Figure .7 Creating RDF document using RDF Editor

The RDF document has been validated through online W3C RDF validation Service. This validation process generates the triples (subject, predicate, and object) for the RDF document (Data Model). The validation process is shown in figure.8

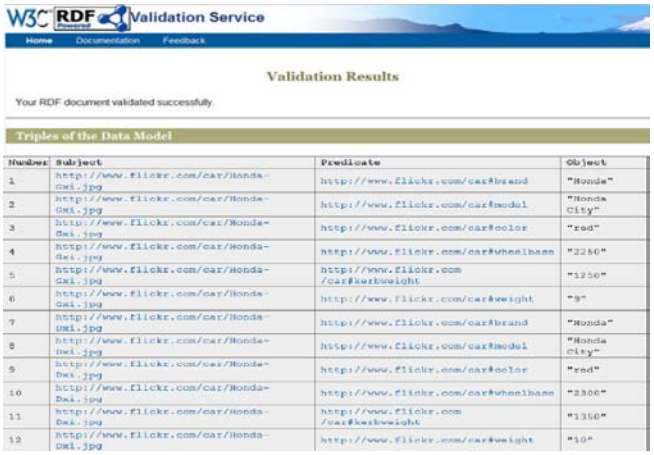


Figure.8 Validation of RDF using W3C RDF Validation Service

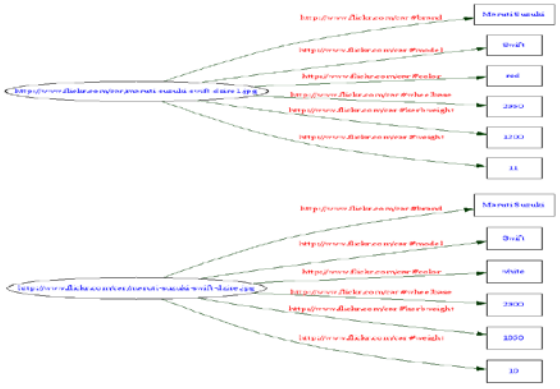


Figure.9 shows the graph predicate and object (triples) generated for our data model showing the subject, predicate and object of few entities of RDF document.

V. QUERY RESULTS

SPARQL tool is used to query the RDF document from different perspectives. The SPARQL, a RDF Query Language, has been used to write queries.

A. Query 1

Query 1 (as shown in figure 5.4) retrieves all the information for concept cars from the RDF document generated in figure 10 Results are generated in the form of triples
(path, attribute, value).

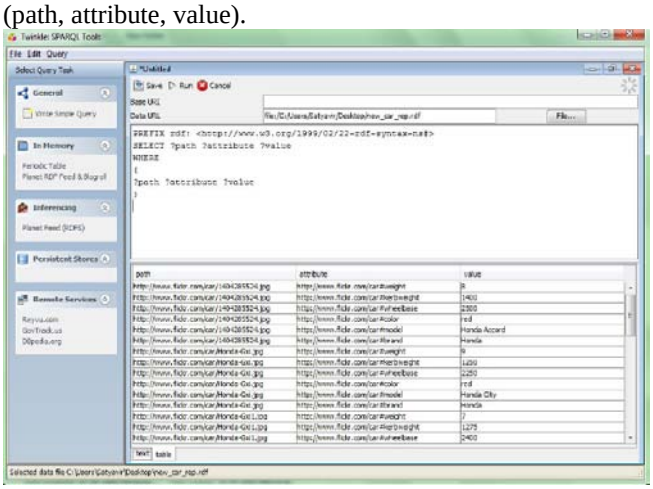


Figure.10 Query and output for all type of cars

B. Query 2

Figure 11 shows output for query on “cars with model name ‘Honda’, color ‘red’ and kerbweight = 1250 kg.

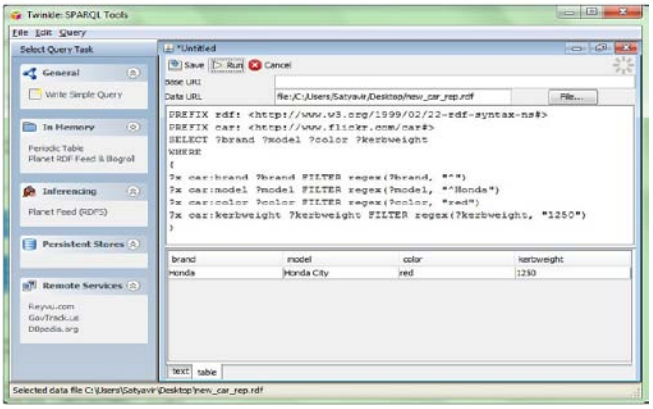


Figure .11 Query and output for cars of ‘Honda’ brand, color is ‘red’ and Kerbweight=1250 kg.

VI. CONCLUSION

This survey work concludes that the RDF is a very powerful tool to annotate images and create data models for the repositories of the different types of resources. The predefined tags used in RDF capture all the targeted information about the resources (images in our case) and put ahead a way to make all the searches over the defined repository more relevant and accurate. The SPARQL, a query language as well as a data access protocol, armed with all features that any general purpose query language can possess solves the purpose of making RDF a true machine understandable language. It has been confirmed that the query results exactly match with what the user desires.

Both, the RDF and the SPARQL combined together can serve as a platform to fulfill the vision of Semantic Web, as proposed by Tin Berners Lee. As the amount of images are growing exponentially on the WWW, using self defined tags and annotations will always increase the efficiency and precsion of image retrieval.

There is scope for extending this work is on the following aspects:

The RDF document of car repository can be modified by adding new tags to it which can bring additional information to data model of cars and therefore enhancing the users’ capability to search more meaningful contents or making a way to enhanced semantic search over the Internet. More profound SPARQL queries can be written in order to provide other related contents (those contents which are semantically linked to the exact content) to the users in response to their search on the Internet.

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