A Novel Approach for Accurate Retrieval of Video using Semantic Annotations

Thesis submitted in partial fulfillment of the requirements for the award of degree of

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Certificate

I hereby certify that the work which is being presented in the thesis entitled, "***A Novel Approach for Accurate Retrieval of Video using Semantic Annotations***", in partial fulfillment of the requirements for the award of degree of Master of Engineering in *Computer Science and Engineering* submitted in Computer Science and Engineering Department of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of *Mr. Vinod Kumar Bhalla* and refers other researcher's work which are duly listed in the reference section.

The matter presented in the thesis has not been submitted for award of any other degree of this or any other University.

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This is to certify that the above statement made by the candidate is correct and true to the best of my knowledge.

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Priyansh Arora

Abstract

The proliferation of Internet has lead to an exponential growth of multimedia content on web. Web contains huge amount of unstructured data, searching for accurate and relevant information is a cumbersome task. Relevant results cannot be fetched from the search engines because they are performing syntactical search for data retrieval. To fetch data efficiently as per the user's query, semantic search is required. There is a need for a standard way of representing and exchanging information over the internet. In semantic web, data is represented in standard languages like RDF and OWL and linked to the commonly accepted ontologies.

As Resource Description Framework (RDF) store the meta information about the data in the form of subject, predicate and object thus, RDF appears to be intuitive solution for making retrieval of videos from web semantic. Semantic annotation of videos increases the efficiency of semantic search by associating the metadata to the resources.

In this thesis, the intent is to generate annotated RDF repository of videos for making semantic retrieval using RDF editor. 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 video search. Ranking of videos has been proposed on the basis of views of a video and rank of pages which have embed video in their web pages; which has been calculated using random web surfer Page rank algorithm.

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Chapter 1
Introduction

The increase in popularity of internet has lead to an exponential growth of multimedia content on web, which in turn has created a problem for users to effectively search vast ocean of data in short time. Due to overload of unstructured information it has become increasingly difficult to find relevant information or to verify the origin of information. In addition, it is difficult to verify that the information, or even the source of the information, is trustworthy.

With the growth of multimedia the huge amount of videos are increasing daily on the Internet. In simple search user gets many irrelevant videos and to retrieve the accurate video from the Web according to user query is a challenging task. There is an increasing demand for semantic retrieval of videos which can be achieved by semantically annotating the information captured in them. Annotating multimedia will not only help users in querying and managing digital repository but also enable applications to automatically exchange, store and reason with the data.

1.1 Semantic Web

Semantic Web is an extension of the existing Web in which information is given a well-defined meaning. The Semantic Web is based on a vision of having data on the Web defined and linked in a way such that it can be used by machines not just for visual display purposes, but for automation, integration and reuse of data across various applications [1].Semantic Web is about making a common format for combining data coming from heterogeneous sources. Semantic web means adding meaning to content of document on the Web and hence creating a universal medium for information exchange. The main idea is to create metadata to describe content of data on web, enabling machines to interpret the meaning. Its vision of create new architecture for the World Wide Web, characterized by the association of machine-accessible formal semantics with more traditional Web content.

The ultimate goal of the Semantic Web is to transform the Web into a medium through which data can be shared, understood and processed by automated tools [2][3]. The Semantic Web extends the Web through the use of standards, markup languages and related processing tools. Semantic Web technologies enable people to create data stores on the Web, build vocabularies, and write rules for handling data. Linked data are empowered by technologies such as RDF, SPARQL, and OWL.

The vision of the Semantic Web is an extension of the existing Web through which machines will be able to interoperate and work on our behalf. It promises to infuse the Internet with a combination of metadata, structure, and various technologies so that machines can derive meaning from information, make more intelligent choices, and complete tasks with reduced human intervention. Semantic web vision is oriented toward machine-readable resources rather than human-readable. It requires resource description so that machines can infer meaning [4]. The document should contain Meta information and vocabularies for the meta information, like Resource Description Framework Schema (RDFS) would be required for the realization of this idea.

Currently, the World Wide Web consists of documents written in HTML. This makes the Web readable for humans, HTML has limited ability to classify the blocks of text apart from the roles played by them, and in current form World Wide Web is very hard to understand. The explosion in both the range and quantity of web content has, however, highlighted some serious shortcomings in the hypertext paradigm [5].The purpose of the Semantic Web is to add a layer of descriptive technologies to Web pages so that become readable. The Semantic Web is implemented in the layers of Web technologies and standards.

1.1.1 Structure of Semantic Web

The Semantic Web is implemented in the layers of Web technologies and standards. The layers are presented in Figure 1.1 and described as follows:

- The Unicode and Uniform Resource Identifier (URI) layers ascertain that international characters sets are used and thus provide means for identifying the objects in the Semantic Web, respectively. The most popular URI's on the World Wide Web are Uniform Resource Locaters (URLs).
- The XML layer with namespace and schema definitions make sure the Semantic Web definitions can integrate with the other XML based standards. XML provides a surface syntax for structured documents, but imposes no semantic constraints on the meaning of these documents. XML Schema is a language for restricting the structure of XML documents [6].XML Schemas provide greater flexibility in the

definition of an XML application, even allowing the definition of complex data types. Furthermore, XML Schemas use the same syntactic style as other XML documents. However, XML Schema only gives XML an advanced grammar specification and data typing capability.

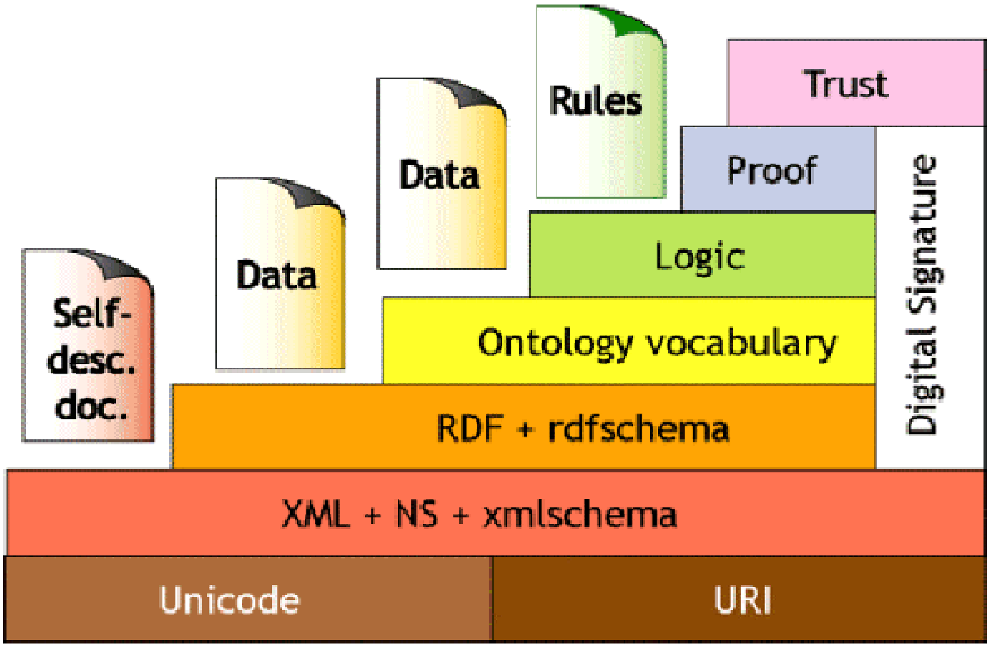

Figure 1.1: Berners-Lee's Semantic Web Architecture [7].

- The Resource Description Framework (RDF) [8] 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 ontology layer supports the evolution of vocabularies as it can define relations between the different concepts. In this layer knowledge is expressed as descriptive statements, stating some relationship exists between one thing and another.
- A digital signature is an electronic signature that can be used to authenticate the identity of the sender of a message or the signer of a document. The Digital

Signature layer ensures that the original content of the message or document is unaltered.

- The top layers Logic, Proof and Trust, are currently being researched and simple application demonstrations are being constructed. The Logic layer enables the writing of rules while the Proof layer executes the rules and evaluates together with the Trust layer mechanism for applications whether to trust the given proof or not.

1.2 Resource Description Framework (RDF)

RDF is a standard model given by W3C for conceptual description or modeling of information that is implemented in web resources. It uses variety of syntax notations and data serialization formats for data exchange. RDF is a graphical language used for representing information about resources on the web. It is a basic ontology language. Resources are described in terms of properties and property values using RDF statements. Statements are represented as triples, consisting of a subject, predicate and object. The World Wide Web was originally built for human consumption, everything on it was machine-readable, but was not machine-understandable. Web contains large volume of data and because of this it is very hard to manage it manually. The solution is to use metadata means “data about data” to describe the data contained on the Web. The distinction between "data" and "metadata" is not an absolute one; it is a distinction created by a particular application, and many times the same resource will be interpreted in both ways simultaneously.

RDF and its schema language Resource Description Framework Schema (RDFS) were proposed by the World Wide Web Consortium to overcome the semantic limitations of XML. Resource Description Framework (RDF) provides interoperability between applications that exchange machine-understandable information on the Web. RDF emphasizes facilities to enable automated processing of Web resources.

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 interpretation 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 1.2):

{feature:size, http://www.myntra.com/clothes#t-shirt,“40”}

{feature:price, http://www.myntra.com/clothes#t-shirt,“Rs1200” }

{feature:brand, http://www.myntra.com/clothes#t-shirt,“adidas” }

{feature:color,http://www.myntra.com/clothes#t-shirt,“http://www.myntra.com/colors#white”}

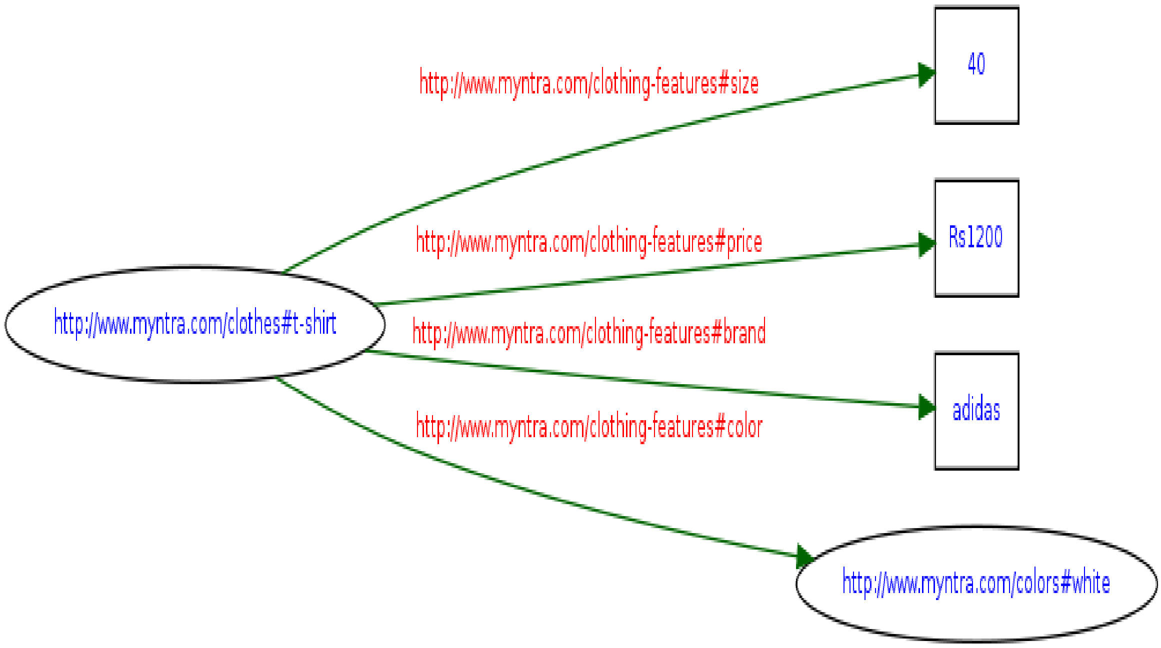

Figure 1.2: RDF triples

The subject has a property with name **feature:size** which has the literal value 40, **feature:brand** which has the literal value adidas, **feature:price** which has the literal value Rs1200. The subject has a property with name **feature:color** with object referring to the statement with ID **http://www.myntra.com/colors#white,** thus objects in RDF can refer the subjects of other statements.

1.2.1 RDF syntax

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:feature="http://www.myntra.com/clothing-features#">
<rdf:Description rdf:about="http://www.myntra.com/clothes#t-shirt">
<feature:size>40</feature:size>
<feature:price>Rs1200</feature:price>
```

<feature:brand>adidas</feature:brand>

<feature:color rdf:resource="http://www.myntra.com/colors#white"/>

</rdf:Description>

</rdf:RDF>

The first line of the RDF document is an XML declaration. The XML declaration is followed by the root element of RDF documents :<rdf:RDF>. The xmlns:rdf namespace specifies that elements with the rdf prefix are from the namespace "http://www.w3.org/1999/02/22-rdf-syntax-ns#".

The xmlns:feature namespace specifies that elements with cd prefix are from the namespace“http://www.myntra.com/clothing-features#".The<rdf:Description> element contains the description of the resource identified by the rdf:about attribute. The elements:<feature:size>,<feature:price>,<feature:brand> <feature:color> are properties of the resource. RDF has the following features [10]:

- **Reification:** An important feature of RDF is its representation of a collection of resources. In addition to making assertions about resources, RDF can be used to make assertions about other RDF statements. This means that an RDF statement can be used in place of an object or property value in an RDF triple, which is known as reification.
- **Collection of Resources:** For representing a list of resources, RDF uses the type “Container” and reified statements are represented using the type “Statement”. A Container object is used to represent a collection of resources in RDF.

The three different types of container objects defined by the RDF specification are Bag, Sequence and Alternative. A Bag represents an unordered list of resources or literals; a Sequence represents an ordered list of resources or literals. Unlike the Bag container type, the order of resources or literals is important. Both Bag and Sequence are not sets, i.e., duplicate values are permitted in both container types.

1.3 Role of Annotations in Semantic Web

Meaningful use of any data requires knowledge about its organization and content. Contextual information that establishes relationships between the data and the real world aspects it applies to is called metadata. In other words, metadata is data that describes information about a piece of data, thereby creating a context in terms of the content and functionality of that data. Domain conceptualizations, ontologies or world models provide agreed upon and unambiguous models for capturing data and metadata to which applications, data providers and consumers can refer. Broadly speaking, there are two kinds of metadata - structural and syntactic metadata [11]. Structural metadata provides information about the organization and structure of some data, e.g. format of the document. Semantic metadata on the other hand, provides information 'about' the data for example the meaning or what the data is about and the available semantic relationships from a domain model in which the data is defined. The key aspect behind the realization of the Semantic Web vision is the provision of metadata and the association of metadata with web resources.

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 processable 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].

Annotation is about attaching names, attributes, comments, descriptions, etc. to a document or to a selected part in a text. It provides additional information (metadata) about an existing piece of data. Tagging is a sequence of characters used to provide some basic information to a document or images. Compared to tagging, annotation speeds up searching and helps you find relevant and precise information;
Semantic Annotation goes one level deeper: It enriches the unstructured or semi-structured data with a context that is further linked to the structured knowledge of a domain. It allows results that are not explicitly related 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].

Thus an annotation is a form of meta-data attached to a particular section of document content. The section may be a single word, a sentence or even a series of paragraphs. An annotation must have a type (or a name) which is used to create classes of similar annotations, usually linked together by their semantics.

Semantic Annotation helps to bridge the ambiguity of the natural language when expressing notions and their computational representation in a formal language. By telling a computer how data items are related and how these relations can be evaluated automatically, it becomes possible to process complex filter and search operations.

1.4 Semantic Annotation of Videos

In general, manual annotation can provide video descriptions at the right level of abstraction. It is, however, time consuming and thus expensive. In addition, it proves to be highly subjective: different human annotators tend to "see" different things in the same image. On the other hand, annotation based on automatic feature extraction is relatively fast and cheap, and can be more systematic.

In the process of video annotation, we may find values for attributes or relationships that are not previously present in the knowledge base. The process of enhancing the existing metadata could be as simple as entering values for attributes; in that case they could be automated. Moreover this process could be as complex as modifying the underlying schema, in that case some user involvement might be required [11].

To annotate the videos, RDF data model can be used. It is based upon the idea of making statements about Web resources in the form of subject-predicate-object expressions, called triples in RDF terminology. This mechanism for describing resources is a major component in what is proposed by the W3C's Semantic Web activity: an evolutionary stage of the World Wide Web in which automated software can store, exchange, and use machine-readable information distributed throughout the Web, in turn enabling users to deal with the information with greater efficiency and certainty. RDF's simple data model and ability to model disparate, abstract concepts has also led to its increasing use in knowledge management applications unrelated to Semantic Web activity [12].

To extract content information by pattern recognition technology of each frame would be a cost way to get semantic information of one frame as it requires complicated and optimized algorithm to realize it. For Example-If a video is of 120 minutes, it can contain around 7000 frames and performing pattern recognition of them is a very complex task. To solve these challenges, RDF documents can be used as one of the alternates for storage of video content because:

RDF supports self-defined tags that allows user to setup new defined semantic description tags and make further modification. RDF as a mechanism for resource description would contribute to the semantic inference based on the ontology theory. Its resource/property/value triples character helps to make inference based on the description documents. Video can be described in several aspects. For Example, Figure 1.3 shows a frame from a video lecture in which balanced tree is taught by Professor Eric domain.

Figure 1.3 Frame1 of a video

<video>

<rdf:Description rdf:about="http://www.youtube.com/watch?v=iumaOUqoSCk">

<video:title>Balanced Search Tree</video:title>

<video:content>educational lecture</video:content>

<video:venue>Massachusetts Institute of Technology(MIT)</video:venue>

<video:person>Eric Demaine</video:person>

</video>

</rdf:Description>

Now when user types Balanced Search Tree Video By Eric Demaine, the search engine would make inference based on the RDF document and finally show relevant video in search result.

1.5 Structure of the Thesis

The rest of the thesis is organized in the following order:

Chapter 2 - Provides a review of all the work done in the area of semantic annotation for Video searching.

Chapter 3 - Gives the problem statement and methodology used to solve it.

Chapter 4 - Gives a detailed introduction about RDF, semantic video retrieval through RDF and provides an idea of a making some self defined tags in RDF files, tools and techniques used.

Chapter 5 - Explains the experiments performed and evaluates the results achieved.

Chapter 6 - Presents the conclusion of this thesis and suggestions for future work.

Thesis concludes with references.

Chapter 2
Literature Review

With the proliferation of internet, the World Wide Web (WWW) has rapidly evolved into a huge mine of global information and its size is increasing every day. Content is expanding at a fast speed than indexers i.e. robot, humans or hybrid systems can index. Searching and accessing relevant information from the WWW is a complex task due to large repository of data on each topic. Gerard Salton came with the development of SMART information retrieval in 1960‟s that moved further the concept of hypertext which was coined by Vannevar Bush in 1945 and gave rise to the term Search Engine [13].

A search engine is a used for retrieval of information stored in a computer system, such as on the World Wide Web, inside a proprietary network, or in a personal computer [14]. Due to the presence of large amount of resources on the Web poses a serious problem of accurate search. This is mainly because current Web is human-readable and machines cannot easily process the information contained in it. Highly sophisticated and efficient keyword based search engines have been developed but they have not been able to bridge this gap [14].

Requirement is to reconstruct the Web by adding some information into the documents stored on the Internet so that the computers can process this extra information and understand what a given document is really about. Another difficulty is integration, there is too much manual work involved and more automation is required. There is a need for improvement especially for searching activity so that the results are more relevant.

One of the promising solutions to this problem is Semantic Web, which is envisioned by Tim Berners-Lee. He defines it as “The Web of data, with meaning in the sense that a computer program can learn enough about what the data means to process it”. Berners-Lee’s vision includes an extended Web that incorporates machine interpretable information, enabling machines to process the volumes of available information, acting on behalf of their human counterparts [15].

Presently, the Hypertext Transport Protocol (HTTP) is used to request documents, which are received by programs and a Web server uses a URL provided in the request to determine which file to deliver. Despite its popularity, HTML suffered from two problems. First, whenever someone felt that HTML was insufficient for their needs, they would simply add additional tags to their documents, resulting in a number of non-standard variants. Second, because HTML was mostly designed for presentation to humans, it was difficult for machines to extract content and perform automated processing on the documents.

To solve the problem of accessing large ocean of data accurately, the World Wide Web Consortium (W3C) developed the Extensible Markup Language (XML) [16]. XML (Extensible Markup Language) is an Industry-standard, system-independent way of representing data. XML was designed to transport and store data, with focus on what data is whereas, HTML was designed to display data, with focus on how data looks. In other words, it can be said that HTML is about displaying information; while XML is about carrying information. XML too could not provide machine understandable construct as the XML schema provides a syntactic description of data and it does not provide semantics to the data and these Schemas use a restricted tag set to describe the structure of an XML document and are syntactically constrained to form a balanced tree (i.e., every starting tag must have a corresponding closing tag). Although, XML provides many different possibilities to encode domain of discourse, but this leads to difficulties when understanding of foreign documents is required. The Resource Description Framework (RDF) is a language designed to support the Semantic Web. It 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. It consists of nodes connected by labeled arcs, where the nodes represent Web resources and the arcs represent properties of these resources.

RDF supports self-defined tags that allow user to define semantic description tags and hence, it serves as a mechanism for resource description, contributing to the semantic inference based on the ontology theory. Its resource/property/value triples character helps to make inferences based on the description documents. By using these characteristics, RDF has been successfully applied for image search and results of image search through RDF are much faster and precise [17].

To enhance the semantic interpretability of videos semantic annotation can be added for describing the basic characteristics of images in RDF. Semantic annotations can be coarsely classified as being formal or informal. Formal semantic annotations follow representation mechanisms, drawn on conceptual models, represented using well-defined knowledge representation languages [4]. Visual Annotations can address thematic descriptions depicting the subject matter associated with it like event, people, object, place and also it can contain some information about low level features.

Since the starting of this decade lot of research has been done on semantic annotation of multimedia collections. In [18] a tool for semantic annotation and search in a collection of art images has been discussed. Knowledge engineering aspect such as the annotation structure and links between the ontologies has been discussed and some ideas have been proposed on how a semantic Web for videos might work. Semantic annotation allows us to make use of concept search instead of keyword search. It paves also the way for more advanced search strategies. For example, users can specialize or generalize a query with the help of the concept hierarchy when too many or too few hits are found.

To make multimedia content semantically machine processable two initiatives taken are the Semantic Web activity of the W3C and ISO's Multimedia Content Description Interface(MPEG-7)[19][20].Layered architecture of semantic web provides mechanism for capturing and reasoning with semantic data but it does not capture any application specific knowledge.MPEG-7 provides description of audiovisual content in form of domain specific ontology.

To address the problem of creation, storage, manipulation and processing of multimedia semantic metadata W3C Multimedia Annotation on the Semantic Web Taskforce, the W3C Multimedia Semantics Incubator Group4 and the Common Multimedia Ontology Framework5, have been established. Semantic annotation of multimedia data can address the issue of effectiveness and efficiency of accessing and managing audiovisual content.

Dilek[21] has proposed text-based automated architecture for the semantic annotation of Turkish news videos based on corresponding video text in a video which increases the performance of the recognizer for the news domain [21]. Semantic annotation of content will provide intelligent management of content and interoperability. Semantics associated with visual content in multimedia comes into a multilayered intertwined fashion [22][23].

After going through various proposal presented for semantic annotations of videos it has been realized that precision of videos retrieval can be improved, by using textual annotation to the videos available on WWW. RDF which serves as a basic language for realizing the dream of Semantic Web can be used as mean to describe all the resources based on some predefined rules. It will make the searching process more systematic because the search engine directly approach to RDF documents for getting the reliable information related to search and returns more relevant results.

Here we propose a semantic annotation method for video retrieval using RDF and accuracy of the search results has been validated with the use of SPARQL query engine which takes RDF as input. To query RDF many query Languages were proposed and implemented after a working group was formed by W3C with the goal of producing a candidate recommendation for RDF based query language as mentioned in [24]. SPARQL that has strong W3C support and gives insight into the future direction of standardization efforts within the W3C, was proposed and it offers almost all the basic query features along with advanced Construct query features.

Chapter 3
Problem Statement

3.1 Problem definition

During the literature survey, it was analyzed that the search based on semantics will make the process of searching multimedia content on the Internet more compliant, according to the need of the user, by making search operation based on the annotations done on videos and not on the keyword matching only. Algorithms related to searching, inherently used keyword matching for searching the textual content but, whenever these algorithms were applied for searching non-text content, it resulted into a non semantic search. Thus,Searching appropriate multimedia content corresponding to user query is a main challenge in multimedia research commonly known as semantic gap[25].Current content analysis system can detect certain semantic concepts such as, places, people,vehicles,countries,etc at acceptable accuracy level; however, performance highly varies with increase in supported concepts[26][27].As a consequence, for intelligent management of content manual description of content will play key role. At present, search and retrieval for text by search engines has reached a maturity level and provides a series of feasible solutions for text search. During last decade, lot of research work has been done for the retrieval of image and video retrieval [28].

At present search, performance of video search engine is still less than satisfactory. Querying a video by keywords is inefficient, because it is not possible to describe content of video in title words. Searches on popular web video repository sites like Youtube, Dailymotion, etc are often based on titles and descriptions that users assign to their videos. Due to the keyword matching process so many a times they return the unexpected results for searched video.

Query1-"*Red Black tree by gayatri*".

Figure 3.1 shows the search result of Query1 on popular video site www.youtube.com results of this search are totally incorrect, due to keyword based syntactical search it returns some videos of event which were uploaded on internet by gayatri and no video related to red black tree appears in the search results.

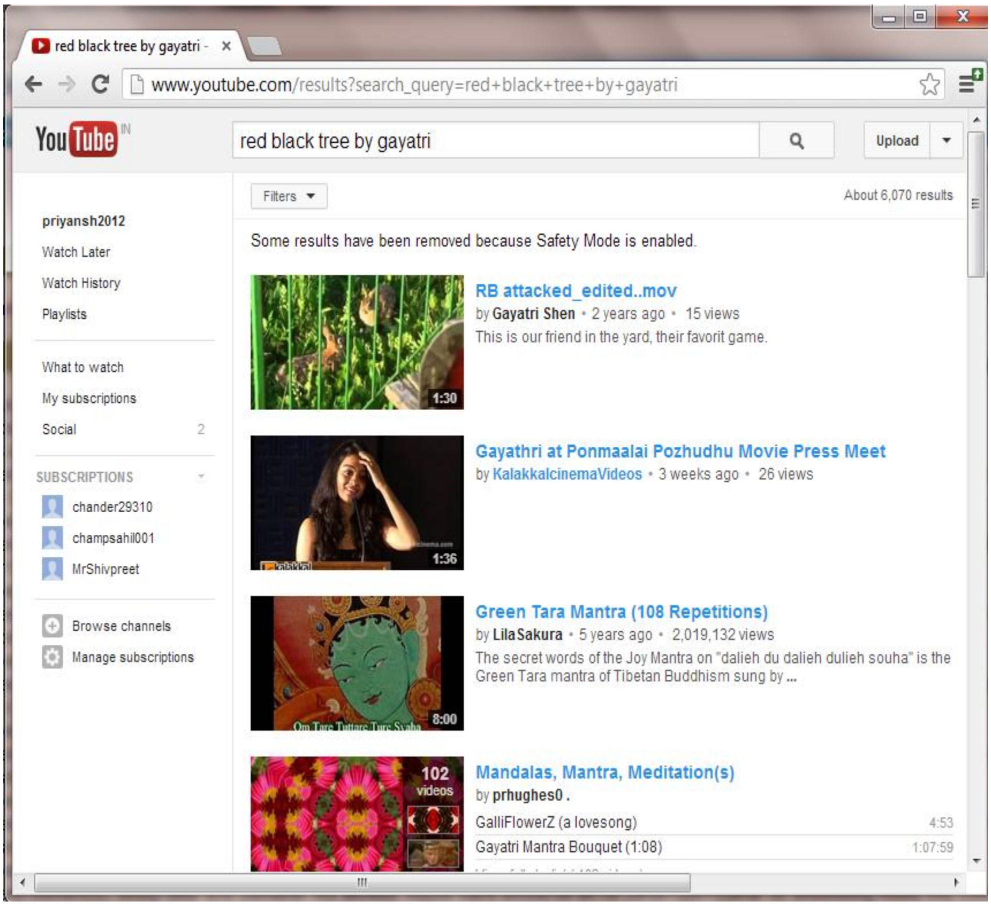

Figure 3.1 Result of Query 1 on www.Youtube.com

Query 2-“*Red Black tree Lecture by gayatri*”.

Figure 3.2 shows the result of a refined Query2, even then results were completely inaccurate and returned videos of some album or some video which had some color word in title. No video of red black tree lecture was returned by query. If the videos were semantically annotated with appropriate spatial and temporal description then the search result would have been accurate and relevant to users query.The result are totally incorrect and irrelevant.

Most of the search results are not relevant and not correlating themselves to the actual need of the user’s query because algorithms do not possess any meaning to know what context user is searching. These algorithms have evolved over a long period of time by incorporating advanced concepts on existing technologies like HTML.New concepts like XML, RDF, OWL have been introduced to facilitate the semantic search on the Web. Finally, keyword searching is being replaced by the semantic searching based on the RDF documents of the multimedia resources. In these RDF documents, resources are annotated by adding all the required pieces of information for making the search more intuitive and relevant.

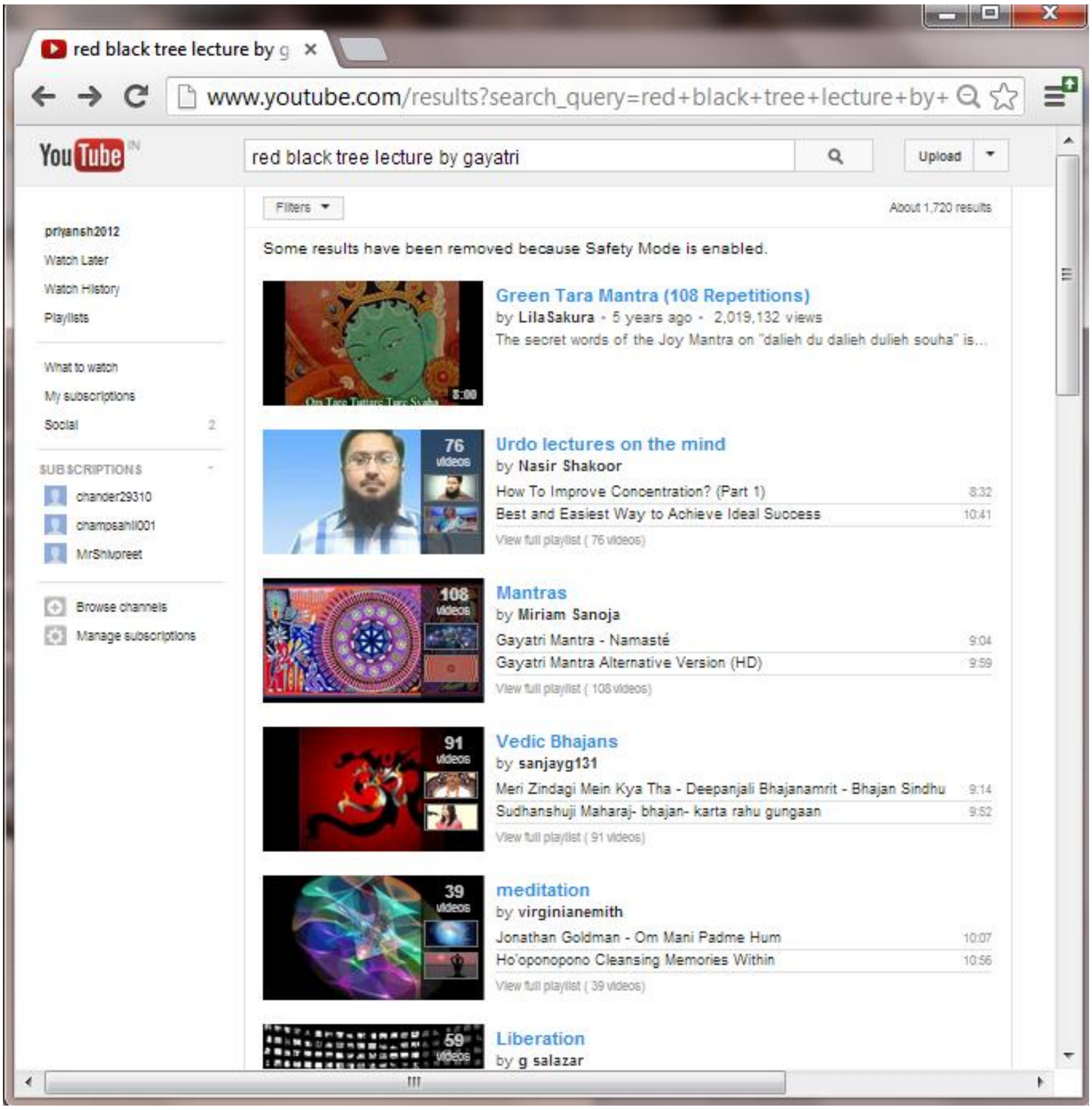

Figure 3.2 – Result of Query 2 on www.youtube.com

Most of the search results are not relevant and not correlating themselves to the actual need of the user's query because algorithms do not possess any meaning to know what context user is searching. These algorithms have evolved over a long period of time by incorporating advanced concepts on existing technologies like HTML.New concepts like XML, RDF, OWL have been introduced to facilitate the semantic search on the Web. Finally, keyword searching is being replaced by the semantic searching based on the RDF documents of the multimedia resources. In these RDF documents, resources are annotated by adding all the required pieces of information for making the search more intuitive and relevant.

The main objective is to create a repository of annotated videos; annotations can be done on entire video, temporal segments (selective shots), frames (temporal segments having zero duration), regions within frames, moving regions. A repository of RDF document will be created to annotate the video where the RDF document serves as a data model. Data model developed needs to be validated, which can be done using online W3C RDF validation service RDF model developed will be queried using SPARQL query engine.

3.2 Methodology

The step-by-step methodology to be followed in enabling Semantic Search on resource repository of images is given below:

- Study of the semantic Web technologies like RDF, OWL etc.
- Review of all syntactic search engine methods used for text and for non text searches.
- Create a RDF documents for important concepts and annotate these documents using RDF editor tool.
- Validate the RDF document through W3C RDF validation service.
- Study of the basic features required for a robust query language.
- Installation of Twinkle Sparql tool and selecting RDF repository.
- Run the SPARQL queries on developed RDF documents with the use of Twinkle SPARQL Tool.
- Display results of videos on the basis of rank associated with video link and analyze the relevance of results with the user query.

Chapter 4
Resource Description Framework

Today, information is the most important resource available. Information has diverse and overlapping groups of producers and consumers, which needs several media for communication between them. Internet represents the latest evolution of such communication channels. The success of Internet is greatly attributed to two application layer protocols HTTP and HTML. Hyper Text Transfer Protocol (HTTP) and Hyper Text Markup Language (HTML) provide a reliable, communication channel. HTML is essentially a presentation layer language for formatting web pages. Since HTML has no inherent semantics, i.e., it does not provide a description of the Web page, a major shift in this paradigm is required. The World Wide Web Consortium, recognizing this need, introduced standardized protocols such as XML, RDF and OWL to address the semantics issue. In the present scenario a search application that can understand the semantics of a Web search will provide a better-refined search than conventional text based searches.

The Resource Description Framework (RDF) is the first W3C standard for enriching information resources of the Web with detailed descriptions. 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.

RDF supports creating and processing meta data by defining a default structure. This structure can be used for any data, independent of their character. Thus, the application areas of RDF are numerous, e.g., web-based services, peer-to-peer networks, and semantic caching models.

4.1 Basic RDF Model

The RDF data model defines the structure of the RDF language [10]. RDF is model and XML syntax for representing information in a way that allows programs to understand the intended meaning. RDF data model is similar to classic conceptual modeling approaches such as entity–relationship. 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 RDF data model is a syntax-neutral way of representing RDF expressions. The data model consists of three data types:

- **Resources:** All data objects described by a RDF statement are called resources. Resources may be anything like a web page, music file, and image. For example, a resource may be a part of a Web page. A resource may also be a whole collection of pages. A resource may also be an object that is not directly accessible via the Web; e.g. a printed book. Resources are always named by URIs plus optional anchor ids.The extensibility of URIs allows the introduction of identifiers for any entity imaginable.
- **Properties:** A specific aspect, characteristic or relation of a resource is described by a property. Each property has a specific meaning with respect to a resource. For example; properties are the creation date of a web site or the author of a journal.
- **Statements:** A statement is a combination of a resource with its describing property and the value of the property. RDF statements are the structural building blocks of the language.

A RDF statement is typically expressed as {Subject, predicate, object}. The interpretation 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. The object of a statement can be another resource or it can be a literal; i.e., a resource or a simple string or other primitive data type defined by XML. In RDF resources are identified by a resource identifier. A resource identifier is a URI plus an optional anchor id.

For Example, a statement Radha is author of www.w3.org/book

This sentence has following parts:

{ www.w3.org/book, author,"Radha"}

Subject	http://www.w3.org/book
Predicate	Author
Object	Radha

Table 4.1: RDF Triples

This Statement can also be expressed as graphs with nodes for resources and values where directed edges represent the properties. Figure 4.2 shows the graphical representation of this RDF statement using directed labeled graph.In this diagram, the oval represents resources (or a subject) and arc represents named properties. Rectangle represents a object it contains a string literal value.

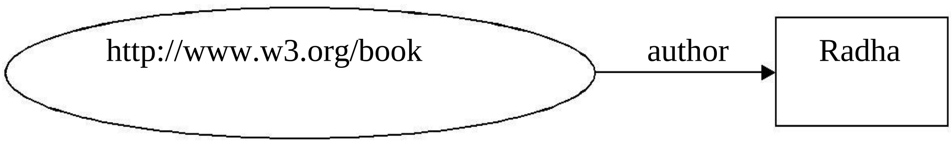

Figure 4.2 Simple node and arc diagram

4.1.1 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>
```

4.1.2 Advantages of using RDF

1. The RDF format, if widely used, will help to make XML more interoperable:

- Instantly characterization of structure, "this element is a type (class), and here are its properties".
- Standardized vocabularies, standardized types (classes) and standardized properties.

2. Basic RDF model can be processed even in absence of more detailed information on the semantics: it already allows basic inferences to take place.

3. The RDF format gives a structured approach to design XML documents.

4. It enables quick identification of weaknesses and inconsistencies of non RDF compliant, hence providing better understanding of the data.

4. RDFS gives the benefits of both worlds:

- Standard XML editors and validators to create, edit, and validate XML file.
- Use the RDF tools to apply inferencing to the data.

RDF Tag	Description
rdf:ID	RDF provides an ID attribute for identifying the resources being described. The value of rdf:ID is a "relative URI". The "complete URI" is obtained by concatenating the URL of the XML document with "#" and then the value of rdf:ID.
xmlns:rdf	The ID attribute is in the RDF namespace.
Class	Identifies the type (class) of the resource
Property	Resource being described.
Value	Values of the properties.
rdf:about	Instead of identifying a resource with a relative URI (which then requires a base URI to be attached before relative URI), we can give the complete identity of a resource. However, we use rdf:about, rather than rdf:ID.

Table 4.2: RDF **e**lements description [19]

4.2 RDF Schema

RDF data model does not provide any mechanism to define names for properties or resources. RDF schema is needed to define resource types and property names. Number of RDF schemas can be defined and used for different application areas.RDF schemas add semantics to RDF. They provide a type of system for resources. W3C has proposed a RDF schema called RDFSchema. Main components to construct a RDFSchema are Class and Property. Classes in RDF Schema are much like classes in object oriented programming languages. This allows resources to be defined as instances of classes, and subclasses of classes.Through subClassOf hierarchy of classes can be created.By using type-property resources can be declared as instances of more than one class. RDF document provide a mechanism to describe metadata about resources. Every entity in RDF is a resource and a class represents a group of resources. Every resource in RDF is an instance of at least one class. The core set of classes and properties are used to describe metadata about web resources by RDF schemas. There exists a subset of RDF resources using that all other RDF schema constructs can be defined. RDF schema statements are valid RDF statements because their structure follows the structure of the RDF datamodel.The core classes in RDF schema are rdfs:class, rdfs:resource, rdfs:property and rdfs:constraint resource.

i. rdfs:class it represents the set of entities used to describe concepts in a schema.

ii. rdfs:resource represents the set of all resources.

iii. rdfs:property represents the set of all RDF properties

iv rdfs:constraint represents the set of all constraints applicable to RDF resources.

4.3 SPARQL

The SPARQL query language for RDF is designed to meet the use cases and requirements identified by the RDF Data Access Working Group in RDF Data Access Use Cases and Requirements. SPARQL offers many basic features desired in an RDF-based query language. It provides a subset of operations on plain literals, XSD integers and XSD floats defined in XQuery and XPath functions and operators such as comparison of numeric values, functions on string values casting, comparison of duration, time and date values [29]. One interesting feature of SPARQL is the RDF keyword CONSTRUCT, a CONSTRUCT query matches a graph pattern against one or more input graphs. The resulting variable bindings are embedded into a graph template in order to generate new RDF data. To further restrict the bindings produced by pattern matching, filter expressions can be used, for example to check for equality of variables, data types of literals etc. [30].

Syntax example:

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX enter: <http://www.bookmyshow.com/favorite#>
SELECT ?type ?detail  ?info
WHERE
```

```
{ ?x enter:type ?type FILTER regex(?type, "Movie")
?x enter:detail ?detail FILTER regex(?detail, "^")
?x enter:rank ?stars FILTER regex(?rak, "^")
?x enter:info ?info FILTER regex(?info, "^") }
```

4.4 Twinkle: Sparql Tool

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

- Ability to 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 the results to file.
- Query local files and remote RDF documents.
- Query RDF data held in relational databases.
- Query online SPARQL endpoints, such as DBpedia.
- Query using standard SPARQL, or ARQ extended syntax.
- Use ARQ extension functions and property functions.
- Apply inference (e.g. RDF Schema, OWL ontology) when running queries.
- Configure commonly used data sources for quick access.

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Chapter 5
Implementation and Results

Visual Annotations can address thematic descriptions depicting the subject matter associated with it like event, people, object, place and also it can contain some information about low level features.

5.1 Video Annotation

Annotations can be identified into following types:

- Content descriptive –describes the subject matter information in multimedia.
- Structural Annotation –describes spatial, temporal decomposition aspects.
- Media Annotation –describes low-level features.
- Administrative Annotation-- describes creation date of annotation, annotation creator, etc.

In video, annotations can be done on entire video, temporal segments (selective shots), frames (temporal segments having zero duration), regions within frames, moving regions Moving region is a region that is followed for a sequence of frames. In the process of video annotation, we may find values for attributes or relationships that are not previously present in the knowledge base. Enhancement of existing metadata can be very simple like entering values for attributes. Moreover this process could be as complex as modifying the underlying schema, in that case some user involvement might be required [11]. Videos 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 search were based on the filename of the video, the link text pointing to the video, and text adjacent to the video.

To annotate the videos, RDF data model has been used. In RDF model statements about Web resources are represented in the form of subject-predicate-object expressions, Known as triples. It is a major component for description of resources in W3C's Semantic Web activity. W3C's Semantic Web is a future stage of the World Wide Web in which software agents will be able to automatically store, exchange, reuse and process machine-readable information throughout the Web, providing users with the information with greater efficiency. RDF supports self-defined tags which allow user to add new defined semantic description tags. RDF as a mechanism for resource description would contribute to the semantic inference based on the ontology theory. Its resource, property, value triples character helps to make inference based on the description documents. To enhance and optimize search results, RDF standard is used now to describe the video resource with attributes as its weight for such content descriptive phrase, which would help user in providing new content description to video by adding new self-defined tags into resource description.

Consider a video of a lecture in which balanced tree is taught by Professor Eric Demaine at MIT USA. In this video lecture he has taught red black tree too.

Figure 5.1 Frame1 of a video1

Figure 5.1 Shows a frame from a video lecture in which balanced tree is taught by professor Eric Demaine.

Figure 5.2 Frame 2 of a video1

Figure 5.2 Shows another frame from the video in which professor is teaching Red Black Tree.

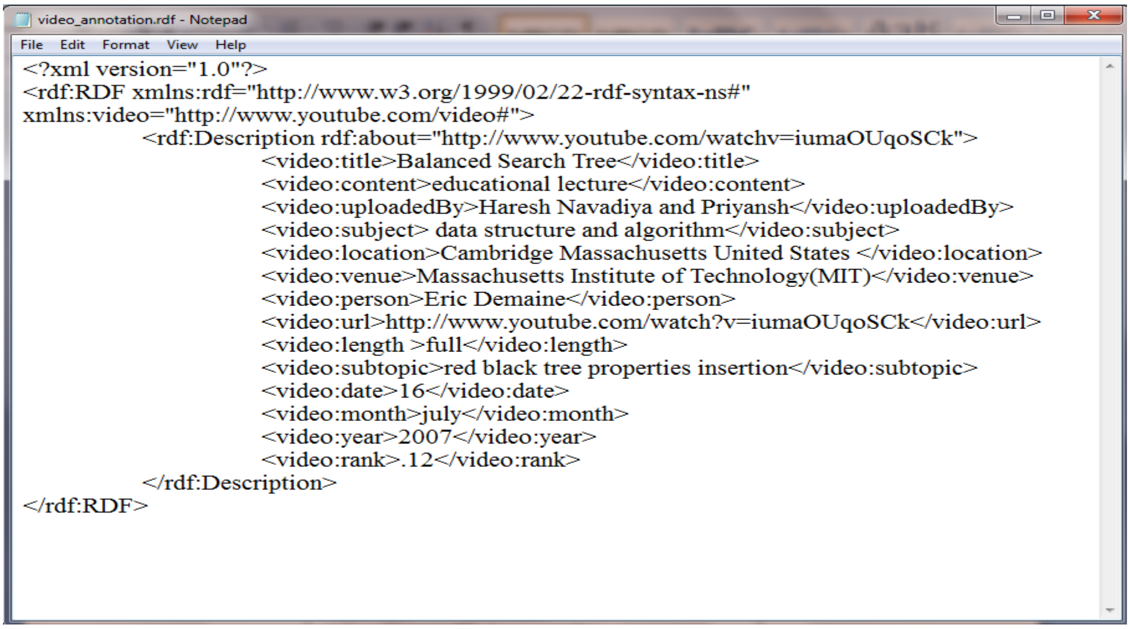
5.1.1 RDF document creation

A rdf for video in Figure 5.1 with few annotations

```
<?xml version="1.0"?>
<rdf:RDFxmlns:rdf=http://www.w3.org/1999/02/22-rdf-syntaxns#
 xmlns:video ="http://www.youtube.com/video#">
<rdf:Description rdf:about="http://www.youtube.com/watch?v=iumaOUqoSCk">
<video:title>Balanced Search Tree</video:title>
<video:person>Eric Demaine</video:person>
<video:length >full</video:length>
</rdf:Description>
</rdf:RDF>
```

When the user searches for a video lecture delievered by Eric Demaine in which he taught red black tree at Massachusetts Institute of Technology (MIT), 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 video lectures given by Eric Demaine or all the lectures on red black tree or some irrelevant video.

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




```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:video="http://www.youtube.com/video#">
        <rdf:Description rdf:about="http://www.youtube.com/watchv=iumaOUqoSCk">
                <video:title>Balanced Search Tree</video:title>
                <video:content>educational lecture</video:content>
                <video:uploadedBy>Haresh Navadiya and Priyansh</video:uploadedBy>
                <video:subject> data structure and algorithm</video:subject>
                <video:location>Cambridge Massachusetts United States </video:location>
                <video:venue>Massachusetts Institute of Technology(MIT)</video:venue>
                <video:person>Eric Demaine</video:person>
                <video:url>http://www.youtube.com/watch?v=iumaOUqoSCk</video:url>
                <video:length >full</video:length>
                <video:subtopic>red black tree properties insertion</video:subtopic>
                <video:date>16</video:date>
                <video:month>july</video:month>
                <video:year>2007</video:year>
                <video:rank>.12</video:rank>
        </rdf:Description>
</rdf:RDF>
```

Figure 5.3 RDF document of Video Using Editor

Figure 5.3 shows the RDF Document of the video. In this RDF document, video has been annotated by using some relevant self defined tags.

Some self defined tag which have been used for annotations are video:title , video:content,video:uploadedby,video:subject, video:location, video:venue, video:url, video:person, video:length, video:subtopic, video:date, video:month,video:year, video:rank.

video:title – it will contain main title of the video .It has been used because some user might search for videos on the basis of title like “show video lecture on redblack tree”.

video:location – It contain the information about place where video was taken. It has been used because some user might for video like “show videos lecture in Patiala”. So our system will search for videos taken in Patiala.

Video:venue- It contains the detail of place where video was shoot. .It has been used because some user might for video like “show video lecture of Thapar University”.

Video:person – It contains the names of person which are in video. It has been used because a video might contain number of important person and there is high probability that users will search for videos on the basis of person name like user can search for “videos by Eric demaine”.

Video:month – It contains information about the month in which video was taken.Because users can search for a specific video of a event held in a particular month. Like user might search for video of a rose festival held in March.

Video:uploadedby – It contains the name of the person who uploaded the video . Now user can search for a video on the basis of name of the uploader of video. Sometime videos are liked by large number of people uploaded by a specific person .so there are chances that people will search for videos on the name of uploader.

Video:content – It information about the content in video to categorise and restrict some people from viewing it like video is a lecture, for children or a adult material etc.

Video:rank –It contains the value of the rank associated with each video. .It has been used because the Rank will order the search result of videos. If one video has highest Rank, it will come on the top level of the result and other videos with the lowest Rank will come in the last page. The Rank totally depends upon appropriate semantic annotation of videos and semantically searches of those videos.

5.1.2 Video Rank Calculation

Consider the illustration in Figure 5.4 of a simple Link Structure of web pages which have embedded a video in them ;this structure can be represented using $N \times N$ **adjacency matrix** A, where $\mathbf{A_{ij} = 1}$ if there is a link (Edge) from webpage in which video is embedded (Vertex) i to webpage j in which video is embedded , and 0 otherwise [6].

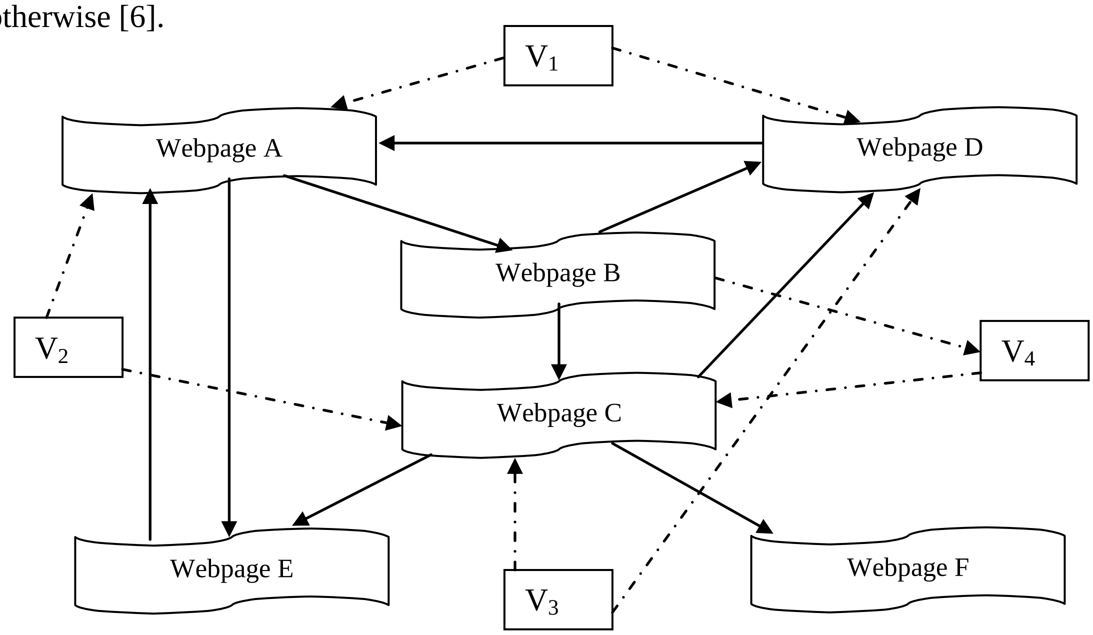


Figure 5.4: Link Structure between Web Pages and Videos

Thus, the 6×6 adjacency matrix for the link structure in Figure 5.4 is

$$\mathbf{A} = \begin{pmatrix} 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

In Matrix A diagonal entries are all zero. We assume that links from a page to itself are ignored when constructing an adjacency matrix.

Now We have Normalized Adjacency Matrix (H) Using Equation 1. Let's Build A Transition Probabilities Matrix (H),

$$H_i = \frac{A_i}{\sum_{k=1}^{N} A_{ik}} \qquad (1)$$

So, that each row A_i of A is divided by its row sum. Apply **equation 1** on Adjacency matrix A. so we have, sparse matrix

$$\mathbf{H} = \begin{pmatrix} 0 & 1/2 & 0 & 0 & 1/2 & 0 \\ 0 & 0 & 1/2 & 1/2 & 0 & 0 \\ 0 & 0 & 0 & 1/3 & 1/3 & 1/3 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Matrix H whose element H_{ij} is the probability of moving from state i (page i) to state j (page j) in one time step.

When a rank calculation reaches a dangling node, user does not have any option left to navigate to any other webpage. But in reality the user may then navigate to some page by typing the URL of the desired webpage which has embedded a video. Thus this case must be represented in the mathematical model for PageRank algorithm.

Using the matrix H is insufficient for the PageRank algorithm, because matrix H is not yet stochastic. Thus, to ensure that H is stochastic, we must ensure that every row sums to one. But in this Matrix H, the sum of the last row of matrix H is Zero because of Dangling Node.

To overcome this problem, pages with no Forward links (Webpage F) are assigned artificial links or “teleporters” to all other pages including itself. Therefore, we define the stochastic S as,

$$S = H + \frac{a * e^T}{N} \qquad (2)$$

Where,

a = N×1 Column Vector such that

$a_i = 1$ if $\sum_{k=1}^{N} H_{ik} = 0$ (i.e. Page i is Dangling Page)

= 0 otherwise

e = N×1 Column Vector of one’s.

Apply **equation 2** on matrix H. so we have stochastic matrix S as,

$$\mathbf{S} = \begin{pmatrix} 0 & 1/2 & 0 & 0 & 1/2 & 0 \\ 0 & 0 & 1/2 & 1/2 & 0 & 0 \\ 0 & 0 & 0 & 1/3 & 1/3 & 1/3 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 1/6 & 1/6 & 1/6 & 1/6 & 1/6 & 1/6 \end{pmatrix}$$

It makes sure that surfer's random walk process does not get stuck and the web pages are the states of the Markov chain. Now we define the irreducible row-stochastic matrix G as

$$\mathrm{G} = \alpha\mathrm{S} + (1-\alpha)\mathrm{E} \ ; \ 0 \le \alpha \le 1 \qquad (3)$$

$$\mathrm{E} = \frac{\mathrm{e} * \mathrm{e}^{\mathrm{T}}}{\mathrm{N}}$$

G is the Google matrix, and we can use it to define
Google uses damping factor α which has value 0.85, and we will use this same value. Thus, apply **equation3** on matrix S, our G is,

$$\mathbf{G} = \begin{pmatrix} 1/40 & 9/20 & 1/40 & 1/40 & 9/20 & 1/40 \\ 1/40 & 1/40 & 9/20 & 9/20 & 1/40 & 1/40 \\ 1/40 & 1/40 & 1/40 & 77/250 & 77/250 & 77/250 \\ 7/8 & 1/40 & 1/40 & 1/40 & 1/40 & 1/40 \\ 7/8 & 1/40 & 1/40 & 1/40 & 1/40 & 1/40 \\ 83/500 & 83/500 & 83/500 & 83/500 & 83/500 & 83/500 \end{pmatrix}$$

Since the matrix G is completely dense, and the graph of G now strongly connected and G is irreducible.

Now that the entire Web matrix is transformed to a two dimensional matrix .To transform it to a one dimensional matrix maintaining the importance of each node in the matrix. This can be done by **Power Method.**

Power method has given stationary result, whose value in each row is same.

$$\mathbf{G}^{(19)} = (0.320 \quad 0.170 \quad 0.107 \quad 0.137 \quad 0.200 \quad 0.064)$$

In our example, stationary values have been obtained after 19 iteration of Matrix G using Power method.

Web Page	PageRank	Relative importance
A	0.320	1
B	0.170	3
C	0.107	5
D	0.137	4
E	0.200	2
F	0.064	6
	Total = 1	

Table 5.1 PageRank of 6 web pages embedding video.

Now Page Rank calculated in Table 5.1 are rank of page in which video has been embedded.

Now as a video is embedded in number of web pages so to calculated actual rank of video, we will add rank of all the web pages which have embed our video,as it is confirmed that this summation of ranks of pages will be less than or equal to 1.

$$R'(V_j) = n \sum_{i=1} R_i \qquad (4)$$

Where,

n = number of web Pages which have embedded video V_j

$R_{i=}$ Is Rank of page which has embedded video V_j

$$\text{Final Rank } RV_j = C * R'(V_j) \qquad (5)$$

Where,

C = Number of views of Video.

Final Rank RV_j calculated in equation5 is a rank of Video V_j , now we can use this rank to order search results. In equation5, C is the number of views of a video. This rank will help in arranging video is a most relevant order.

5.1.3 Validation of RDF Document

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).It will check parse RDF document and check for syntactical error. Figure 5.5 shows the process and results of validation.

Validation Results

Your RDF document validated successfully.

Triples of the Data Model

Number	Subject	Predicate	Object
1	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#title	"Balanced Search Tree"
2	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#content	"educational lecture"
3	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#uploadedBy	"Haresh Navadiya and Priyansh"
4	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#subject	"data structure and algorithm"
5	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#location	"Cambridge Massachusetts United States"
6	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#venue	"Massachusetts Institute of Technology(MIT)"
7	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#person	"Eric Demaine"
8	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#url	"http://www.youtube.com/watch?v=iumaOUqoSCk"
9	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#length	"full"
10	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#subtopic	"red black tree properties insertion"
11	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#date	"16"
12	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#month	"july"
13	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#year	"2007"
14	http://www.youtube.com/watch?v=iumaOUqoSCk	http://www.youtube.com/video#rank	".12"

Figure 5.5: Validation of RDF using W3C RDF Validation Service

RDF document has been validated successfully and its results show the subject, predicate and object in document. Now we will generate graph of our RDF data model.

5.1.4 Graphical Representation of RDF

Graph generated for our data model showing the subject, predicate and object (triples) of few entities of RDF document. In this graph, the ovals represent resources (subject) and arcs represent named properties. Nodes that represent string literals are drawn as rectangles.

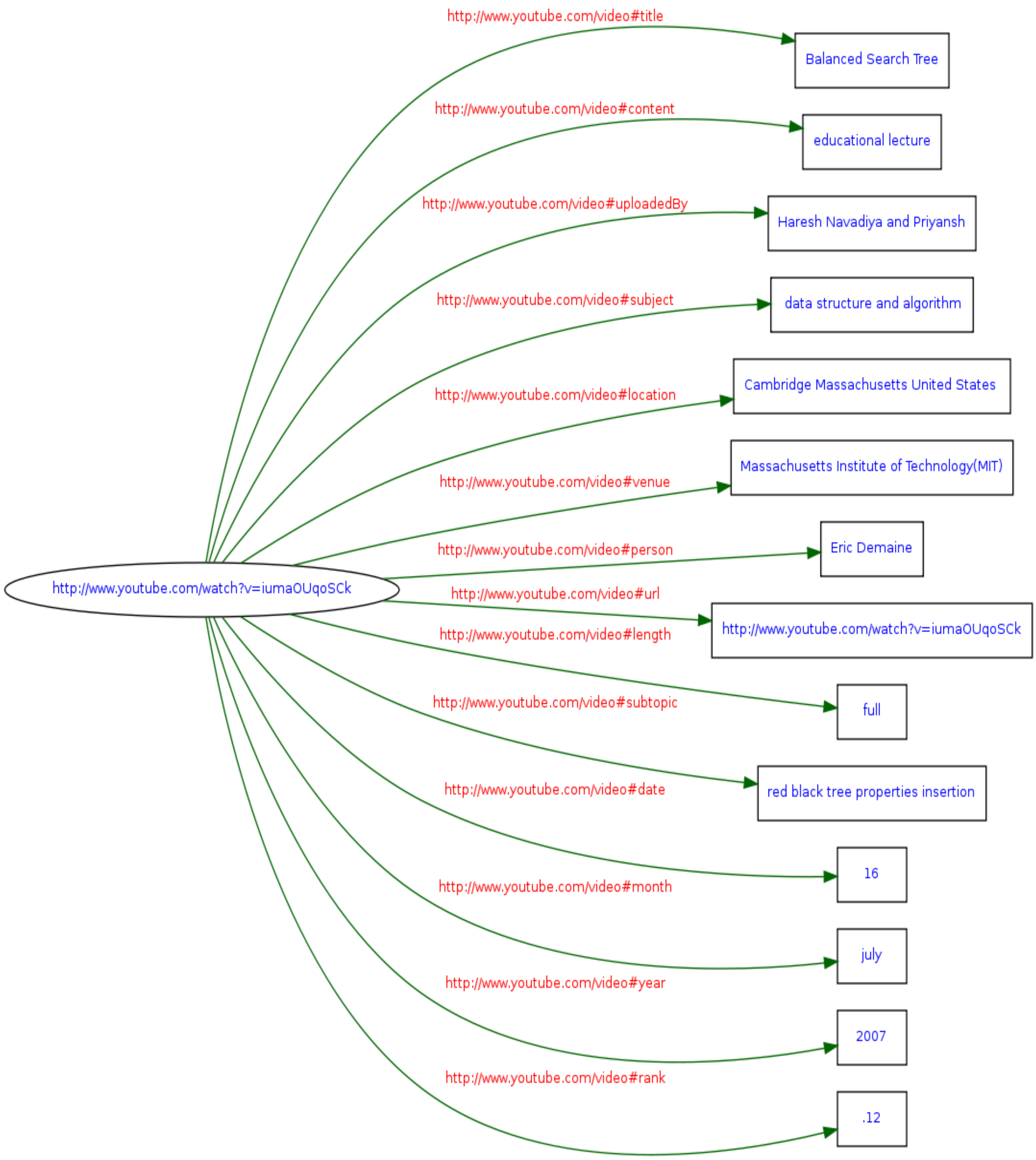


Figure 5.6: Graph of video 1 Entity of RDF Document

Figure 5.6 shows the graph generated for a video 1 of our data model showing the subject-http://www.youtube.com/watch?v=iumaOUqoSCk.The video which has been annotated . Value on the arc is property the predicate,annotated tag . It shows various semantic annotations like subtopic, subject which describe the content of the video. It also shows some Media annotations like length, location etc. Administrative annotations have also been done like date of creation, uploaded by, venue and location of video. Value in the rectangular box on the right hand side is the literal value associated with each property like name of person in video is Eric Demaine, location at which this video was taken is United States, content in video is a educational lecture.

5.2 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. For result analysis RDF Repository for more than 200 videos has been created When user queries for a video, our proposed system will search for relevant video in a RDF Document.

5.2.1 Query 1

Suppose user queries to search for all videos of "lecture", and then a query in SPARQL is run on annotated RDF repository. Query 1 (as shown in figure 5.6) retrieves all the information from the RDF document. Figure 5.6 shows the all the lecture videos,their title,content type and are sorted on the basis of calculated rank associated with each video.

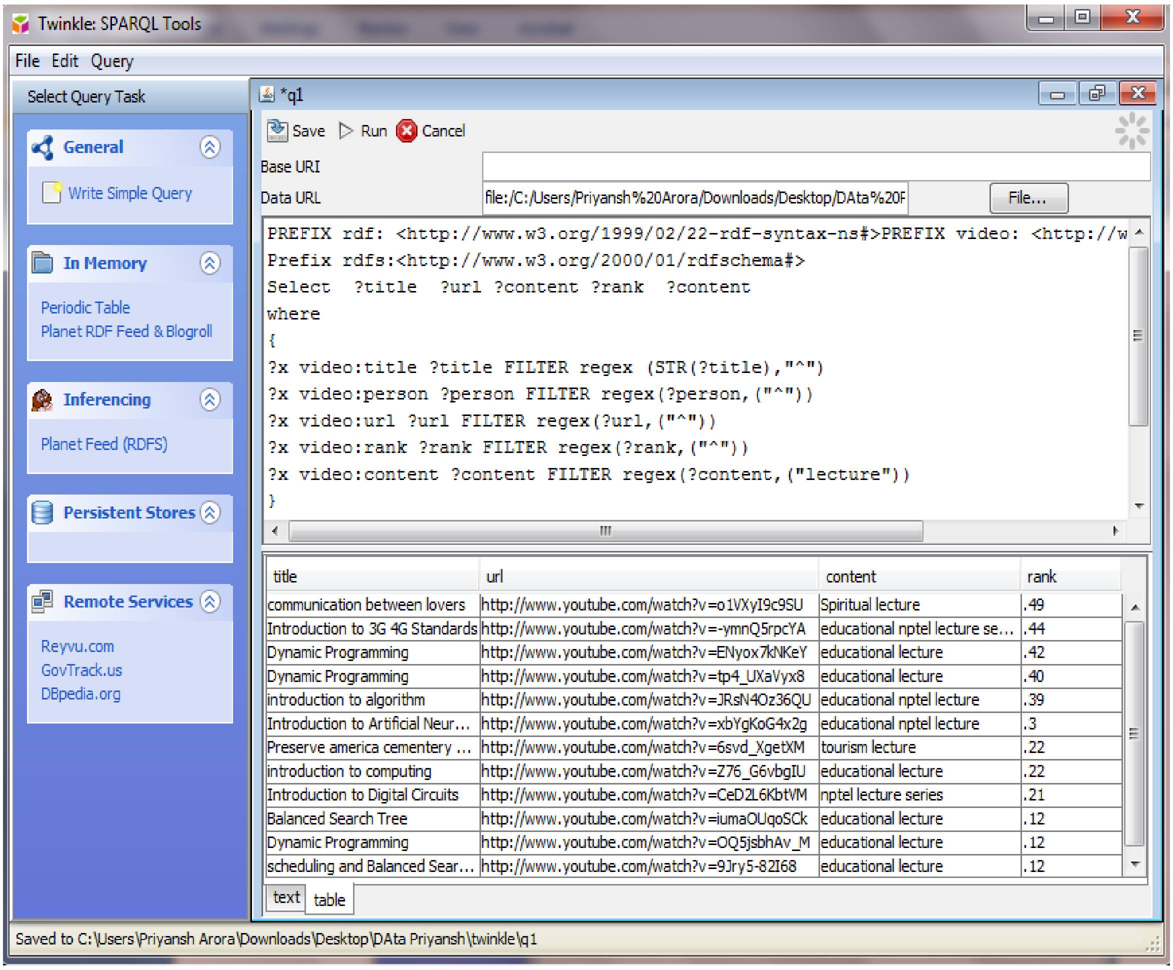


Figure 5.7: Query and output for all lecture.

5.2.2 Query 2

Figure 5.7 shows output for query on “all videos of educational lecture” irrespective of any person and topic.

This query will return number of educational videos, for arranging result in a relevant order , videos have been arranged on the basis of rank associated with each video.

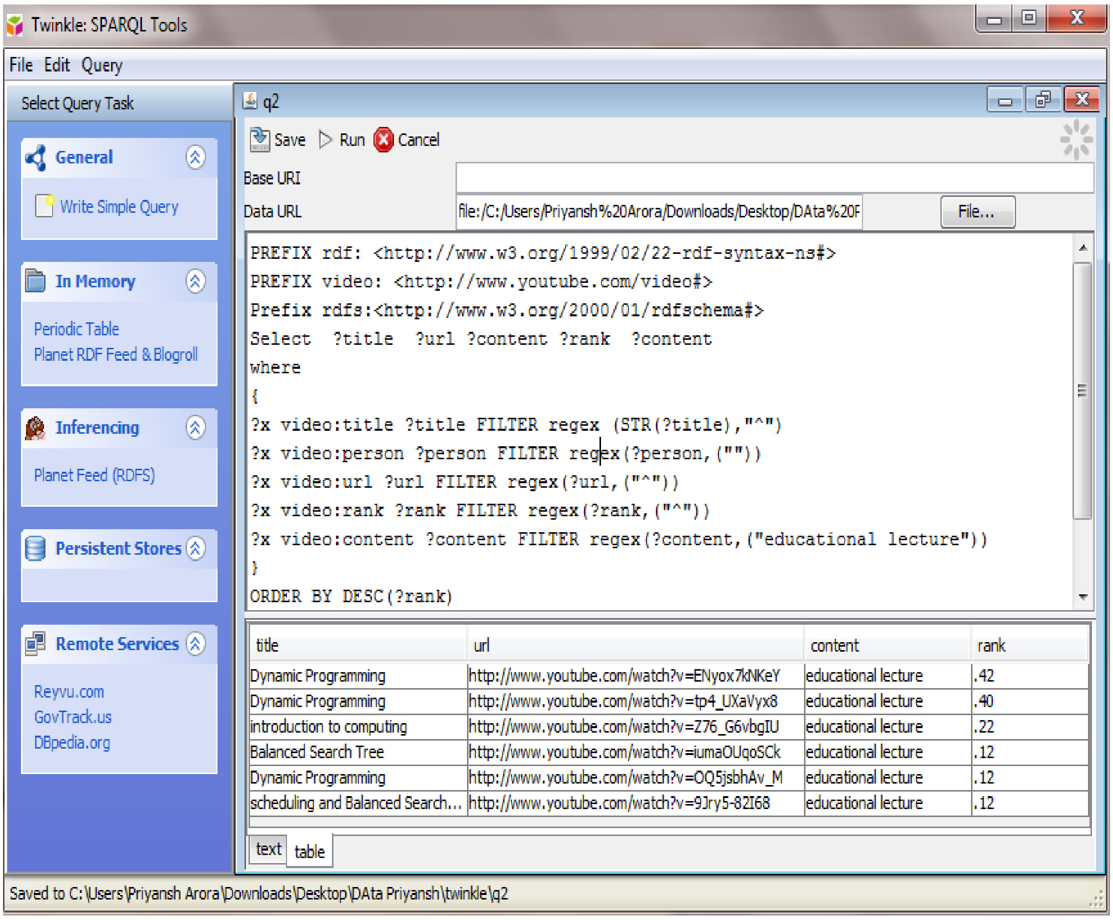


Figure 5.8: Query and output for all video of educational lecture

This query is executed on a RDF repository of videos and retrieves semantically the educational lecture video irrespective of topic, location and title. The result in Figure 5.8 shows video title, content in it and has been sorted on the basis of rank.

5.2.3 Query 3

If the users search for videos of "lectures given by Eric". Then SPARQL query will search for all the lecture videos of Eric. Figure 5.8 shows output for query on "all videos of lecture given by Eric" irrespective of topic.

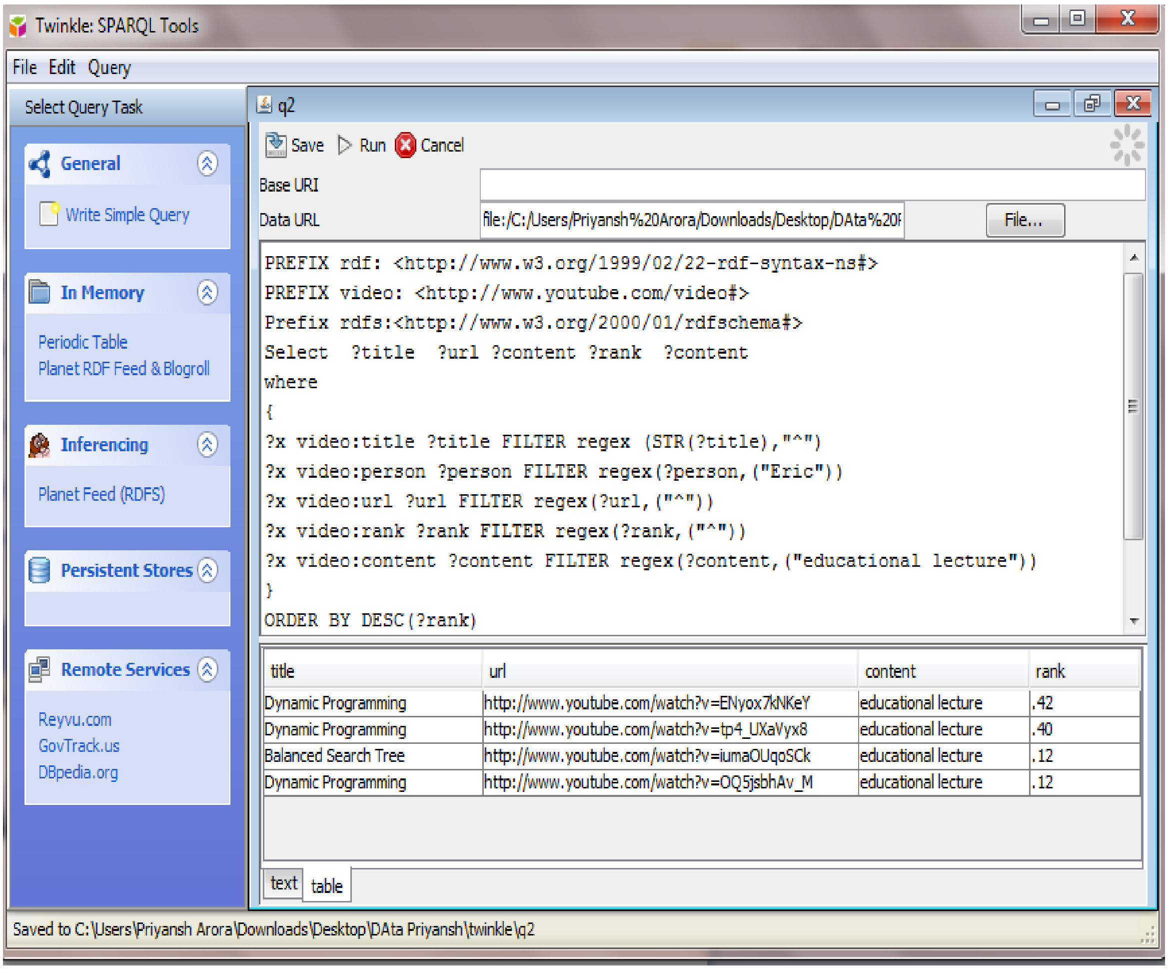


Figure 5.9: Query and output for all video of educational lecture given By Eric irrespective of title.

This query is executed on a RDF repository of videos and retrieves semantically the educational lecture video which have been given by Eric irrespective of topic, location and title. The result in Figure 5.9 shows video title, content in it and has been sorted on the basis of rank .

5.2.4 Query 4

If the users search for video of “lecture given by Eric on Blackjack”. Then SPARQL query will search for all the lecture videos of Eric. Figure 5.9 shows output for query on “videos of lecture given by Eric on blackjack”.

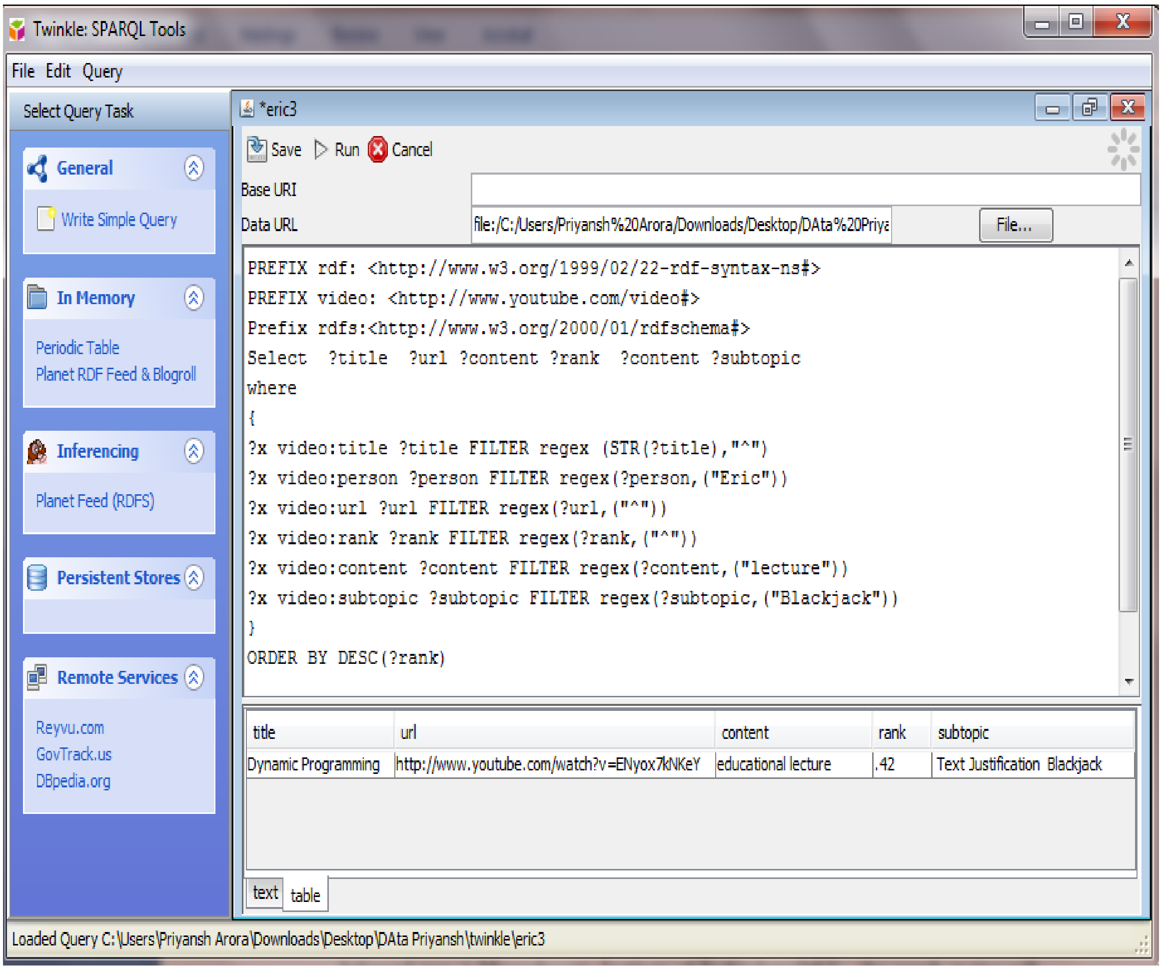


Figure 5.10: Query and output for all video of lecture given By Eric on topic Blackjack.

This query is executed on a RDF repository of videos and retrieves semantically the educational lecture video given by Eric on a particular topic Blackjack irrespective of location . The result in Figure 5.10 shows video title, content in it and has been sorted on the basis of rank .

5.2.5 Query 5

If the users search for video of "uploaded by navadiya". Then SPARQL query will search all videos in RDF repository . Figure 5.9 shows output for query on "videos uploaded by navadiya", title name,uploader name and result has been arranged on the basis of rank associated with each video.

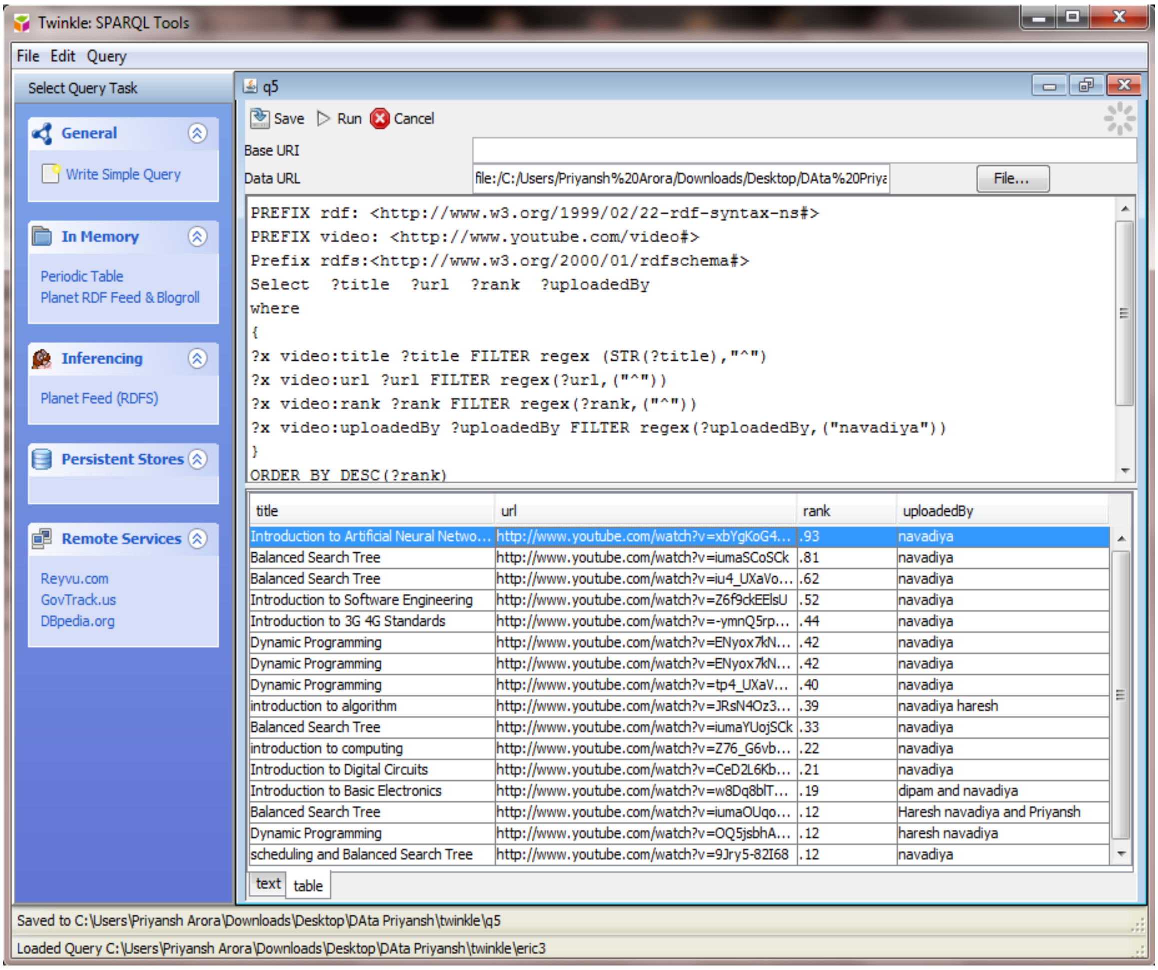


Figure 5.11: Query and output for all video uploaded By Navadiya on any topic.

When user searches a video of a lecture by Eric Demaine on Red Black Tree and balanced tree at Massachusetts Institute of Technology(MIT) , the search engine will make inference based on the corresponding RDF document and finally provide that particular video which fulfills the user search query. Similarly, when the user searches for video of a lecture by Eric Demaine on Dynamic Programming in which he has taught shortest path and Fibonacci, the search engine will make inference based on the respective RDF document and finally provide the desired relevant video.

Hence, by creating the RDF document for any video or multimedia resource and providing maximum content description of that video or resource, we have enhanced the searching process and the videos retrieved are more semantic in comparison to traditional search.

After executing number of queries on the RDF repository, it has been analyzed that retrieval accuracy increases with detailed annotation of video. As the number of semantic annotation, specific videos can be retrieved by quering.

Chapter 6
Conclusion and Future Scope

6.1 Conclusion

There is a considerable demand for semantic Annotation of video content and retrieval of video from large video archives. This thesis work concludes that the RDF is a very powerful tool to annotate videos and create data models for the repositories of the different types of resources. We have described our proposed system for semantically annotating videos using RDF model and querying them using a SPARQL language. Predefined tags used in RDF capture all the targeted information about the video and put ahead a way to make all the searches over the defined repository more relevant and accurate. By analysis of results of various queries, we can conclude that semantic annotation of videos by RDF model enhances the search accuracy.

With use of RDF semantic content annotation of videos, users can retrieve more relevant video. It helps the user to retrieve videos on the basis of content in them. Rank tag in our proposed system increase the efficiency of result by sorting the results on the basis of rank associated with each video. 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 Tim Berners Lee. As the amount of videos are growing exponentially on the WWW, using self defined tags and semantic annotations will always increase the efficiency and relevance of video retrieval.

6.2 Future Scope

In the presented work, only a sample RDF repository is created which can be modified by adding more annotations and therefore enhancing the users' capability to search more meaningful contents or making a way to enhanced semantic search over the Internet.

Designing a ranking algorithm particularly for videos, so that relevant videos after semantic retrieval can be arranged in an order.

At present semantic Web is in developing stage and languages like RDF and OWL are being accepted as building blocks for context sensitive search but a lot of standardization needs to be done in this direction.

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List of Publications

[1] Priyansh Arora and V. K. Bhalla, "A Novel Approach for Enhancement of Video Retrieval Accuracy using Semantic Annotation," *International Journal of Computer Science & Engineering Technology*.[Accepted]

[2] Priyansh Arora and V.K.Bhalla,"Development of Semantic Ontology for Tourism Information Using Protégé," *in Journal of Computer Technology & Applications*. [Accepted]

[3] Priyansh Arora and V.K.Bhalla," Performance Analysis Of Rdf And Relational Databases," in International Journal of Computer Science and Mobile Computing.[Commmunicated]