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WEB USAGE MINING USING SEMANTIC WEB APPROACH: A STUDY, SURVEY AND ANALYSIS

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ABSTRACT

The ultimate aim of this research paper is to show the web usage mining using semantic web approach. Web data mining is an essential approach in data mining that allows user or machine to retrieves and analyzes the information from web in reflex manner. In fact it is an art of getting the desired result in terms of relevant information from World Wide Web. Web usage mining is one of the essential branch of web data mining. Semantic web helps in integration the data from different distributed environments or web resources. Web resources is organized in the form of metadata known as Resource Description Framework (RDF). RDF is Extended Markup Language (XML) based data model, where data is depicted in the form of triplets. In this paper we are including the study of KNIME tool to show web usage mining. KNIME (read as "naim") stand for Konstanz Information Miner, is developed by KNIME.com and written in Java. It is an open source data analytics, reporting and integration platform. We are also including Apache Jena Fuseki, Open virtuoso (For DBpedia) tools to show web usage mining using Semantic web approach. To facilitate RDF query, we will use SPARQL. It is very efficient language to execute RDF data.

Thus we are proposing web usage mining using semantic web approach to retrieve the results of queries efficiently needed by the specific user or Query machine. Various Queries have been considered and demonstrated.

Index Terms— Web Mining, Semantic web, Query execution, RDF, SPARQL, W3C, KNIME, Jena Fuseki, Open Virtuoso, DBpedia .

I. INTRODUCTION

The World Wide Web(WWW) is an only feasible solution to get information. A huge thanks to Sir Tim Berners Lee and his colleague for their idea and achievement due to which information technology sector survived. But dynamic updation of Web Data leads to a abnormal growth of repository of Web. Web stores inter-related files on multiple Web servers, where files are related to each other according to some logical reasoning. Thus Web mining is very critical task and it is defined as the essential branch of data mining to extract information from Web data[1]. According to context the Web data can be:

i. Web content –text, image, records, etc.

ii. Web structure –hyperlinks, tags, etc.
iii. Web usage –http logs, app server logs, etc.

Thus Web mining is categorized into three different types:

1. **Web Content Mining:** Web content mining includes the web documents which may consist of text, html, multimedia documents i.e., images, audio, video and sound etc. The search result mining contains the web search results. It may be a structure documents or unstructured documents.[2]

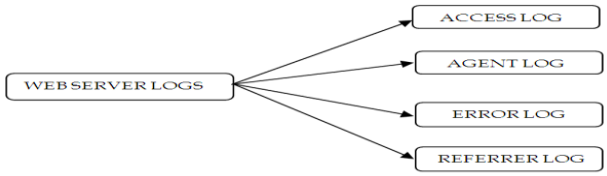
2. **Web Structure Mining**: Web structure mining is the study of data interconnected to the structure of a particular website. It consists of web graph which contains the web pages or web documents as nodes and hyperlinks as edges those are connecting between two related pages[3].

3. **Web usage mining**: Web usage mining is also called as web log mining which is used to analyze the behavior of online users. It fed into two types of tracking; one is general access tracking and another one is customize usage tracking[4].

Web Usage Mining: Main area of concern is web usage Mining. It is also known as web log mining which is used to analyze the behaviour of online users.
According to flow chart-1, web usage mining is classified into two categories:-

A) General Access Tracking: - The general access tracking is used to predict the customer behaviour on the web and it identifies the user while the user interacts with the web. It can store the data automatically when the web server log and application log.
B) Customize Usage Tracking: It is the ability to track various kinds of business events and log them in application server logs after customization of web data. Usage profiles are maintained while customized usage tracking.

General Access tracking has two main components: web server logs and Application server logs. Flow chart for sub-classification of web server logs is as follows:-



[Fig-1: Clasifictions of web server log]

The web log is located in three different locations they are web server log, web proxy server and client browser and it contains only plain text file (.txt).
Hence Web usage mining is to extract the data which are stored in server access logs, referrer logs, agent logs and error logs.

1. **Access log**: Access log is used to capture the information about the user and it has many numbers of attributes. It will record each click event, hits and access of the user. It is one of the web server logs [16].
2. **Agent log**: - Agent log is used to record the details about online user behaviour, user's browser, browser's version and operating system. It is a standard log file while comparing the access log.
3. **Error log**: - When user click on a particular link and the browser does not display the particular page or website then the user receives error 404 not found.
4. **Referrer log**: - Referrer log is used to store the information of the URLs of web pages on other sites that link to web pages. That is, if a user gets to one of the server's pages by clicking on a link from another site, the URL of that site will appear in this log.

Steps in web usage mining: Web usage mining process is generally divided into three tasks[12]:
1. Data pre-processing
2. Pattern discovery
3. Pattern analysis

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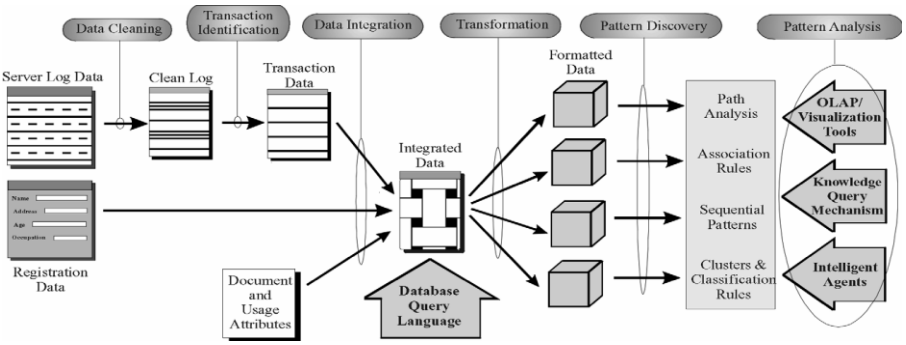
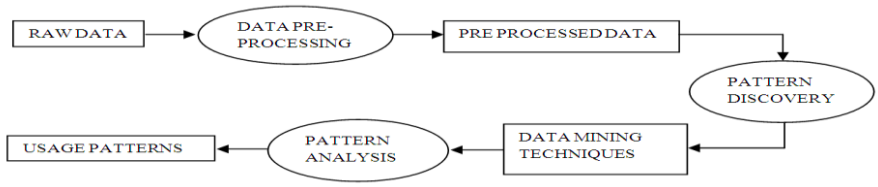


[Fig-2: Stages of Web Usage Mining]

The above complex steps can be simplified as:



[Fig-3: Simplified Stages of Web Usage Mining]

1. **Data pre-processing:-** Web log data pre-processing is nothing but, to identify users, sessions, page views and so on. In order to improve the efficiency and scalability many steps are required, these are, data fusion, data cleaning, user identification by IP address, authentication data, cookies, client information and site topology, session identification, formatting, and path completion [6].
2. **Pattern discovery: -** The data mining techniques and algorithms are used to perform in the pattern discovery by using clustering, association rules and sequential analysis. The association technique is mostly used in pattern discovery for detection of relation between visited pages by online users. It is used to extract patterns of usage from web data [4]. The extract pattern can be stand for in many ways such as graphs, charts, tables and forms.
3. **Pattern analysis: -** The last process of the web usage mining is pattern analysis. There are so many techniques are used for pattern analysis such as visualization technique, OLAP technique, data and knowledge querying and usability analysis [4]

In context of Web Usage mining using Semantic Web Approach[21] , we are using RDF. It is a kind of data model which is extension of XML . The data in RDF is organised in the form of three tuple known as triplets i.e. <Subject, Predicate, Object>. Here <Subject , Predicate, Object> can be termed as <Resource Identifier , Attribute or Property name, Attribute or Property value> respectively[6]. To facilitate RDF query, we will use SPARQL. It is very efficient language to execute RDF data.
The word SPARQL is an recursive acronym for " SPARQL Protocol And RDF Query Language"[8].

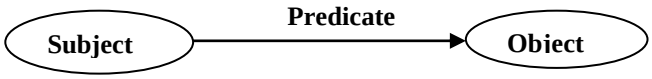


Fig. 4: RDF triples

Subject	Predicate	Object
Prachi	homeTel	(011) 276-51355
Bhargav	email	mkj@gmail.com

Table-1: Example of RDF data table

The following code will express the above triples in RDF format(Say "ex.rdf"):

< rdf: RDF xmlns: rdf= "http://learningsparql.com /ns/ addressbook#" >
< rdf: RDF name: rdf= "http://learningsparql.com /ns/demo#" >
< rdf: RDF homeTel: rdf= "http://learningsparql.com /ns/demo#" >
< rdf: RDF email: rdf= "http://learningsparql.com /ns/ demo#" >

<rdf: Decription rdf:about="http://learningsparql.com /ns/demo#ex" >
<name> Prachi </name>
<homeTel> "(011) 234-51355</homeTel>
<email>prachijha@gmail.com </email>
<name> Bhargav </name>
<homeTel> "(011) 211-51365</homeTel> <email>bhargavjha@gmail.com </email>
</rdf: Decription>
</rdf: RDF>
Also, the following code will express the above triples in Turtle RDF format(Say "ex.ttl"):
@prefix ab: <http://learningsparql.com/ns/demo#ex>.
d:Prachi ab:homeTel "(011) 234-51355".
d:Prachi ab:email " prachijha@gmail.com " .
d: Bhargav ab:homeTel "(011) 211-51365".
d: Bhargav ab:email "bhargavjha@gmail.com" .
Based on above example of Rdf data model, following graph can be drawn:

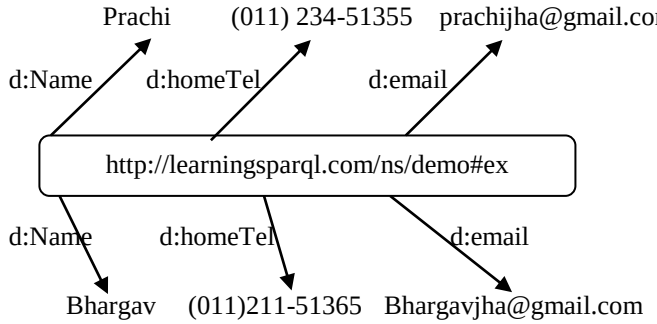


Fig. 2: Graph of the ex.ttl

Thus RDF is the data model for Semantic Web and SPARQL is Query Language for this data model[7]. The existing web search is key based searching and carried out on web1.0 and web 2.0[8]. Web 3.0[9] is future of web searching i.e. semantic web. Web 1.0 is "Readable", web 2.0 is "Writable" and web 3.0 is "Executable" phrase of World Wide Web with interactive data. Example of web 1.0 applications are govt. information portals. Example of web 2.0 applications are Youtube, Wiki, Facebook. One example of web 3.0 application is Tivo(a digital video recorder).

The SPARQL is most suitable querying language for web 3.0 i.e. semantic web. There are various tools available which helps in execution of SPARQL queries and semantic based searching like- Jena Fuseki[11], Virtuoso Sparql Query Editor[12]. To retrieve the web information, the Semantic web technology is the first panacea adopted by Sir Tim Berner's Lee, inventor of WWW(World Wide Web) and his W3C(World Wide Consortium) colleague [21]. The information is now available to both humans and machines. Semantic Web enables users to retrieve information easily and facilitate them to find, view, share, and combine information more conveniently[14].

II. BACKGROUND

[A] DATASETS(FILENAME): EX01.TTL

@prefix ab: <http://learningsparql.com/ns/addressbook#> .
@prefix d: <http://learningsparql.com/ns/data#> .
d:i0432 ab:firstName "Tapan" .
d:i0432 ab:lastName "kumar" .
d:i0432 ab:homeTel "(011) 276-5135" .
d:i0432 ab:email "tapan49@hotmail.com" .
d:i0432 ab:email "tapan49@gmail.com" .
d:i0432 ab:email "tapan49@yahoo.com" .
d:i9771 ab:firstName "Rakesh" .
d:i9771 ab:lastName "ranjan" .
d:i9771 ab:homeTel "(011) 646-5488" .
d:i9771 ab:email "rakesh@gmail.com"
d:i8301 ab:firstName "Gourav" .

d:i8301 ab:lastName "sharma" .
d:i8301 ab:email "gvm@yahoo.com" .
d:i8301 ab:email "sharma@gmail.com"

[B]TOOLS: In this paper I am presenting a study, survey and analysis of Web usage mining using semantic web approach. We will study about semantic web and different query processing tools like- Jena Fuseki tool, Virtuoso SPARQL Query Editor. Some other tools for query execution are Jena ARQ, Twinkle Tool etc. I am presenting here the query execution using Apache Jena Fuseki tool.

a) KNIME: KNIME (read as "naim") stand for Konstanz Information Miner, is developed by KNIME.com AG and written in Java. It is an open source data analytics, reporting and integration platform. Its stable version is released in 6 Dec 2015. KNIME integrates various components for machine learning and data mining through its modular data pipelining concept. A GUI allows assembly of nodes for data preprocessing (ETL: Extraction, Transformation, Loading), for modeling, data analysis and visualization. Since 2006, KNIME has been used in pharmaceutical research, but is also used in other areas like CRM customer data analysis, business intelligence and financial data analysis.

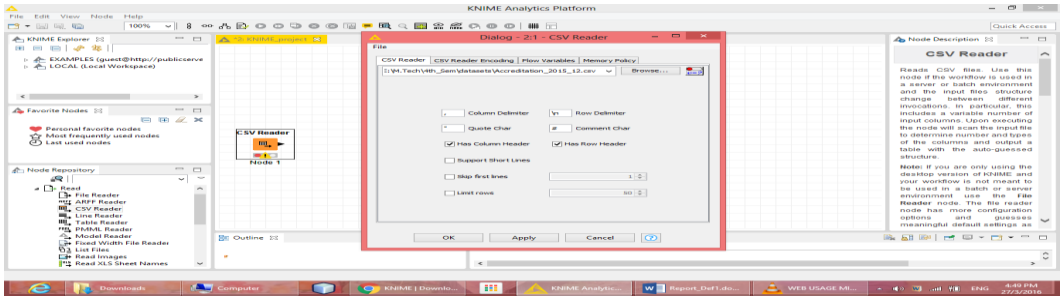
b) **Jena Fuseki Tool**: Apache's Jena Fuseki is known as "SPARQL SERVER" and works as web server triple-store which accepts and execute the SPARQ queries [15]. Fuseki's main screen can be seen at http://localhost:3030/ in the browser after running the server. It provides REST-style SPARQL HTTP Update, SPARQL Query, and SPARQL Update using the SPARQL protocol over HTTP.

c) **QUERYING PUBLIC DATA SOURCES (E.g: HTTP://DBPEDIA.ORG/) Using VIRTUOSO SPARQL QUERY EDITOR:** For querying public data sources Virtuoso Sparql Query Editor Tool is used. Here I am using the Virtuoso version 07.20.3213. Virtuoso provides both a native database capability and a virtual database strength that integrates remote or third-party ODBC data sources smoothly with Virtuoso's own. The virtual database (VDB) allows transparent unified queries across all linked data source [16].

III.EXPERIMENTS & RESULTS

The main idea is Implementation of Web Usage mining Using Semantic Web Approach. Here we are proposing three different strategy using three different tool as describe above.

[1]Using KNIME: - It can be downloaded from its official website www.knime.org.
Step-I: Go to https://www.knime.org/downloads/overview
Step-II: choose your Platform & accept term and conditions.
Step-III: Install & Learn KNIME.
IMPLEMENTATION OF WUM USING KNIME: It works on Node- Connector paradigm.
We are uploading NAC_Test.csv file as a dummy data sets, to show implementation of web usage mining using KNIME tool[16]. NAC_Test.csv file have sufficient rows and columns for such purpose.
Working with KNIME Analytics Tools involves following steps:-
Step- I: Drag CSV Reader Node and click to Configure option. A dialog box will open Adding NAC_Test.csv file to workspace into CSV Reader Node.



Step-II: Right click on CSV reader to see the uploaded file i.e. File Table.

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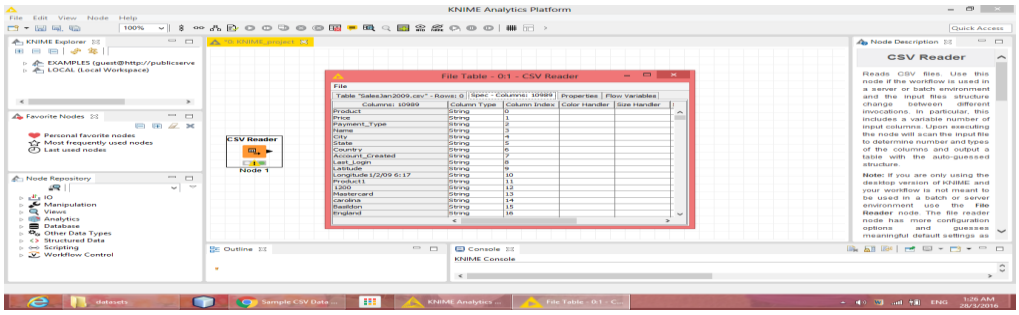
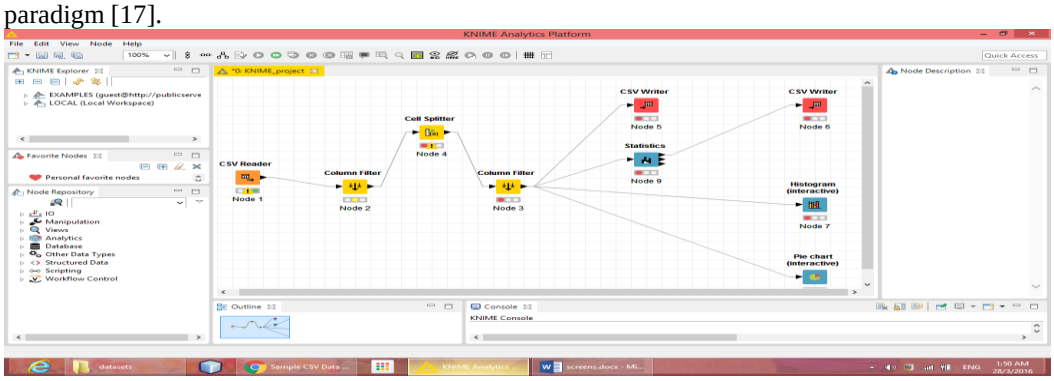
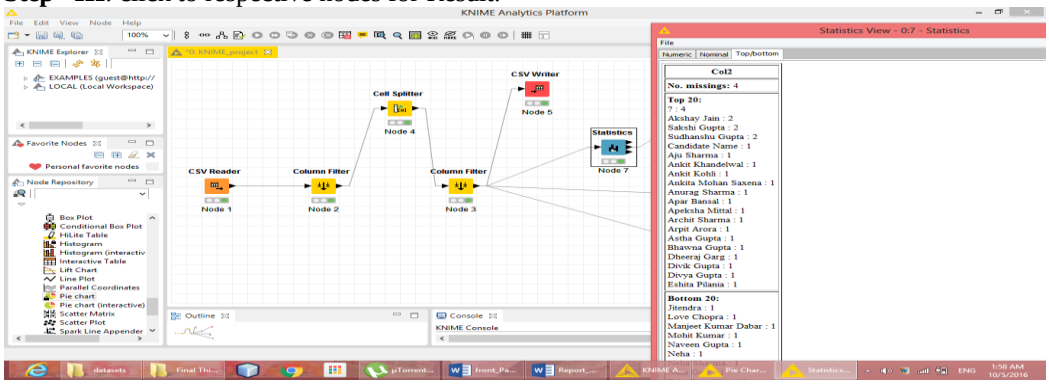


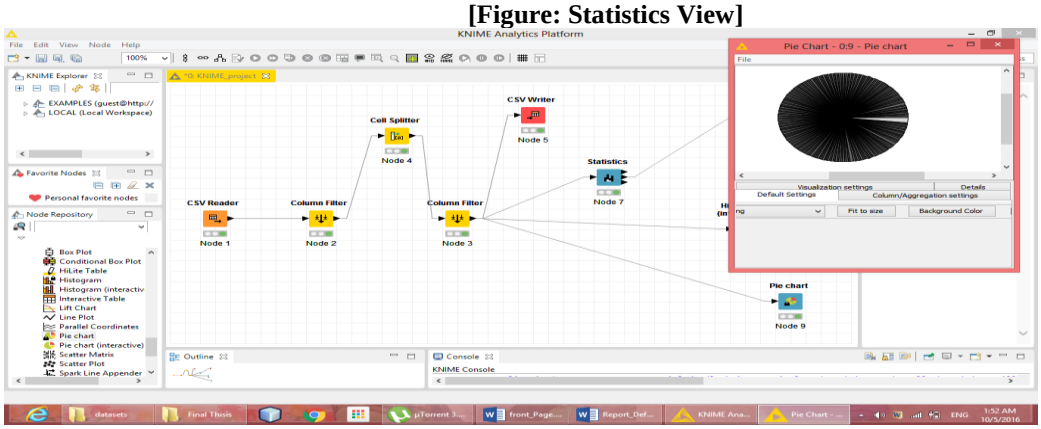
Step –III: Place the respective nodes at appropriate position and connect them as it work on Node- Connector paradigm [17].



Step –III: click to respective nodes for Result:



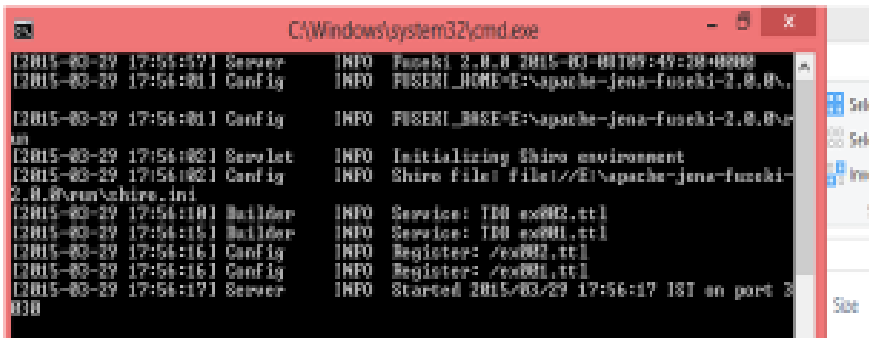
[Figure: Statistics View]



[Figure: Pie Chart View]

[2] Using Jena Fuseki Tool:

#starting of server



#Localhost: 3030 & Uploading your turtle file (dataset)

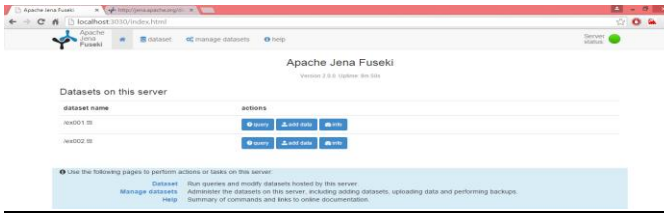


ILLUSTRATION-1: To select all triplets as Subject, Predicate and Object.
Query:
SELECT ?subject ?predicate ?object
WHERE { ?subject ?predicate ?object }
Output Screen:

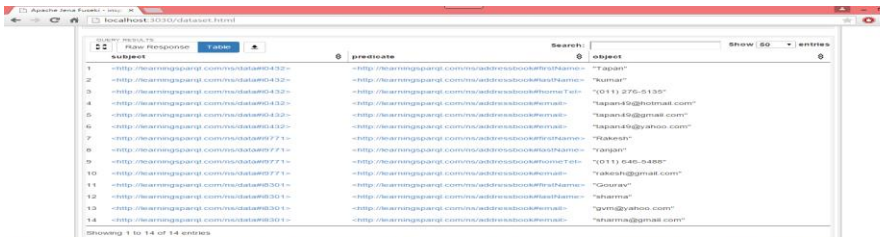


ILLUSTRATION-2: Select the email associated with the person having first name=”Tapan”.
Query: PREFIX ab: <http://learningsparql.com/ns/addressbook#>
SELECT ?TapanEmail
WHERE { ?person ab:firstName "Tapan" .
?person ab:email ?TapanEmail . }
Output screen:

ILLUSTRATION-3: Select the email associated with the person having first name=”Gourav” and last name=”sharma”.
Query:
PREFIX ab: <http://learningsparql.com/ns/addressbook#>

SELECT ?GouravEmail
WHERE
{ ?person ab:firstName "Gourav" .
?person ab:lastName "sharma" .
?person ab:email ?GouravEmail . }
Output screen

ILLUSTRATION-4: Select the first name and last name of person having home telephone number "(011) 276-5135"
Query
PREFIX ab: <http://learningsparql.com/ns/addressbook#>
SELECT ?first ?last
WHERE { ?person ab:homeTel "(011) 276-5135" . ?person ab:firstName ?first . ?person ab:lastName ?last . }
Output Screen:

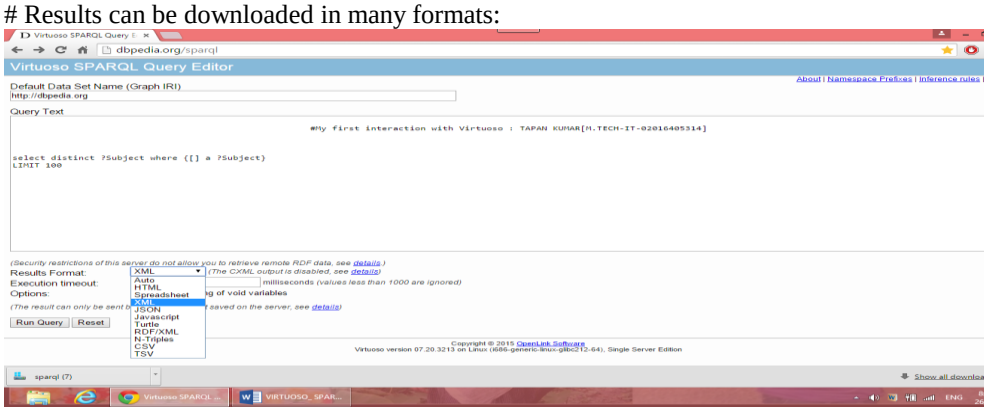
ILLUSTRATION-5: To select Subject(as S), Predicate(as P) and Object(as o) Filter by “yahoo”.
Query:
PREFIX ab: <http://learningsparql.com/ns/addressbook#>
SELECT * WHERE { ?s ?p ?o . FILTER (regex(?o, "yahoo","i")) }
Output Screen:

[3] Using Virtuoso Sparql Query Editor:

ILLUSTRATION-8 #For default dataset: http://dbpedia.org
Query : select distinct ?Concept where
{ [] a ?Concept } LIMIT 100
Query Screen

Output Screen [in Turtle Format]

Results can be downloaded in many formats:



IV. Literature Survey

According to author various research in the area of Web mining leads to confusions regarded the usage of the term Web mining and they also suggested three Web mining categories. They also explored the connection between the Web mining categories and the related agent paradigm. There parameters were based on presentation issues, on the process, on the learning algorithm, and on the application of the recent works[1].

Herrouz, Khentout and Djoudi explained that Web mining uses various data mining techniques to discover useful knowledge from Web hyperlinks, page content and usage log. The main uses of web content mining are to gather, categorize, organize and provide the best possible information available on the Web to the user requesting the information. The mining tools are imperative to scanning the many HTML documents, images, and text. [2].

According to the authors web site structure acknowledge browsing behavior and way of finding results. They explained the profiles of web sites' organizational structure by modeling them as graphs and considering several social network analysis features[3].

The authors aim was to focuses on two important issues: improving search-engine performance through static caching of search results, and helping users to find interesting web pages by recommending news articles and blog posts. Concerning the static caching of search results, they presented the query covering approach. For the recommendation of web pages, they presented a graph based approach, which helps to identify user-log[4].

This paper concerned with the approaches of web substance mining and different uses of web mining. Web contains accumulation of hyperlinks, texts and images. Web mining methods are incredible framework utilized for data extraction. They suggested an organized and extensive outline of the writing in the region of Web Data Extraction Methods and Applications[5].

There are many examples of scientific workflow system and here author's main focus was cheminformatics applications and workflow tools some application of cheminformatics are Pipeline Pilot and KNIME. It works on node- connector Paradigm. Workflow solutions have been used in the field of bioinformatics, "business intelligence" and "predictive analytics". Thus they explained various tools like KNIME[6].

Author's main motive was to explain the technical differences between Web 1.0 and 2.0. They said that Web 2.0 include the growth of social networks, bi–directional communication, various 'glue' technologies, and significant diversity in content types. While most of Web 2.0 runs on the same substrate as 1.0. [7].

Author's main motive was to explain the SPARQL query execution in Semantic Web Data with illustrations. They also explained about RDF and Jena Tools. They proposed a framework to explain various SPARQL query execution techniques. They also illustrated query execution in public data sources using Virtuoso SPARQL Query Editor tool[8].

The author's main objective was study of Ontology , which plays an important role in exchange of information, use of knowledge and its re-use, shared and common understanding of a domain specific knowledge that can be

communicated between people and across application systems which is the goal of semantic web. They explained three main objectives. First, they considers the computer science domain and demonstrates the development of Ontology in this domain using Protégé 3.4 Editor. Second, they explained the techniques and query language SPARQL for data retrieval from Ontology. Third, they suggested an approach for retrieving information from Ontology through natural language queries by demonstrating the layout of IRSCSD (Information retrieval system for computer science domain)[9].

According to author's view extracting social context from online social communities, and a prototype that exploits this information in the browsing process, is critical task. By using the SIOC ontology they got access to high-quality data with rich structure, which they used to directly analyses for implicit social relations. Relations between people can be derived from their online interactions, such as content that they create or reply to. [10].

The author's goal was to provide a more current evaluation and update of web mining research and techniques available. Current advances in each of the three different types of web mining are reviewed in the categories of web content mining, web usage mining, and web structure mining.

They divided web mining processes into the following five subtasks: (1) resource finding and retrieving, (2) information selection and preprocessing, (3) patterns analysis and recognition, (4) validation and interpretation, and (5) visualization. They also done the comparisons and summaries of selected software for web mining[11].

In accordance with the World Wide Web Consortium's work on Web characterization terminology, they reformulated definitions for the main WUM terms. They also proposed new definitions of three other related terms (visit, episode, and Web server log file). In addition, they also formalized and studied the WUM data-preprocessing problem[12].

According author's view SPARQL is the W3C candidate recommendation query language for RDF. They addressed systematically the formal study of SPARQL, concentrating in its graph pattern facility. They provided a compositional semantics. They also compare the semantics to an alternative operational semantics, predicted simple and natural conditions when both semantics coincide and discussed optimizations procedures[13].

Companies have huge amounts of precious data lying around throughout their servers and networks that needs to be moved from one location to another such as from one business center to another or to a data warehouse for analysis. The problem is that the data lies in different sorts of heterogeneous systems, and therefore in different formats. To accumulate data at one place and to make it suitable for strategic decisions we need a data warehouse system. To deal with the problem of time taken by ETL process, in this paper author presented a new technique of ETL using pipelining. They divided the ETL process into various segments which work simultaneously using pipelining and reduce the time for ETL considerably[14].

Author's main motive was to design and integration of the plug-in, and also demonstrate the usage of the nodes on ChEBI, a library of small molecules of biological interest. KNIME-CDK is an open-source plug-in for the Konstanz Information Miner, a free workflow platform. KNIME-CDK is built on top of the open-source Chemistry Development Toolkit and allows for efficient cross-vendor structural cheminformatics. Its ease-of-use and modularity enables researchers to automate routine tasks and data analysis, bringing complimentary cheminformatics functionality to the workflow environment[15].

Author's aim was to characterize of six most used free software tools for general data mining that are available today: RapidMiner, R, Weka, KNIME, Orange, and scikit-learn. The goal is to provide the interested researcher with all the important pros and cons regarding the use of a particular tool. They also done a comparison of the implemented algorithms covering all areas of data mining (classification, regression, clustering, associative rules, feature selection, evaluation criteria, visualization, etc.). This multidimensional overview in the form of expert paper on data mining tools emphasizes the quality of RapidMiner, R, Weka, and KNIME platforms, but also acknowledges the significant advancements made in the other tools[16].

V. CONCLUSION

In this research paper a study ,survey and analysis of the Web Usage Mining using Semantic web approach has been studied using KNIME and Apache Jena Fuseki tool by various illustrations. Also Web usage Mining of public data sources has been studied using Virtuoso Sparql Query Editor Tool by various illustrations.

Web Usage Mining using Semantic web approach has got and continues to get popularity in various applications. As the current system is expected to add more functionality and dependency according to requirement changes and technology, proper working platform has been kept in mind to make it easier for future enhancements.

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