# Survey on ontology Based Semantic Web Usage Mining for Enhanced Recommendation Model

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**Abstract:** Web Usage Mining is the process of extracting useful knowledge such as browsing pattern from weblog. The predicted behavioural pattern from the weblog is used to construct personalized recommendation system for website engineers. Integration of semantic information into web usage miningphases will support intelligent process in the web so as to prune the search space.Ontology plays a pivotal role in integrating semantic information into web usage mining. The deployment of ontology captures the domain of interest which deals machine understandable data on the current human-readable web. This paper discusses various methodologies to create domain ontologies and semantic enhanced web usage mining techniques which add semantic information into weblog data. The paper also discusses the framework of Enhanced Recommendation Model for Semantic Web Usage Mining which includes semantic metadata of web pages.

**Index Terms**— Knowledge Discovery, Ontology, OWL, RDF, Semantic Web, Weblog

## 1 INTRODUCTION

With the rapid growth of internet technologies, web has become a huge repository of information and keeps growing exponentially as the new information is added. It is considered as one of the most significant resource for gathering, sharing, and distributing information and services. The volume of information causes many problems that relate to the increasingly difficulty of finding, organizing, accessing and maintaining the required information by users. User is willing to view the web to access the information quickly and easily. Hence it became more challenging to the website owners to selectively provide relevant information to the people with diverse needs. Modelling and analyzing web navigational behavior is helpful to provide useful information to the user.

This motivated researchers to provide web personalized online services such as Web recommendations to the Web users. In recent times, Web Usage Mining has emerged as a popular approach in providing Web personalization [1].


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The sequence of processes under web usage mining provides a knowledge or pattern of browsing behavior of users. The pattern can be used by the web site owners to modify the structure of web link which promotes the types of customer to the website.

However conventional web usage based recommender systems converts the weblog data into patterns in terms of URL or page address clicked by the past user. The pattern does not contain semantic information because the processes are not using domain knowledge of the web application and their focus is only on web usage data. These patterns do not provide explicit insight into the user's underlying interests and preferences. Exploring semantic information in web usage mining predicts the user preferences effectively in terms of browsing patterns according to the user types. This semantic based navigational pattern will provide additional information for strategic decision making.

### 1.1 Semantic Web Usage Mining and Domain Knowledge

The semantic web is an advanced web technology which has the information in a well defined representation, understandable by the computer. The process of web usage mining is integrating a new semantic structure for generating personalized web experience for the users in the web. The semantic information such as objects of web pages and its relations are defined in the schema called ontology.

An ontology is an explicit specification of a conceptualization i.e., a specification of an abstract, simplified view of a real world domain. A core ontology is represented as a 5-tuple in form of $O: = \{C, R, Hc, rel, A\}$ where $C$ is a set of concepts which represent the entities in the ontology domain; $R$ is a set of relations, defined among the concepts; $Hc$is a taxonomy or concept hierarchy which defines the is-a relation among concepts; $rel$element corresponds to a function, $rel$: $R$ - $>C$ $x$ $C$ that specifies the relations on $R.A$ is a set of axioms usually expressed in a logical language.

The semantic web usage mining process combines the domain knowledge of website into all the phases of web usage mining. The domain knowledge must be represented in the ontology language. Identifying the concepts, Individuals and relations of website domain is a challenging task. The following section explains the methods to construct such ontology for website domain.

## 2. REVIEW ON ONTOLOGY CONSTRUCTION PROCESS

The representation of ontology is commonly defined as an explicit specification of a conceptualization i.e., a model of the real world domain such as Education, Agriculture, Health service, e-government and so forth; which is explicitly represented with existing objects, concepts, entities and relationships between them.

The process of developing ontology for a given domain of knowledge could be a complex and challenging task. Therefore, ontology developers need appropriate methodologies that will guide them in the process of building an ontology characterizing a particular domain. Detailed comparative studies of ontology development methodologies and its framework are provided in [1], [2], [3].

### 2.1.Ontology for no priori knowledge of Domain

The ontology can be build by enterprise ontology development which describes the group of steps and tasks that is to be done for building an ontology if no priori information or ontology. This method of building ontologies starts from scratch, which does not use a-priori knowledge. An example of such a methodology is *OntoKnowledge*(Staab et al., 2001) which proposes a set of generic techniques, methods and principles for each process (feasibility study, initialization, refinement, evaluation and maintenance). Some research work is dedicated to collaborative ontology building such as *CO4* (Euzenat, 1995) and *(KA)2*(Decker et al., 1999). Another research area deals with ontology reengineering (Gòmez-Pérez&Rojas, 1999). Some ontologies can be developed by some Learning methods. Learning methodologies can be distinguished according to their input data type: texts, dictionaries (Jannink, 1999), knowledge bases (Suryanto&Compton, 2001), relational (Rubin et al., 2002), (Stojanovic et al., 2002) and semi-structured data (Deitel et al., 2001; Papatheodrou et al., 2002; Volzet al.2003).

### B. Ontology Learning and Extraction Methods

Learning and extracting ontology from the web is a challenging task. Learning is one of the ontology development process, where the machine learning technique has been used to improve ontology engineering process. The technique is combined with web mining process such as information retrieval and agents to discover the semantics from different types of unstructured and semi structured data.

The Researcher [4] developed a knowledge base from web using machine learning algorithm. The author describes the model as trainable information extraction system that has two inputs for ontology and training inputs. The system learns to extract information from other pages and hyperlinks on the web. Some approaches have been suggested to develop an ontology which describes the group of steps and tasks that is to be done for building ontology. Several approaches focused on discovering taxonomic relations between concepts from web which serve as a building block of Ontology.

The approach described in [5] is based on the methodology to extract information from the web to build taxonomy of terms and web resources for a given domain. This taxonomy represents a hierarchy of classes and gives to the user a general view of the kind of concepts. The approach describes the following steps: (1) extract some keywords representative of the domain, (2) find a collection of web sites related to the previous keywords, (3) exhaustive analysis of each website, (4) the analyzer searches the initial keywords in a web site and finds the preceding and following words; these words are candidates to be concepts, (5) for each selected concept, a statistical analysis is performed based on the number of occurrences of this word in the web sites and finally, (6) for each concept extracted using a window around the initial keyword, a new keyword is defined and the algorithm recursively iterates. In this approach most representative website for each concept are retrieved and categorized. The result produces a hierarchical and categorized organization of the available resources for the given domain. The taxonomy information provides a valuable element for machine processable information in terms of standard representation language: OWL (Web Ontology Language).

The authors in [6] present a method and a tool, OntoLearn aimed at the extraction of domain ontologies from websites. OntoLearn extracts a domain terminology from available documents. The complex domain terms are semantically interpreted and arranged in a hierarchical fashion. Finally, a general-purpose ontology is enriched with the detected domain concepts.

The researcher in [7] proposed a method to extract domain ontology from web sites without using a priori knowledge. This approach takes the web pages structure into account and defines a contextual hierarchy. The data preprocessing is an important step to define the more relevant terms to be classified. Weights are associated to the terms according to their position in this conceptual hierarchy. Then, these terms are automatically classified and concepts are extracted. In (Ben Mustapha et al., 2006), the authors define an ontological architecture based on a semantic triplet, namely: semantics of the contents, structure and services of a domain. This paper focusses on the domain ontology construction and is

based on a meta-ontology that represents the linguistic structure and helps to extract lexico-syntactic patterns. This approach is a hybrid one, based on statistical and linguistic techniques. A set of candidate concepts, relationships and lexico-syntactic patterns is extracted from a domain corpus and iteratively validated using other web corpus.

In [8] the author presents a survey regarding learning methods of ontology from web. This paper proposes a survey of main several approaches of ontology learning from Web. The paper discusses processes of semantic search and ontology learning from texts can collaborate for learning of multilayer ontology warehouse. The paper discusses the incremental approach for ontology learning from web documents and web structure mining based approach for constructing ontology .

Several studies have been dedicated to build ontologies and most of the researchers propose methods for extending an existing ontology with additional information. Few papers propose methods for creating taxonomy of concepts or classes of domain of interest. The machine learning methods have also been proposed to automatically enrich the ontology with semantic relations.

In [9] the author discusses SHOE Simple HTML Ontology Extension, which allows the web user to annotate the pages with ontology information such as content of the page. Separate tags are used to annotate the web pages. This offers an powerful mechanism of Intelligent Agent, which provides a simple way of discovering knowledge in the World Wide Web. SHOE provides ability to define ontologies, extends the ontology, declaring relationships between entities and entity attributes.

## 3. REVIEW ON ONTOLOGY BASED SEMANTIC WEB USAGE MINING FRAMEWORK

Web usage mining process intended to discover navigational pattern left by the past users which can be used to improve the customer service. Several processes of WUM use only the web log data rather than the knowledge. The knowledge representation in term of ontology can also be incorporated in web usage mining called Semantic Web Usage Mining, provides the effective or knowledgeable user preference or path in an effective approach. Several research studies have been done under by integrating knowledge representation into web usage mining process. In this section we discuss various methods of incorporating ontology into mining process.

Several research studies focusses a frame work that discussed user navigational pattern in terms of ontology and integrates this knowledge in to semantic web. Most of the work shows that integrating the semantics involved in structural links with the web usage mining process can improve the discovered patterns. On the other hand much work was also done in the integration of the content features of site with web usage mining process .

The Researcher Berendt et al [10], was the first to explore Semantic Web Usage Mining. The authors presented a Semantic Web Personalization Framework (SEWeP) that integrate Usage data with semantics represented in ontology terms used to produce semantically enhanced navigational patterns that can be used for producing valuable recommendation system. They have elaborated different ways of how the fields of semantic web and web mining can cooperate. The first part of the work is on extracting semantics from web page. The second part is on the improvement of web usage mining by using semantics structures in the form of ontology. The author focuses word disambiguation technique to annotate the website content with ontology terms. The framework exploits the inherent semantic similarities between ontology terms in order to cluster the web documents.

The idea of semantically enhancing the web logs using ontology concepts is independently described by Oberle et.al. [11]. This framework is based on a semantic web site built on an underlying ontology. This site contains both static and dynamic pages being generated out of the ontology. The authors present a general framework where data mining can then be performed on these semantic web logs to extract knowledge about groups of users, users' preferences, and rules. Since the proposed framework is built on a semantic web knowledge portal, the web content is inherently semantically- annotated exploiting the portal's inherent RDF annotations. The authors discuss how this frameworkcan be extended using generalizations/specializations of the ontology terms, as well as for supporting the web personalization process.

Acharyya and Ghosh [12] also propose a general personalization framework based on the conceptual modeling of the users' navigational behavior. The proposed methodology involves mapping each visited page to a topic or concept, imposing a tree hierarchy (taxonomy) on these topics, and then estimating the parameters of a semi Markov process defined on this tree based on the observed user paths. In this Markov models-based work, the semantic characterization of the context is performed manually. Moreover, no semantic similarity measure is exploited for enhancing the prediction process, except for generalizations / specializations of the ontology terms.

The researchers in [13] represent a general framework for using domain ontologies to automatically characterize usage profiles containinga set of structured web objects. This paper discusses a method to use domain ontology to enhance web usage mining for traditional web usage log. The requested URL in the

weblog is represented by entities or concept in domain ontology. Instead of representing pages, the framework assumes the pages as object. The paper discussed the framework in the context of web personalization, using the full semantic power of the ontology. The goal of this paper is to represent usage profile of user with not simply as a set of pages, but as a set of objects / concepts embedded in the user navigational pages. The work in this paper also discusses the method of characterizes a behavior of user based on the common objects in the domain ontology.

The researcher Eirinaki et al [14] obtained Concept logs (C-log) by enriching web server log record with keyword from a taxonomy representing the semantics of the requested URLs. The C-logs are used as input of web usage mining process, resulting in a semantically focused set of recommendations. The author have implemented the DBSCAN clustering method for clustering the document.

The researcher [15] have proposed an approach called Web Usage Analyzer, based on the integration of the design-time conceptual models of the application and the usage data collected at runtime. The first module is the Log Synchronizer, which takes in input: The Application Server Logs, which are logs in the ECFL (Extended Common Log Format) format, also including user session identifiers; The WebML Runtime Logs, which stores events and data produced and consumed by the application runtime for serving page requests. The module synchronizes these data and produces a unified XML representation of the available logs, called as Synch Logs. The central contribution is the Web Usage Analyser, a software module that collects application server and runtime log data and
merges them with the conceptual schema of the application, using XML as a common format for representing both data sources. The resulting conceptual logs are then fed to an XSL-based processor, which extracts useful reports about the data access, hypertext access, and navigation paths occurring at run time. These reports quickly highlight weak design decisions and can be used to put in the necessary corrections.
The original features of the proposed technique and tool can be summarized as follows:

- Web usage data are expressed in the same vocabulary as the conceptual models (e.g., they refer to entity, relationships, content units, pages, areas, and so on). This eliminates the impendence mismatch between log data and design documents, which occurs when conventional, low-level log analysis tools are used and even permits to display web usage statistics directly on the conceptual design diagrams.
- The proposed framework is easily implementable and adapts well to any web conceptual model. The pre-requisites for its Implementation is the capability of logging a few data on the objects and object types involved in the computation of page contents. The required data have minimal size and their calculation does not impact sensibly the overall runtime performance

In [16] the author uses semantic web usage mining approach for discovering periodic web access patterns from annotated web usage logs, which incorporated information on consumer emotions and behavior. In this work the log data are annotated with emotional influences of user and topic of interest. The author presented an approach for automatic generation of personal web usage ontology of periodic access patterns from web usage logs. Here the author used fuzzy logic to represent temporal concepts and requested resource attributes. Web access activities are modeled using personal web usage lattice and from this personal web usage ontology is generated and written in OWL.

In [17] the researchers adopt the Uschold and Kong ontology building methodology to build a domain ontology describing the semantic content of a government service domain. The author discussed UML method to represent domain knowledge. Finally Protégé and Jena API are employed to build a Web Ontology Language (OWL) and Resource Description Frame Work (RDF) representations of the domain ontology.

In [18] the researchers integrated the semantic information in the web usage mining process. In order to integrate semantic information the authors extend the classical workflow of the web usage mining process with new steps of integrating domain knowledge in the form of ontology. The author considered the domain ontology created by the ontology engineer. Server log files are preprocessed to remove irrelevant requests. The cleaned and filtered web log file is passed to ontology based web log parser and all the ontology instances represented by the web pages are extracted. Sequential pattern mining technique, a variant of A priori algorithm enhanced by semantic information are applied over the sematic objects to discover the frequent sequential patterns. The frequent navigational patterns are extracted in the form of ontology instances instead of web page views and the resultant semantic patterns are used for generating web page recommendation to the user.

In [19] the researchers focus Semantic Aware Web Usage Mining framework called SemAware. They described the method of integration of semantic information into web usage mining process. They used the domain ontology and applies the sequential pattern mining algorithm on it. It prunes the search space in the mining process of the web log. Also the paper discusses Markov model and probability matrix with semantic information to predict the next page available. The method avoids the problem of ambiguous prediction.

In [20] the researchers characterize the website based on semantics of queries. They linked the entities in

the queries to the Linked Open Data(LOD) available on the web such as Dbpedia and Freebase which will provide background Knowledge of all entities of query log. After linking each entity has its type, attribute relationship and permanent identifiers. They used semantic details in the pattern mining and prediction process.

In [21] the author discussed the semantic web usage mining process by a concept based approach. In order to perform a semantic web usage mining, it proposed a hybrid system has a traditional solution with a concept based classification of documents. The conceptual based classifications of web document are performed using fuzzy reasoning model.

In this system [22] three models are implemented. In the first model ( DomainOntoWP) domain ontology is constructed, which represents the domain knowledge of a web site. To construct the domain ontology, the keywords from the webpage title is extracted and assumed each keyword represents the concept of the domain. Ushold andGruminger 's hybrid approach is used to develop the taxonomic relationship between the concepts. In the second model (TermNetWP) the semantic network of a website is automatically derived which represents the association between the terms and webpages. The domains concepts and co-occurrence relations are weighted to identify the sematic relationship between the terms. Based on the relationship relevant pages for the given website are identified. The third model is a conceptual prediction model (TermNavNet) gives the webpage recommendations by integrating the domain knowledge model ( DomainOntoWP) and semantic network model(TErmNetWP) with the web usage knowledge discovered form the web log files using a web usage mining techniques.

In this system [23] Markov chain model is enhanced with the semantic metadata of web pages and it is used to generate next-page recommendations. This Semantic Variable Length Markov Chain Model (SVLMC) combines fields of Web usage mining and Semantic web by enriching the Markov transition probability matrix with rich semantic information extracted from web pages. Two open source web servicesOpenCalasis and Alchemy API are used to extract semantic meta data from web pages.

## 4.SEMANTIC ENHANCEDRECOMMENDATION MODEL

Many researchers are trying to provide semantic based knowledgeable web personalized recommendation system for website visitors. The conventional web usage mining based recommendation system does not support personalized service for new users. They have limited ability to use domain knowledge of web log files. In this paper we would propose a frame work which integrates semantic information in all the phases such as preprocessing, pattern discovery and pattern analysis of web usage mining process. Every phase includes the definition of all entities in web log data. Hence the knowledge based processes can be performed in all phases of Web Usage Mining.

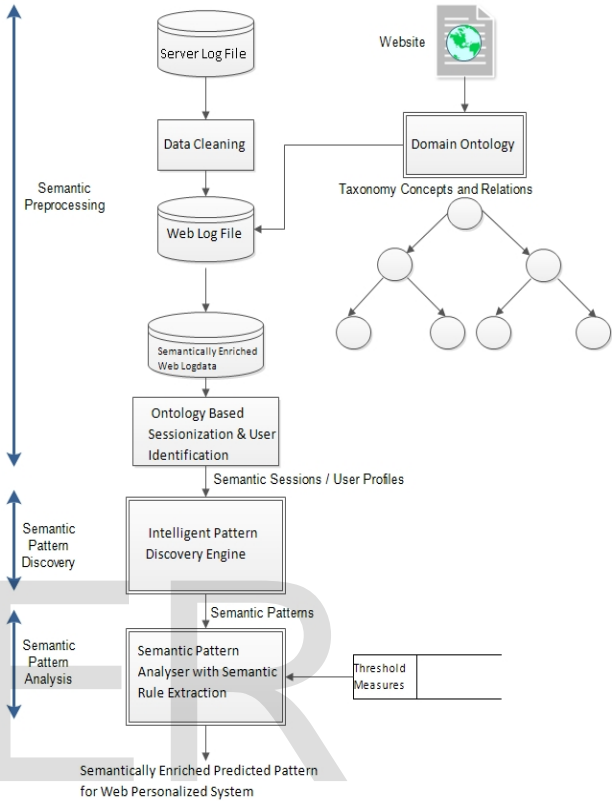


Fig.1 Framework for Sematically Enriched Web Usage Mining for Recommendation Model

We have proposed the recommendation model incorporating semantic information in web usage mining process as shown in figure-1,which outlines the proposed architecture.

The proposed Recommendation Model performs mining process in 3 phases, such as Semanticpreprocessing, Semantic Pattern Discovery and Semantic Pattern Analysis.

In the recommended framework, the Semantic Preprocessing phase incorporates the processes like data cleaning, a server log file is preprocessed to remove unnecessary information then the user and their corresponding sessions are identified. The URL (Web page) in the session are enhanced with semantic information, then semantic based sessions are identified. The next phase called Semantic Pattern Discovery applies semantic based efficient Data Mining techniques on session sequences so as to predict knowledgeable patterns. The final phase of the framework called semantic pattern analysis performs the

semantic rule extraction process which combines the usable threshold values in order to find the effective and value based intelligent rule to make the strategic decision making process in Business Intelligent. Our proposed model is an Integrated system consists of Semantic based three phases performs together to predict the Intelligent pattern for Web Usage Mining applications.

## 5. CONCLUSION

This paper discussed the various framework and methodologies to create domain ontologies which adds semantic information into weblog data and analyzed research work of ontology based semantic web usage mining process. Adding semantic information into the web usage mining process can provide us with more interesting patterns, compared with the patterns given by the conventional web usage mining process. This paper proposed an Integrated architecture contains three phases. Semantic Preprocessing removes irrelevant request and add ontology structure of web pages. The ontology structure consists of taxonomy of classes, relations and properties of classes in a web site structure. Intelligent Pattern Discovery Engine identifies semantically enriched patterns. Finally Semantic Pattern Analyser predicts the pattern based on threshold values for personalized system.



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