Semantic Web Personalization Domains

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ABSTACT: *Semantic Web is the next generation web where information is given well defined meaning by being organized into conceptual spaces called as ontologies. Intelligent processing is done by using ontology relations conditions and restrictions. Personalization is adaptation of information according to user needs. Personalization when applied to Semantic Web produce much better results when compared to traditional web therefore Semantic Web provides a better platform for realizing personalization. This paper explores the various domains in which Semantic Web personalization have been successfully applied in the last few years.*

Key Words: Semantic Web, Ontologies, Personalization, Recommendation, User Profile

Received: 10 September 2014, Revised 11 October 2014, Accepted 14 October 2014

1. Introduction

1.1 Semantic web

Semantic web mining integrates semantics with the unstructured data on web making it machines understandable so that intelligent techniques can be applied to get more efficient results [1, 2]. Semantics can be used to improve mining and mining can be used to extract semantics. The semantic web has a layer structure that defines the levels of abstraction applied to the Web.

Advantages of Semantic web mining over Web Content, Structure, Usage mining are given as follows

1.1.1Semantic Web Content Mining

Web mining computes the similarity between documents by binary matching without taking actual semantic similarity. In semantic web we can overcome the problem of binary matching by using hierarchical relationships and computing the semantic similarities among the ontology terms. The semantic web structures, such as ontologies enable a uniform and more flexible document matching process in semantic web. Ontology maps the keywords to the concepts of an ontology, or topic hierarchy.

1.1.2 Semantic Web Structure Mining

In Semantic web structure mining the users' navigational behavior is studied in terms of ontology. The extracted paths of navigations are mapped to ontology term generalization and specialization can be applied to concepts of ontologies to derive

personalization information for a particular user based on his profile. The knowledge of user navigation behavior is integrated in semantic web sites.

1.1.3 Semantic Usage Mining

Standard Web usage mining processes leave aside semantic information from web documents that may lead to poor, erroneous, hard to interpret and far from real visitors' preferences results. Semantic web usage mining take into account not only the information stored in server logs, but also the meaning that is constituted by the sets and sequences of Web page accesses.

2. Personalization

2.1 Web Personalization

Personalization can be applied to various aspects of a website which can be broadly classified as

• Navigation personalization

Navigation is the process of following links and browsing web pages. Navigation is necessary because it is not normally possible to satisfy all user needs on a single web page or on the first visited web page. Navigation personalization generates hierarchy of a set of web pages for users depending on their search path followed in past and their interest profile.

• Content personalization

Content personalization generates recommendations based on the contents of web pages viewed by user and his interest profile; it involves user adaptation of information presented on a website.

2.1.1 Required Data for Personalization

The data collected and used for personalization are basically classified in four categories as follows [3].

Content

The data that is presented to end user appropriately structured is called content data. These data can be structured data, such as information retrieved from databases or simple text, images.

Structure

The way content is organized is represented by structure data. Structure data can be either data entities used within a Web page, such as HTML or XML tags, or data entities used to put a Web site together, such as hyperlinks connecting one page to another.

Usage

The web site usage is represented as usage data, usage contains data such as, path of files or directories accessed, address referred, IP address of visitors, information regarding time and date of access and other attributes that can be included in a Web access log.

User Profile

The data about the users of a Web site is provided by a user profile. A user profile contains preferences ,interest ,age and demographic information such as name, age, country, marital status, education, interests etc for each user of a Web site, user profile can be acquired either explicitly or implicitly, explicit profile is acquired through registration forms or questionnaires, and implicit profile can be inferred by analyzing Web usage logs.

2.1.2 Analysis of Data

After collecting the data it has to be analyzed, there are broadly four basic ways used for the analysis [3].

• Content-based filtering,

• Collaborative filtering,

• Rule-based filtering

• Web usage mining.

Content-based Filtering Systems

User preferences are used in Content-based filtering system solely to make recommendations of items. The behavior of each user is tracked and a set of items are recommended to user based on items that a user has liked in the past. Similarity measures are used to compute the similarity between the new items that are recommended and already liked items by users.

Collaborative Filtering Systems

Recommender systems based on collaborative filtering predict user preferences for products or services by learning past user-item relationships from a group of user who share the same preferences and taste. Collaborative filtering system makes prediction based on the similarity between new individuals and existing data. Collaborative filtering systems invite users to rate objects or divulge their preferences and interests and then return information that is predicted to be of interest for them. This is based on the assumption that users with similar behavior (for example users that rate similar objects) have analogous interests.

Rule-based Filtering Systems

Users are required to answer a set of questions in rule-based filtering system. A decision tree is used in rule based system and these questions are derived from a decision tree and as the user proceeds on answering them, what she/he finally receives as a result (a set of products that are recommended). The result is tailored to their needs.

Content-based, rule-based and collaborative filtering may also be used in combination, for deducing more accurate conclusions.

Web Usage Mining

Statistical and data mining methods are used on web log data in web usage mining analysis, which produces a set of useful patterns as a result indication the users' navigational behavior. Web usage mining employs data mining methods such as association rule mining, sequential pattern discovery, clustering and classification. Personalization of site is done by according to each user's behavior, profile and the knowledge derived from application of data mining methods. Personalization of site can be carried through the highlighting of existing hyperlinks, the dynamic insertion of new hyperlinks that seem to be of interest for the current user, or even the creation of new index pages.

2.1.3 Importance of User Profiling for Personalization

User profile plays a significant role in personalization. The difference between recommendations system and personalization systems is the personalization system takes user profile in context to make recommendations where as the recommendations system can be considered as "non-personalized " if they recommends items without considering user profile. The most important task in personalization of a Web site is to identify and distinguish between different users or groups of users. This process is called user profiling. User profiling creates an information base that contains information regarding the preferences, characteristics, and activities of the users. User profiling is mainly used in e-commerce, because Internet technologies provide easier means of collecting information about the users of a Web site, which in the case of e-business sites are potential customers. Modeling user profiles is an important part of the personalization. Various methods can be used to collect user information and to compose user profiles from this user information. User information can be obtained explicitly or implicitly.

Explicit Profile

Explicit profile is also called as static profile. Explicit profile is collected as online forms, questionnaires and reviewing. The information collected is structured in order to create static profiles.

Implicit Profile

Implicit profile is also called dynamic profile. Implicit profile is created by observing the preferences and behaviors of each user and are recorded and analyzed through cookies and log files.

2.1.4 Data used for Implicit Profile

User behavior is observed for the creation of implicit profile. Personalization techniques can use the information regarding selection of navigation path or content to learn about user profile [3]. Two most widely used techniques for construction of user profile are given as follows

Web Usage Data

Web Usage Mining (WUM) data is used for the construction of user profile. Raw web usage data contains hidden valuable information about user which can be used for constructing user profile**.**

Cookies

A cookie uniquely identify a user during Web interactions within a site and contains data parameters that contains information about what actions the user has taken at a remote site and also allows the remote HTML server to keep a record of the user identity. A cookie file contents depend on the Web site that is being visited. In general, information about the visitor's identification is stored, along with password information. Credit card details can also be stored as cookie content if the visitor is carrying out online transactions. Cookies can be used for constructing the implicit user profile because cookies point back to more detailed customer information stored at the Web server.

2.1.5 Significance of Implicit Profile

The main advantage of implicit profile is that it does not require any additional intervention by the user during the user modeling process. The main drawback of implicit profile techniques is that they can typically only capture positive feedback i.e. when a user clicks on an item, this means that a use has some degree of interest in that item, But what happens if a user fails to examine some data item (negative feedback), i.e. when he is not interested in that item is not captured by implicit profiling.

2.1.6 Privacy Issues

Privacy is the most important issue that is encountered during the user profiling. In many cases user does not like their behavior to be studied and all actions to be recorded without his consent. If a user has agreed to supply personal information to a site, through cookie technology then he will not be aware that the cookie information can be exchanged between different sites, resulting in disclosure of his private information to other site without the user's permission. P3P (Platform for Privacy Preferences) is a W3C proposed recommendation that suggests an infrastructure for the privacy of data interchange. This standard enables Web sites to express their privacy practices in a standardized format that can be automatically retrieved and interpreted by user agents.

2.2 Semantic Web Personalization

2.2.1 Features of Semantic Recommendation Systems

The semantic web system are characterized for incorporating semantic knowledge in their recommendation processes to generate high quality recommendations by taking advantage of current Semantic Web technologies. Most important issue in deploying recommender systems into the Semantic Web is the decentralization [4].

Ontology

The main difference between web and Semantic web is the Semantic Web is made up of machine readable content distributed all over the web this machine readable content should be represented in some format so that interoperatibily can be obtained between two machines and to ensure that agents can understand and reason about the respective information we establish ontologies or common content model. Ontology is the backbone of semantic web. The first step towards semantic web is to use the existing web to extract ontologies that can be used by semantic web.

Communication

Semantic web recommendation system is a decentralized recommender. Aggregation of distributed metadata constitutes a Semantic Web, which represents an inherently data-centric environment model. In semantic web communication is carried by the exchange of asynchronous message, hence the communication is restricted to only asynchronous messages. The messages

are exchanged by publishing or updating documents encoded in RDF, OWL, or similar formats.

Scalability

The Semantic Web contains millions of machine-readable pages. To predict the computational complexity and to obtain scalability efficient filtering techniques have to be used in semantic web to filter out pages while, maintaining reasonable recall, i.e., not sacrificing too many relevant pages.

Security

Because of decentralized nature of semantic web it does not have means to control the users' identity and penalize malevolent behavior which is present in centralized systems. Semantic Web cannot prevent deception and insincerity. Spoofing and identity forging thus become facile to achieve. Some subjective means enabling each individual to decide which peers and content to rely upon are needed to be incorporated in semantic web.

Profile

Semantic web does not impose any restrictions on agents regarding which items to rate. The interest profiles which represents the user's opinion for every product which is generally represented by vectors may become large and sparse, in order to reduce dimensionality and ensure profile overlap, new approaches are needed in order to make profile similarity measures meaningful.

2.2.2 Requirements of Semantic Web Personalization

Different kinds of knowledge [5] about user context and domain are the primary requirement for personalization of semantic need that are.

- Knowledge about the user
- Knowledge representing user's goal
- Knowledge about the context,
- Knowledge about the Domain

2.2.2.1 Knowledge about the User

The Knowledge about the user can be divided in two categories first category represents the generic knowledge about the user's general characteristics that do not change with time ex:general information of user, static preferences, interest and other category represents in state knowledge that change with time with respect to particular applications systems.

2.2.2.2 Knowledge about User's Goal

Most of the time a user's goal is considered as being coincident with a query but there are some other goals that the user might think of while performing personalization. Broadly there can be three different types of goals

Interest

The goal corresponds to a general interest of the user in some applications.

Conditions

Conditions embedded in rule can be used as goals in others applications. A rule is triggered when an event satisfying a rule condition occurs and the user is informed regarding the satisfactions of a rule in a way that can be subject to further personalization.

Learning

Learning is a third kind of goal, is more abstract and cannot be directly interpretable as a query. A learning goal is a description of the expertise that a user would like to acquire .The information of learning goal is used by the system to build a solution that contains many Web resources, to be used as learning materials. The learning materials are not the direct solution but the learning

goal will be reached by the user if s/he will follow the proposed reading path i.e. the composition of resources is a means for reaching the learning goal.

2.2.2.3 Knowledge about the Context

Context represents the knowledge about the resources that can be queried, retrieved or composed. For carrying out effective personalization the correct resource has to be selected from a set of candidate resource. Knowledge about the context plays a very important part in performing resource selection. In many applications, three kinds of contextual information can be identified:

• Location in Time

• Location in Space

• Role

Location in Time and Space

The context description for Location in time and space can obtained from other information sources and is not necessary taken directly from user. If context descriptions in location and time are chosen for refining resource selection, then only those resources that fit the context description are displayed.

Roles

Predefined views are called as Roles there is a restriction on the action that the role players can execute. They are used to personalize the selection of information sources, the selection of information and, of course, presentation.

2.2.2.4 Knowledge about Domain

Domain knowledge is used by the inference mechanism for obtaining personalization. The aim of Domain knowledge is to give a structure to the knowledge. Domain knowledge represents high-level description of the structure of interest that is not related to a specific material which can be personalized and filled with contents on demand, in a way that fits the specific user. Semantic web constructs the Domain ontology to represent the knowledge about the domain in ontology terms so that it can be machine understandable. The ontological terms are related by domain knowledge in a way that can be exploited by other inference mechanisms not only to perform personalization but also ontological reasoning. It is especially at this level that rules can play a fundamental role in the construction of personalization systems in the Semantic Web.

2.2.3 Recommendation System Vs Personalization System

Personalization can be considered as a form of Recommendations where we consider the user profile for making recommendations where as a recommendation system can be considered as non-personalized system where the recommendations are made without considering the user profile hence the same set of recommendations will be generated for any user irrespective of his preferences. Personalized recommendations are based on user data which is collected and represented into user profiles. The general process that is followed in personalized recommendation systems consists of an iterative process that can be defined by two main stages.

User Modeling

User profiles are created and maintained in user modeling process by collecting data from various sources of feedback. User modeling can be performed either implicitly observing user behavior or explicitly requesting direct input from the user.

Generating Recommendations

The second step consists of generating recommendations based on combination of knowledge collected by the user profile and results obtained from combining different recommendation techniques.

2.2.4 Use of Semantic Personalization Systems

There are two basic uses of Semantic web personalization system

• Personalized Recommendations

• Personalized search

Personalized Recommendation systems do not ask the user to submit the query. Recommendations systems look for the users' needs more actively. Most search systems ask users to submit information needs with queries. Search systems receive the

Domain	**User Modeling**	**Recommendation Technique**	**Personalization**
E-commerce	Vector Space Model Explicit feedback (ratings)	Collaborative Filtering (User-based)	Recommending Top-N items
Travel Support System	Ontology model Explicit and Implicit feedback Tree coloring method	Content-based	Ranking the recommendations based on conditional probabilities
Scientific papers	Explicit and Implicit feedback	Content-based	Ranking the recommendations based on recommendations confidence
Job Recruitment	Tree coloring method Taxonomy model Explicit feedback (via web forms) Created by the user	Content-based	Matching the Applicants RDF profile and job requirement
Music	Ontology model Created by the user Implicit feedback (listening habits) Tree coloring method	Content-based	Combining the implicit feedback and semantic description of music
T.V	Ontology model Explicit and Implicit feedback Domain inferences (upwards) Tree coloring method	Content-based (case base)	Inference techniques based On complex associations
E-learning	Ontology model represents students	Content based	Based on information needs represented as student profile
NEWS	Graph based visualization knowledge base	Content based	Selecting NEWS items of interest and writing the query for fetching the relevant items
Ad-Recommendations	Domain ontology	Content based	Generating recommendations for semantically related Ads based on the user profiles

Table 6. Comparison of Application domains

needs passively. There are many problems associated with submitting queries to search system ex if a user does not know keywords of item exactly, he/she may hesitate what queries have to be submitted. Moreover if a user submits wrong queries that are not relevant to items, he/she may be dissatisfied with search results. To solve these problems, personalized recommendation systems are proposed.

3. Domains of Semantic Web Personalization

In last few years many domains have successfully used the semantic web technologies to improve the accuracy of the personalized recommendations few among them are listed below.

3.1 E-commerce

Semantic web personalization is applied to e-commerce domain to overcome the product overload of internet shoppers. Semantic recommendation procedure proved to more efficient than the traditional recommendations procedure when applied to Internet shopping malls because the semantic recommendations use the semantic knowledge about the products to make recommendations [6]. The techniques of web usage mining, product classification, association rule mining, and frequently purchasing habits are used to carry out semantic recommendations. The job of Web usage mining systems is to discover user file by running any number of data mining algorithms on usage data which is gathered from one or more Web sites. Thus the user need not specify rating nor explicit preferences. The profile is dynamically generated from usage information. The products are represented as a set of classes with attributes among the set of attributes subclass attribute is used for classification of products.

Personalized recommendations are produced by classifying the products and customers into classes, identifying the active user who can buy the product among a set of customer, determining the class of the active user, finally recommending the Top-N items from the customer product matrix.

3.2 Travel Support System

Semantic web technology can be used to personalize the access to travel support system based on explicit and implicit user preferences [7]. The systems take the input from verified content providers which are the sites that provide reliable and consistent information and from other sources that consists of unverified unstructured internet based information. The inputs are processed by content collection system which stores the information in the forms of semantically demarcated token describing the world of travel each token represents an instance of a concept defined by our travel ontology. The content management subsystem manages the central repository containing travel data.

Personalization is performed by the content delivery subsystem which manipulates the data stored in the central repository for delivery to the user based on the user preferences and submitted queries. User preferences are represented as a user profile which is created by collecting user opinion of objects from the travel ontology. We use RDF reification to attach meta-statements to the opinion statements in the user profiles. A user profile can be represented as a probability graphs with the probabilities for each statement, we can also derive conditional probabilities for each statement which specifies the strength of user preferences. The statements with high conditional probabilities represent strong user preferences which can be used to rank the recommendations results.

3.3 Scientific Papers

Semantic web can be used to make recommendation for online research papers [8]. The approach used for making recommendations first collects the user profile by logging all URLs visited by the user next the nearest neighbor algorithm is used to classify the URLs based on the training set of labeled example papers. Explicit feedback is collected when a user looks at the pages. First step required for generating recommendations is the computations of correlations between paper topic classifications and user browsing logs. A count is accumulated as an interest score for the topic when a user browses a research paper that has been classified as belonging to that topic. Explicit feedback on recommendations also accumulates interest value for topics

In order to make personalized recommendations we compute the correlations between user profile and users current topics of interest and papers classified as belonging to those topics. In order to ensure that no repeated recommendations are given to the user recommendations are produced for a paper only if it does not appear in the user's browsed URL log. The top three interesting topics are selected based on the interest count, total ten recommendations are produced by ranking the papers in order of the recommendation confidence.

3.4 Job Recruitment

Semantic web technologies can be used for generating personalized online job information [9]. The advantages of using Semantic web technology are the increase in market transparency, reduced cost of transactions for employers. The recruitment process is carried out in four basics steps. The first step consists of requirement analysis which represents the details of job posting and is represented as controlled vocabularies. The second step is publishing of job postings on the companies' web sites which are done using controlled vocabularies and RDF data formats. The posting are crawled by the job portals. Semantic matching is carried out between the posting and background knowledge of an industrial domain by the job portals. Third step is the receiving and pre selections of job applications where a job applicant RDF profile is created and sends to the different employers. Last step consists is interview in which an applicant is accessed for his skills by a face to face meeting.

Personalization is done at the job recruitment by forwarding the applicants profile to the corresponding employers based on the semantic matching which is computed between the applicants RDF profile and job descriptions posted on the employers web site. The annotations using the controlled vocabularies are combined with the background knowledge about a certain applications domain by semantic matching.

3.5 Music

Semantic recommendations can be used for generating recommendations for music based on the FOAF and RDF site summary (RSS) vocabulary which is used to gather music information [10].To make recommendations we use the user FOAF information, context information which is gathered from music related to RSS feed, content information which is extracted from the audio itself, and a common music ontology which is used for mapping music related concepts.

Personalized recommendation system combines the implicit feedback based on listening habits and the semantic descriptions of the music available to make high quality recommendations.

3.6 T.V

Semantic web can used for making recommendations for TV programs by using OWL ontology in the TV domain to recommend items semantically associated with the user's preferences which is collected by an explicit and implicit feedback [11]. AVATAR is a TV program recommendation system that uses a tree coloring method that is based on a combination of different semantic associations among the domain concepts. AVATAR exploits the hierarchical structures of defined ontology classes to make upward domain inferences.

Personalization is performed by applying inference techniques. Reasoning about the semantics of items and user preferences are performed to discover complex associations between them, which provides additional knowledge about the user preferences, and permit the recommender system to compare them with the available items in a more effective way. AVATAR is a flexible recommendation strategy which can be applied to many recommender systems, regardless of their application domain.

3.7 E-learning

Semantic web technologies can be used in education systems to provide more personalized and intelligent learning environment [12]. The use of semantic web can accomplish AAAL :Anytime, Anywhere, Anybody Learning where most of the WWW resources are reusable learning objects and personalized learning material can be provided for students, data can be collected related to interaction between students and web environment, service can be recommended based on the students needs. Semantic web based education system helps the user by guiding and helping them to accomplish their goals, this is achieved by using ontologies which assure interoperability between educational system and Tutoring agents which helps the process of learning by evaluating similarity between profiles ,recommend educational content, compose semantic web services for education. A set of tools and services are required to make the content of semantic web machine process able and machine understandable.

Therefore semantic web technology can be effectively used for generating personalized recommendation for students based on their information needs which are represented as student profile.

3.8 News

Semantic web based personalization can be performed on NEWS by using ontology based framework [13].The heart of this framework is the knowledge base which describes the general domain the user is interested in. The first phase of personalization is the classification phase which classifies the news using natural language processing techniques. The output of the classification phase is stored in the form of NEWS ontology. The second phase consists updating of knowledge base which scans the News

items to find the information, reorganize the concepts in the knowledge base and detects the changes in the real world by using a set of rules. A lexicographic patterns and a set of actions from a rule which has syntactic argument based on ontology classes along with one or more actions which should be executed once the pattern is found. Actions are of two types Add action which adds a news items to NEWS ontology and Remove action which removes items from NEWS ontology. Actions must be ordered as they update the News ontology.

Personalization is performed in two basic steps. First step consists of query formulation which consists of user choosing the concepts of interest using graph based visualization of knowledge base after choosing the concepts of interest the user can specify the keyword based query along with the timestamp. Second step is query execution which executes the query by fetching all news items relevant to the query and results are presented with the most relevant item at the top and least relevant item at the bottom.

3.9 Ad-Recommendations

Semantic web can be used for generating personalized Ad recommendations [14]. The user profiles are generated in this approach by analyzing the contents that are consumed by a user and extracting the semantic information based on the domain ontology. This information is transferred into a set of user preferences which are stored in semantic user profile.

Personalization is performed by generating a set of recommendations for semantically related Ads based on the user profiles. The degree of confidence that a user might like an Ad is used for ranking the Ads to achieve more accurate recommendations. Comparison of application domains is given in Table 6.

4. Business Benefits of Personalization

Business benefits of personalization are many because personalization can be applied to many types of contents as discussed in the previous section. Many business goals are achieved by applying personalization techniques. In this section we focus on the most significant business advantages of personalization.

4.1 Attracting Customers

Personalization can be used to place interesting contents in front of the browser such that a browser will be tempted to buy the products which increase the sales of the sellers. The content that is placed will be personalized based on the browser preferences.

4.2 Friendly Interface

Personalization acts as a friendly interface which guides the customers to purchase items. Along with the information of the required item the customer is given additional information regarding other items which he may find interesting depending on his profile.

4.3 Provides Offers

Personalization helps the sellers on web to provide exciting offers to the customers so that customers will bookmark the site and return to the site later. Personalization helps to retain customers by enhancing the site stickiness.

4.4 Reaching Back Customers

Personalization can be used to reach back customer who has purchased certain items from a site via email or other means to let them know that the site has some new items which may be interesting to the user. These notifications are personalized with respect to the personal profile of the customer.

4.5 Success

Personalization can be used to access the success of particular site by measuring the increase in sales, items per sale, site traffic, and conversions. Personalization converts the browser to buyers and success is measured after and before the applications of personalization so that we access what benefit the personalization has offered.

4.6 Fixing Price and Promotions Strategies

Personalization can be used to decide the prices of items and for deciding the promotion strategy for items. Individual prices can be fixed depending on the preferences of the user. When individual prices are used it becomes difficult to maintain consistent

marketing strategy therefore we use individual marketing strategies depending on the purchasing habits of the customers.

5. Metrics

The metrics used for personalization can be categorized into two categories.

5.1 Search Personalization

The metrics used for search personalization is Top-n Recall and Top- n Precision. The effectiveness of re-ranking in measured in terms of Top-n Recall and Top- n Precision. The value of n determines the number of search results that are included in the computation of recall and precision, if $n = 50$, only the top 50 results are taken into consideration. Starting with the top fifty results and going down to top ten search results, the values for n include $n = \{50, 40, 30, 20, 10\}$.

5.1.1 Top-n Recall

The Top-n Recall is computed by dividing the number of relevant documents that appear within the top *n* search results at each interval with the total number of relevant documents for the given concept.

$$Top\ n\ Recall = \frac{\#\ of\ relevant\ retrived\ within\ in\ n}{total\ \#\ of\ relevant\ documents}$$

5.1.2 Top-n Precision

The Top-n Precision is computed at each interval by dividing the number of relevant documents that appear within the top n results with *n*.

$$Top\ n\ Precision\ = \frac{\#\ of\ relevant\ retrived\ within\ in\ n}{n}$$

5.2 Personalized Recommendations

The metrics used for personalized recommendations are Precision and Recall. Precision and recall measures the performance of recommendations system.

5.2.1 Precision

Precision represents the probability that a recommended item is relevant

$$Precision = \frac{Nrs}{Ns}$$

Where *Nrs* represents the number of relevant items selected and *Ns* represents the number of selected items.

5.2.2 Recall

Recall represents the probability that a relevant item will be recommended.

$$Recall = \frac{Nrs}{Ns}$$

Where *Nrs* represents the number of relevant items selected and *Nr* represents the number of relevant items

6.Conclusion

This paper started with an introduction of Semantic Web. Differences between web mining and Semantic Web mining were explored. Personalization concepts, data, issues were discussed in context of Web, Semantic Web.

Domains in which Semantic Web personalization have been successfully used are discussed along with the comparisons of various techniques used for Personalization. At last business benefits of personalization are listed.

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