

Semantic Web Personalization: A Survey

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Abstract

With millions of pages available on web, it has become difficult to access relevant information. One possible approach to solve this problem is web personalization. Web personalization is defined as any action that customizes the information or services provided by a web site to an individual. When personalization is applied to the semantic web it offers many advantages when compared to the traditional web because semantic web integrates semantics with the unstructured data on web so that intelligent techniques can be applied to get more efficient results. We have presented various approaches that are used for personalization in semantic web in this paper. The core of semantic web is the ontologies which are defined as explicit formalization of a shared understanding of a conceptualization. We exploit the machine understandable feature of semantic web to device strategies that perform effective personalization such that the results returned to the user are more relevant to the goal set by him. In this paper we have presented the classification of personalization techniques used for semantic web.

Keywords: semantic web,ontologies,personalization,recommendation,user profile.

1. Introduction

It is difficult to personalize world wide web because web is a place for human to human communication whereas personalization requires software system to take part in interaction. Personalization system requires knowledge to be represented in a machine interpretable form which is not available in web. In semantic web we can develop languages for expressing information in machine process able form therefore semantic web is the most appropriate platform for realizing personalization [1].In this paper we have discussed various techniques that are used for personalization of semantic web in detail.

First section of the paper gives introduction to semantic web then section two in details describes personalization in context of web and semantic web. Section three discusses classification of various approaches of semantic web personalization. Section four discusses the comparison of all approaches used for personalization.

2. Semantic Web Personalization

2.1 Objective of semantic web personalization

Two main objectives of semantic web personalization are to perform content-aware navigation and fruition of the resources. Knowledge is used along with the descriptive keywords to identify the most appropriate resources. The main advantage of using knowledge is the precision of the answers is increased. In semantic web the answers are always personalized or adapted so as to meet specific requirements which are the key features that characterize the semantic web.

2.2 Advantages of semantic web personalization over web personalization

The main advantage of semantic web is enriching web data, which is usually represented in HTML or other XML formats, by meta-data specifying the meaning of such data. It incorporates intelligent reasoning capabilities in web based systems. Semantic web based personalization has several advantages over web based personalization few of them are

Uniformity in representing knowledge

The knowledge in semantic web is represented in a uniform way. Such that it is possible to use the knowledge to describe, share and exchange knowledge about information resources, domains they describe, users who use them and further knowledge needed and acquired automatically in web systems. The semantic web based system provides better interpretability when compared to the traditional web based systems.

Domain models

Semantic web uses domain models which are used to describe and index information resources. Domain models describe the semantics about the information resources in a way that can be used to have a better understanding of how the information resources fit to user query and user's interests which can be used by the personalization systems. Domain models provide explicit semantics.

RDF and formal reasoning

A means to formalize information resources about some specific domain knowledge in semantic web is by using semantic web vocabularies and ontologies. Each information resources on web have its own identifier specified as a unified resource identifier (URI) which is globally unique. Semantic web uses resource description format (RDF) and formal reasoning which are the basic languages that provide syntax for describing assertions about resources. Formal reasoning can be done on the top of formal representations. Many query languages are introduced to query metadata for providing efficient and effective access to data on the semantic web such as the SPARQL11 which is the most recent RDF query languages. In addition to query languages, different reasoning technologies are available. The most common used reasoning techniques use description Logics reasoning (DL) such as the OWL-DL ones: Pellet12, Racer13 and Fact++14.

3. Classification of semantic web personalization systems

Currently, the main specializations of semantic personalized recommender systems can be distinguished as

- Vocabulary or ontology based system,
- Context-based recommenders,
- Trust network-based recommenders,
- Rule based filtering,
- Content based filtering ,
- Collaborative filtering ,
- Hybrid Recommendations.

3.1 Ontology based system

Ontology based systems can be used to personalize the semantic web by using the concepts of domain ontology which contains the information regarding the domain of interest in an ontology format.

3.1.1 Domain ontology

In this approach domain ontology is used to personalize navigations in semantic web based on query submitted [2]. Domain ontology consists of large information spaces with many similar instances represented with semantic markup (e.g., OWL). Classification ontology is created describing important aspect of instances from domain ontology by a faceted browser. The classification ontology is used to define restrictions on the instances. The restrictions can be used by the user to reduce the total number of displayed instances by enabling one or more restrictions thus decreasing the size of the visible information space. To perform more precise queries individual restrictions can be further combined to form complex restrictions.

Personalization is done by combining the results obtained by imposing restrictions with the user model which represents individual user interest.

3.1.2 Graph based user profile

In this approach a personalized search is performed. Short term user interest is represented by the user profile which is represented as a graph [3]. Graph based user profile consists of interrelated concepts of the ODP ontology, inferred using score propagation method through semantic links of the ontology. A session boundary recognition mechanism using kendall rank correlation is used to establish a session boundary, which tracks the changes in the dominant concepts held by the user profile and a new submitted query by quantifying the conceptual correlation between the user profile and the query.

Personalization is performed by re-ranking the search results of queries in the same search session based on user profile. Comparison of approaches is shown in Table 1.

Table 1: Comparison of Ontology Approach's

Ontology Approach	User Information	Method	Steps	Personalization
Domain Ontology (Content)	User Model	Classification ontology	Restriction are defined	Combining restrictions with user model
Graph based method (Search)	User profile as Graph	Session boundary recognition method	Conceptual correlation is calculated	Re-Ranking the search results of the query based on user profile

3.2 Context-Based Personalization

Context represents any information that can be used to characterize the situation of an entity where an entity can be a person, place, or object that is considered relevant to the interaction between a user and an application, including location, time, activities, and the preferences of each entity, i.e user's intent for information seeking is represented by context[4]. The user context is automatically collected by context aware computing which extract information that is relevant to current context. To better understand what the user is trying to accomplish, and what services the user might be interested context awareness computes a broad range of contextual attributes such as the user's activities, current positions, and their surrounding environments.

3.2.1 Advantages of using context aware systems in semantic web personalization

Semantic web personalization can use the benefits of existing ontologies which forms the back bone of semantic web. There are several reasons for developing context-aware systems based on ontologies.

Context ontology sharing

Computational entities such as agents and services in pervasive computing environments can use the context ontology which enables them to have a common set of concepts about context while interacting with one another.

Ontology reuse

Existing web ontologies of different domains can be reused for the construction of context ontology instead of starting from scratch.

Logic reasoning mechanisms

Context-aware computing can exploit various existing logic reasoning mechanisms to deduce high-level conceptual context from low-level raw context based on ontologies and it can also be used to check and solve inconsistencies in context knowledge which occurs due to imperfect sensing.

3.2.2 Personalized web search

Personalization involves the process of gathering user-specific information during interaction with the user, which is then used to deliver appropriate results to the users based on their information needs. Personalized web search helps the user to find the information on web according to his/her preferences.

User profile as context

In using user profile as context for personalizing search we use domain ontology as the fundamental source of semantic knowledge [5]. The user context is modeled as ontological profiles by assigning implicitly derived interest scores to existing concepts in a domain ontology therefore domain ontology is used to create an instance of it in the form of user context model which represents the user where each concepts is annotated by the interest scores derived and updated implicitly based on the user's information access behavior. After deriving the interest scores a spreading activation algorithm is used to maintain and incrementally update the interest scores based on the user's ongoing behavior.

Personalization is done by re-ranking the search results based on the interest scores and the semantic evidence captured in an ontological user profile and presented to the user of the system. The user will be presented with most relevant results because the re-ranking is done using the user model which captures the user current interest.

User activity as context

In this approach we monitor the activity of a user on his machine by a windows application which captures content from open internet explorer and msn messenger ms-office documents [6]. The content gathered is used to

build a user's contextual profile which is stored on the client machine. User contextual profile for the time window is represented as a classifier which is a weighted ontology where weight of a concept in the ontology represents the amount of information recently viewed or created by the user that was classified into that concept. ODP ontology is used to classify the content captured within a specific time. Classification of titles and summaries is done to create a document profile in the same manner as the user's contextual profile. The conceptual similarity between each document profile and the user's contextual profile is calculated using the cosine similarity function.

Personalization is done by finding the similarity between the user contextual profile and the document profile, when the user issues a query the user contextual profile is uploaded to the server along with the query, query is given as an input to search engine which returns the results as the titles, summaries and ranks of the top ten results. Re-ranking of results is done by using a combination of their original rank and their conceptual similarity to the user's contextual profile. The results returned to the user that is highly relevant to the user interest because we have used user activity to create the contextual user model which is used to re-rank search results.

User search history as context

In this approach a statistical method is used that learns the user interests by collecting evidence from his search history [7]. This method is based two main steps the first step collects information from user feedback at each retrieval session to get the user search history information for a particular period of time. The search history is used to infer the user contexts which are expressed as a set of weighted dominant keywords. The second step consists of using the context discovered in the first step to learn the user interests by using a learning algorithm based on a correlation measure which estimates the level of changes in the user interest's structure during a period of time. In this approach the updation of the user search history representation is done using user relevance point of view on familiar words, so as to build and learn different user's interests.

Personalization is carried out when user submits a query to the search engine at a particular retrieval session as a result of query submitted many documents are returned and the document which generate an observable behavior like reading, printing ,saving or is explicitly judged as relevant by the user are considered as relevant. The potential space search of the user across the past search sessions is represented by the set of relevant documents. After getting the relevant documents across a set of search sessions we extract the user contexts from his search history in order to learn his long-term interests. A statistical method is used for this purpose which constructs and updates a set of user's interests. The statistical method induces a set of beliefs on the user contexts which are represented as a set of weighted key words at each learning period. The final results that are returned will be personalized with respect to the user history.

Table 2: Comparison of context approaches

Context Approach	User Context	Method	Steps	Personalization
User Profile (Search)	User ontological profile	User context model	Spreading activation	Re-ranking the search results based on user model and profile
User Activity (Search)	User contextual profile as classifier	Document profile	Similarity calculated using cosine measure	Similarity between document profile and contextual profile
User Search History (Search)	User search history as weighted dominant keywords	Learning algorithm based on correlation measure	Relevant documents for each session	Statistical method induces beliefs on user context

3.2.3 Personalized recommendations

Recommender systems provide advice to users about items they might be interested in. The advantage of using context based recommendations over traditional recommendation approaches is that traditional recommendations do not consider the changes of user preferences according to context where as context based recommendations are based on user context which can change over time. As a result, the traditional approaches consider the user's overall preferences, although the user preferences on items varies according to his/her context.

Concept level

In this approach the raw user context information is used to make recommendation [8]. Since the user's raw context cannot be applied to recommendation systems directly, it should be abstracted into a concept level by

analyzing the semantics of context information. A layered approach is used based on three layers i.e. abstract context layer, an aggregated context layer, and an item layer. The raw context having the characteristic of consecutive data is abstracted into a set of concepts in the abstract context layer, by applying fuzzy set theory. Appropriate weight for each concept is determined in the aggregated context layer based on the importance of each context with respect to each user. Items are represented as a set of concepts in a large scale knowledge base such as the web directory in the item layer, which represents the semantics of items. An aggregated context is represented to make recommendations, which consists of user context concepts and domain concepts.

Personalized recommendations are made by following three steps. First the similarity between user's current context and aggregated context is computed. Second the correlation between aggregated context and an item is computed. Third the expected preferences are derived as multiplication of two results which is repeatedly performed for all results of two previous steps for all aggregated contexts and the sum value indicates the preferences on the item. Items having high value of sum are recommended to the user.

Table 3: Comparison of context approaches

Context Approach	User Context	Method	Steps	Personalization
Concept level (Content)	Raw context abstracted into a set of concepts using fuzzy set theory	Weight for each concept based with respect each user are determined	Items are represented as concepts, Aggregated context is calculated	Similarity between users current context and aggregated context is computed, correlation is performed
Context history (Content)	Users' profile, the current & past context, users actions for the past context and the services	Users' preferences and association rules are used for calculating inference	Context history is used to stores and classify the user profiles services	Reasoning users' preferences from context history ,infers the association rules

Context history

In this approach we use context history for reasoning the preference rules and recommending the personalized intelligent services to user [9]. Context history consists of users' profile, the current context of users, the collection of the past context and users actions for the past context and the services selected by the users. Context history has many possibilities to improve the personalized intelligent services offered by applications by extracting useful user's patterns, preferences and habits, from context history. Context history overcomes the limitations of the previous context-aware application which considers only current context and it can also be used for predicting the future context. In this approach an agent-based framework is used for providing the personalized recommendations based on the extracted users' preferences and association rules. The framework has four layers. First layer is the data gathering layer which collects sensor data as raw context, user data as profiles and service data. Second layer is the context management layer that makes inferences of high-level context from low-level context; context history is used to stores collected information and to classify the user profiles and the selected services under the same high-level context. Third layer is the preference management layer that reasons users' preferences from context history and manages them and infers the association rules for recommending the next services.

Personalized recommendations are generated by the final layer which is the application layer based on the extracted preference rules and association rules. Comparison of context based approaches for recommendation is shown in Table 3.

3.3 Trust Network based systems

Semantic web is described to be a web of knowledge having properties such as heterogeneity, openness and ubiquity. In Semantic web environment everyone has the ability to contribute, trustworthiness of the people and their contributions are of great importance and value. Therefore trust plays a crucial role in bringing the semantic web to its full potential. We can exploit trust for personalization of semantic web by using several concepts such as FOAF (Friend of a Friend) which is a widely used semantic web technology which allows the specification of personal information.

3.3.1 Trust based on labels/rating

In this approach we demonstrate how trust based on label/rating can be used for personalization in semantic web [10]. This approach uses collaborative filtering technique for assigning rating to labels describing whether the user agree or disagree with the assigned labels. User can create a label describing every web resources and can also rate the existing labels to express agreement and disagreement with the existing labels. Labels can be either owner defined (defined by the owner of the resources) or user defined (defined by the user other than owner). Trust is computed based on the associated labels and rating. Trust policies can be user defined and owner defined user defined trust policies specify which members are justified as trustworthy by each user. Owner defined trust policies specifies which members are trustworthy to associate label or rating with the resources owned by the user. Information of a user is stored in user preferences. User preferences contain scope which defines the URI pattern to which the preferences can be applied. User preferences also contain conditions specified on resource descriptions and trust values. There can be two kinds of constraints specified first is property constraint which poses conditions on resource properties and corresponding trust values second is content constraint which poses constraints on content description and the corresponding trust values. Actions are carried out if condition is satisfied, two actions can be specified as block and notify. Block denies access to resources that satisfies at least one condition in user preferences. Notify allows the access to the resources and it also notify the end user that the resources matches one or more user preferences. User can also specify how to use owner or user defined trust policies to compute descriptors trustworthiness.

Personalization can be performed for a user based on the user preferences. When a member request access to resources verification is carried out to determine whether a resource satisfies one or more his user preferences if it satisfies then the action specified in the satisfied user preferences is carried out. If there is not user preferences that matches to the requested resource access to the resource is granted.

3.3.2 FOAF

This approach uses FOAF to identify a person browsing habits in the website. It uses an extension of HTTP Get method to include new parameters that point to the URL of the users FOAF file [11]. This approach overcomes the drawback of earlier approaches where the user must create an account on each website and login every time a personalized service is required which required the users to remember multiple logins and repeat login procedure every time he wants to use the service. FOAF vocabulary are written as RDF statements on web which contains information describing a person in terms of several attributes such as home page, photographs, affiliations contact details as well as acquaintance. Advantage of representing FOAF information in RDF vocabulary is that we can follow links to FOAF files of friends and acquaintances to gather more information.

Personalization is performed by sending user FOAF information every time a user sends request to the server this is done by extending the HTTP Get method to include the parameters that point to the URL of the user FOAF file. When the request is received by the web server it examines the parameters in order to determine which information has to be send back, the FOAF information presented as a URL in parameters is retrieved by the server and according to the user information present in the FOAF the result is personalized and send to the user. Apart from personalization of returned site this approach has many advantages as such, first the personal information is under the control of the user rather than multiple site, second the profile information can be used to fill up the forms on the websites, third the knowledge of acquaintance or friends visited the same page can help the user to find interesting information because friends and acquaintances may have similar preferences. Comparison of trust based recommendations approaches is shown in Table 4.

Table 4: Comparison of trust network based approaches

Trust Based Network	User Information	Method	Steps	Personalization
Trust based on labels/rating	User preferences contain URI pattern	Collaborative filtering technique for assigning rating to labels	Trust is based on the labels and rating. Trust policies can be user defined and owner defined	If user preferences are satisfies then the action is carried out
FOAF	User information is stored in FOAF file	Extension of HTTP Get method to include new parameters	FOAF information is represented in RDF vocabulary	According to the user information present in the FOAF file

3.4 Rule based recommendations

In Rule based recommendation basically a set of rules are used to make personalized recommendations. Rule based system uses information stored in web logs to extract patterns of usages which are used to device the rules.

In the current approach web usage data is used to extract rules to carry a mapping between usage patterns to knowledge about user stored in ontology based user model by using specialized set of rules [12]. The user model is expressed in the form of ontology and is based on two main parts. First part comprises of domain independent parts which describes the characteristics such as age or sex or general information which can be reused across many domains. Second part consists of domain dependent information which is stored in clients and server logs. In this approach client side and server side logging is used to overcome the drawbacks of individual logging approaches. The information stored in both logs is integrated into continuous streams of events for a particular user and user sessions. Event ontology is created which defines the semantics of individual events and attributes. Event ontology is used for gathering information regarding individual events which can be used by several reasoning agents to process records of user interactions and update the user model. To extract the knowledge in the form of interesting patterns from user interactions we use rule formalism. Rules contain all knowledge required for processing log of events and updating the user model. Each rule consists of pattern and a consequence. A pattern is found when a sequence of events is mapped to a specific event. The number of changes to the user model and what and how updations should be made to the user model is represented by a consequence. The changes are carried only if the pattern is matching by the using the consequence part of the rule. The experiments were carried by using a faced browser. Faceted browser employs faceted navigation which is based on faceted classification. Faceted classification is an orthogonal multidimensional classification of information artifacts; it consists of facets which describes individual properties of instances in an information space to specify the desired properties of instances in the visible information space.

Personalization is carried by using a set of available facets and restrictions based on the in session user behavior, by observing long term user characteristics stored in user model and also characteristics of other users. Faceted are disabled if they are less relevant to the current user task or reordered based on the relevance.

3.5 Semantic content filtering

Semantic content based filtering is based on using semantic relations. Semantic content based filtering can enhance content based recommendation by addressing the two most significant problems encountered during traditional content based filtering.

1. Cold start problem

Cold start problems occurs when there are not enough user ratings. By using semantic content based filtering we can partially solves the cold-start problem by retrieving more semantically related concepts.

2. Over-specialization problem.

We can provide more interesting or surprising recommendations for concepts by using combinations of content feature and semantic relations in semantic content based filtering, which can partially solves the over-specialization problem which means that the user is restricted to getting recommendations which bear a strong resemblance to those he already knows or defines in the user profile.

3.5.1 Art recommendations

In this approach we use metadata vocabularies or domain ontologies to analyze item features/descriptions for identifying items that are likely to be interesting to the user of semantic content based recommender system. In the current approach we analyze the cultural heritage information personalization (CHIP) system which is an art recommender system with four different semantic metadata vocabularies to provide more rich semantic relations [13]. Metadata vocabularies not only provide hierarchical relations such as broader/narrower within one vocabulary, but also more sophisticated relations across two different vocabularies, e.g. hasStyle and birth/deathPlace. We can use semantic relations to provide additional concepts when there are few ratings to solve cold start problem. We can use semantic relations within one vocabulary or across multiple vocabularies to retrieve new concepts, which might be surprising or interesting for users to overcome over specialization problem. In CHIP at the beginning of each session, participants are asked to fill out a a questionnaire comprising of age, whether they are familiar with the rijksmuseum collection, any experience with recommender systems in general, what are the expectation from art recommendations, and for what purpose they will use art recommendations. Each participant must rate an initial set of items in questionnaire.

Personalized Recommendations are carried out in two steps. First step is the pre-task which finds an artwork that he/she likes by collecting all items having above average rating or items having 4 or 5 start rating. This step produces the first set of recommended concepts as a baseline, based on the basic artwork features. The second step is the main task to rate recommended concepts based on semantic relations which are used to produce a

new set of recommended concepts based on the ratings of concepts with 4 or 5 stars. Users are also allowed to rate the recommended items. The user could also click on the “why recommended" icon for each recommended concept and give feedback on interestingness.

Table 5: Comparison of rule, content and collaborative approaches

Approach	User /Item Information	Method	Steps	Personalization
Rule based	The user model is expressed in the form of ontology	An event ontology is created from client side and server side log	Rule is defined consisting of pattern and a consequence.	By defining facets and restrictions
Content Filtering	Questionnaire is used to collect user information	Metadata vocabularies or domain ontologies to analyze item features/descriptions	Semantic relations within one or across many vocabularies are computed	Combining the feedback from user with semantically similar items
Collaborative filtering(Domain ontology) Content	Users and items are mapped to the domain ontology	User preferences is represented as a set of probabilities	Semantic similarity between two users is computed	For two similar users the set of not common items are recommended

3.6 Semantic collaborative filtering

In semantic collaborative filtering recommendations systems we incorporate the semantic knowledge to improve the performance of traditional collaborative filtering recommendations system. Traditional collaborative filtering system computes exact match to find similar users and items whereas semantic collaborative filtering system uses semantic match. The main advantages of semantic collaborative filtering are

- Users and items are mapped to a set of concepts in domain ontology to reduce item sparsity problem in semantic collaborative filtering.
- It reduces cold start problem by recommending items that have high semantic similarity.
- User preferences can be expressed as ratings.

3.6.1 Domain ontology

In this approach of semantic collaborative filtering all users and items are mapped to the domain ontology [14]. The user preferences are represented as a set of probabilities that a user might like those concepts. Semantic similarity between two users is computed based on the common concepts of domain ontology.

Personalized Recommendations are made after computing semantic similarities between users, if two users are having high semantic similarity and have purchased different set of items then the set of items that are not purchased by the first user but are purchased by the second user are recommended to the first user and vice versa.

3.7 Hybrid Recommendations

We can combine the content based filtering techniques and collaborative filtering techniques and rule based filtering to generate hybrid recommendations that take the advantages of all filtering techniques to produce high quality recommendations. Comparison of approaches is given in Table 5.

3.7.1 SMARTMUSEUM

In SMARTMUSUEM we present an approach which combine the three most widely used techniques for making recommendations i.e. rule based, content based, and collaborative filtering based recommendations [15]. SMARTMUSEUM which is a platform that makes recommendations for visitors based on the physical context information which consist of inside scenario which relies on RFID tags attached to the objects for identification in the museum and outside scenario which consists of GPRS system to identify the site of museum. The web page access duration is also collected to rank the recommendations. The rule based recommendations components filters the recommendations based on individual abilities and user preferences which are defined implicitly in his profile as context and group information. Context which consists of user current context i.e. the location of the user at the moment recommendations are requested, visit duration ,purpose of the visit ,visit along the family, friends or tourist groups given by the user at the beginning of the tour. The profile consists of

three resource descriptions framework (RDF) coded segments which consists of user ability information, preferences /interest information and visit history. Two profiles are created as user interest profile and context profile, user interest profile consists of basic preferences of the user and can be upgraded based on the tagging behavior of the user, context profile consists of user current context, location information of the user.

Personalized recommendations are generated based on the tuples in the user profile and in context profile. Recommendations consist of location and RFID information generated for a particular user which can be further refined by selecting a particular location and type of objects.

4. Comparison of Semantic Web Personalization Techniques

All techniques used for personalization uses one or the other form of ontology which is the backbone of semantic web.

•Ontology based techniques for personalization just considers the domain ontology for personalization without considering the context information and acquaintance information of the user which may vary with time.

•Context based personalization techniques uses the user preferences along with context information of the user for personalizing the user request. The results obtained by the user may vary depending on the context in which he has made the request in context based system. Context based personalization provides an advantage over ontology based personalization by considering time varying user context.

•Trust based personalization techniques exploit the user acquaintance information to personalize the recommendations or search. Trust based personalization system is based on the concept that acquaintances may share similar preferences. Trust based personalization techniques explores an area which is not covered in both ontology based personalization techniques and context based personalization techniques and may provide some interesting recommendations which may not be provided by the prior techniques.

•Rule based techniques uses rules to extract personalization information. In the current survey we have used web usage data in the form of logs to infer the rule and make recommendations based on the matched patterns. The problems of rule based system are initially some time has to be spend in designing the rule, updating the rule and on the analysis of web usage data. Rule based systems are useful when enough amounts of web usage data are available. If the amount of web usage data is less than other personalization techniques can be applied.

• Semantic content based filtering and Semantic collaborative filtering are extensions of the content based filtering and collaborative filtering based recommendations where we compute the semantic similarity between items and users. All items are mapped to the domain ontology which reduces item sparcity problem present in traditional collaborative filtering recommendations. We overcome the cold start problem by recommending the items which have high semantic similarity to the given item.

Table 6.Comparison of semantic web personalization approaches

Approach	User information						Personalization			
	Profile	Ontology	Context	Acquaintance	Web logs	Search history	Re-ranking	Combin user information	Similarity computaion	Top–N Recommendatioations
Ontology based	✓	✓					✓	✓		
Context based	✓	✓	✓			✓	✓	✓	✓	✓
Trust Network based	✓			✓				✓		
Rule based Recommendations	✓	✓			✓			✓		
Content based filtering	✓	✓						✓		✓
Collaborative filtering	✓	✓							✓	✓

Therefore we can infer that all techniques have their advantages and disadvantages hence we can use the technique for personalization which best solve the problem at hand. Comparison of all approaches discussed in the current survey is given in Table 6.

5.Conclusion

Semantic web technology is getting increasingly popular and adopted in different fields. personalization plays a fundamental role in the semantic web, because the semantic web is a knowledge-aware web which gives answers to the user depending on what they expect. Research in the field of semantic web personalization is just at the beginning.

In this paper we have presented the classification of personalization techniques used for semantic web. Semantic web is the next generation web which incorporates machine processable information to support users in their task. When personalization is applied to the semantic web it offers many advantages when compared to the traditional web because semantic web integrates semantics with the unstructured data on web so that intelligent techniques can be applied to get more efficient results. Ontologies play a major role in semantic web personalization.

6.Future Work

Corporate semantic web is already popular but the public semantic web which is the real semantic web is not yet realistic. There are many challenges that must be faced while developing public semantic web. The most important challenge lies in the representation of ontologies, Mapping and merging ontologies and using existing ontologies, which represents different types of knowledge in the semantic web. To apply personalization to semantic web we must first represent knowledge in proper from.

Much research is done in the context based personalization of semantic web which uses user profile as context where as other personalization techniques such as rule based ,content based filtering , collaborative filtering need to be explored further. Personalization based on trust networks is becoming increasing popular because of social networking and semantic web has a great potential for exploring new dimensions for trust based personalization. We need to study the advantage of semantic web technology on the existing approaches of personalization's. We must integrate computational intelligence techniques with semantic web personalization techniques to obtain high quality results which match the user request for information.

References

[1] Eirinaki Magdalini and Vazirgiannis Michalis,"Web Mining for web personalization", *ACM Transactions on*

*Internet Technology,Vol. 3, No. 1, (February 2003),*2-24

[2] Tvaroˇ Zek Michal,"Personalized navigation in the semantic web", Lecture Notes in Computer Science, Volume 4018, Adaptive Hypermedia and Adaptive Web-Based Systems,*Springer(2006), 467-472*.

[3] Daoud Mariam, Tamine-Lechani Lynda and Boughanem Mohand,"Using a graph-based ontological user profile for personalizing search", *,ACM. CIKM'08(October 26–30, 2008)*

[4] Hong Jong-Yi, Suh Eui-Ho and Kim Sung-Jin, "Context-aware systems a literature review and classification", *Elsevier Expert Systems with Applications 36 (2009) 8509–8522*.

[5] Sieg A., Mobasher B., and Burke R., "Learning ontology-based user profiles: a semantic approach to personalized web search", *IEEE Intelligent Informatics Bulletin, vol. 8, (2007).*

[6] Challam V., Gauch S., and Chandramouli "A.,Contextual search using ontology-based user profiles", RIA2007, (2007).

[7] Tamine Lynda, Boughanem Mohand and Zemirli Nesrine, "Inferring the user interests using the search history", *LWA 2006,(2006)*.

[8] Shin Dongmin, Lee Jae-Won, Yeon Jongheum,and Lee Sang-Goo,"Context-aware recommendation by aggregating user context",*proceedings of 2009 IEEE Conference on Commerce and Enterprise Computing(2009).*

[9] Hong Jongyi,-Ho Suh A, Eui , Kim Junyoung ,and Kim Suyeon, "Context-aware system for proactive personalized service based on context history", *,Expert Systems with Applications Elsevier 36 (2009) 7448–7457.*

[10] Carminati Barbara, Ferrari Elena, and Perego Andrea," Combining social networks and semantic web technologies for personalizing web access, collaborative computing: networking, applications and worksharing*"* Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, Volume 10. ISBN 978-3-642-03353-7. *Springer Berlin Heidelberg, (2009), p. 126*

[11] Ankolekar Anupriya and Vrandeˇci´ Denny, "Personalizing web surfing with semantically enriched personal profiles", *International Workshop On Semantic Web Personalization at Budva, ontenegro,(June 12, 2006)*.

[12] Barla Michal, Tvaroˇzek Michal,and Bielikov M´Aria "A, Rule-based user characteristics acquisition from logs with semantics for personalized web-based systems" *Computing and Informatics, Vol. 28, (Sep-22 2009). 399–427*

[13] Wang Yiwen, Stash Natalia, Aroyo Lora, Hollink Laura,and Schreiber Guus," Semantic relations in content based recommender systems", *Citeseer*.(*2009)*

[14] Lee Jae-Won, Nam Kwang-Hyun, and Lee Sang-Goo,"Semantics based collaborative filtering", *Springer-Verlag Berlin Heidelberg Software Engineering, Artificial Intelligence,(2009),201–208.* [15] LIIV [15] Innar, Ruotsalo Tuukka, Tammet Tanel and Kuusik Alar, "Personalized context-aware recommendations in smartmuseum:combining semantics with statistics" ,*in proceedings of Third internal conference on Advances in semantic processing,IEEE (2009) , 50 – 55.*