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Web Personalization Using Ontology: A Survey

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ABSTRACT
This paper contains concept of ontologies on the basis of user behaviour being analysed. Ontologies are the structural frameworks for organizing information and are used in artificial intelligence, the Semantic Web, systems engineering, software engineering, biomedical informatics, library science, enterprise bookmarking, and information architecture as a form of knowledge representation about the world or some part of it. The creation of domain ontologies is also fundamental to the definition and use of an enterprise architecture framework. This paper also describes creation of ontological user profiles for web information gathering and How the ontology is useful in Web Personalization.
Keywords *- ontologies, framework, semantic web, enterprise bookmarking ,web information gathering.*

I. INTRODUCTION

In computer science and information science, an ontology formally represents knowledge as a set of concepts within a domain, and the relationships between those concepts. It can be used to reason about the entities within that domain and may be used to describe the domain. In theory, an ontology is a "formal, explicit specification of a shared conceptualization". An ontology renders shared vocabulary and taxonomy which models a domain with the definition of objects and/or concepts and their properties and relations.
Personalized ontology is a new research area in the academia, and under the joint venture of the major information technology companies and academia is consistently working on the improvement of user friendliness, security and many other aspects of ontologies. It is worth mentioning that with the improvement of user profiles, the development of ontologies is very fast. One can easily predicts that in the next 3 to 5 years personalized ontologies will become a key factor of business ,knowledge search for the entire information technology industry.

The targeted marketing & accuracy of information retrieval of ontology model will determine the success.
The left over paper contains the different concept of the Ontology in section 2. The need of the ontology model is discussed in section 3. In section 4 the Architecture of the ontology is presented. In section 5 different design patterns of ontology models are discussed. Section 6 contains Web Ontology Language (OWL). Section 7 presents the Onto Web Semantic Model. Section 8 Contains Methodologies of Web Personalization, Section 9 discusses the advantages of Ontology Model for Web Personalization and Section 10 contains Conclusion of the paper followed by Acknowledgement and References.

II. THE CONCEPT OF ONTOLOGY

An Ontology is the study of the nature of being, existence, as well as the basic categories of being and their relations. As a model for knowledge description and formalization, ontologies are widely used to represent user profiles in personalized web information gathering[1].
An ontologis defines as a set of representational primitives with which to model a domain of knowledge or discourse. The representational primitives are typically classes (or sets), attributes (or properties), and relationships (or relations among class members). The definitions of the representational primitives include information about their meaning and constraints on their logically consistent application.
In computer science and information science, an **ontology** formally represents knowledge as a set of concepts within a domain, and the relationships between those concepts. It can be used to reason about the entities within that domain and may be used to describe the domain.

The essential points of definition of ontology are

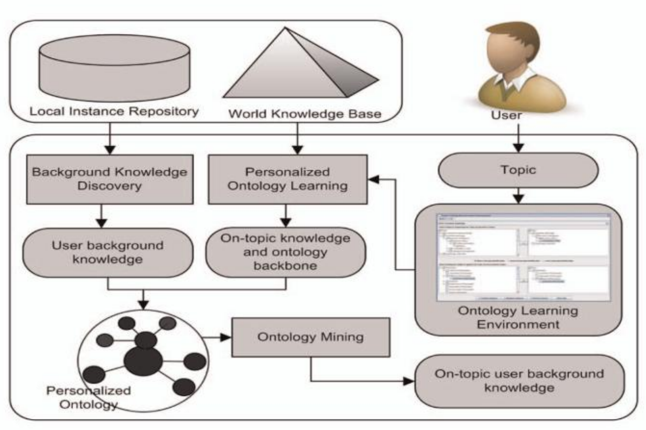
- An ontology defines the concepts, relationships, and other distinctions that are inter related for modeling to a particular domain [2].
- The specification takes the form of the definitions of representational vocabulary (classes, relations, and so forth), which provide meanings for the vocabulary and formal constraints on its coherent use[3].

In computer and information science, ontology is a technical term denoting an artifact that is *designed* for a purpose, which is to enable the modeling of knowledge about *some* domain, real or imagined.

III. THE NEED OF ONTOLOGY MODEL

Why would someone want to develop an ontology? Some of the reasons are:[4]

- It studies the ontology development process, the ontology life cycle, the methods and methodologies for building.
- Ontology engineering aims to make explicit the knowledge contained within software applications, and within enterprises and business procedures for a particular domain.
- It understands to reuse of the domain knowledge
- It separates the domain knowledge from the current databases.



1. ARCHITECTURE OF ONTOLOGY

Fig. 1. Architecture of Ontology Model.

4.1 Personalized Ontology Construction

Personalized ontologies are a conceptualization model that formally describes and specifies user background knowledge. From observations in daily life, we found that web users might have different expectations for the same search query[10]. For example, for the topic "New York," business travelers may demand different information from leisure travelers [11]. Sometimes even the same user may have different expectations for the same search query if applied in a different situation. A user may become a business traveler when planning for a business trip, or a leisure traveler when planning for a family holiday. Based on this observation, an assumption is formed that web users have a personal concept model for their information needs. A user's concept model may change according to different information needs. In this section, a model constructing personalized ontologies for web users's concept models is introduced.

4.2 World Knowledge Representation

World knowledge is important for information gathering. According to the definition provided by , world knowledge is commonsense knowledge possessed by people and acquired through their experience and education. In this proposed model, user background knowledge is extracted from a world knowledge base encoded from the Library of Congress Subject Headings (LCSH). We first need to construct the world knowledge base. The world knowledge base must cover an exhaustive range of topics, since usersmay come from different backgrounds. For this reason, the LCSH system is an ideal world knowledge base. The LCSH was developed for organizing and retrieving information from a large volume of library collections. For over a hundred years, the knowledge contained in the LCSH has undergone continuous revision and enrichment. The LCSH represents the natural growth and distribution of human intellectual work, and covers comprehensive and exhaustive topics of world knowledge . In addition, the LCSH is the most comprehensive nonspecialized controlled vocabulary in English. In many respects, the system has become a de facto standard for subject cataloging and indexing, and is used as a means for enhancing subject access to knowledge management systems. The LCSH system is superior compared with other world knowledge taxonomies used in previous works. The primitive knowledge unit in our world knowledge base is subjects. They are encoded from the subject headings in the LCSH. These subjects are formalized as follows:

Definition 1. Let SS be a set of subjects, an element s 2 SS is formalized as a 4-tuple s :¼
hlabel; neighbor; ancestor descendanti, where label is the heading of s in the LCSH
thesaurus;. neighbor is a function returning the subjects that have direct links to s in the world knowledge base; ancestor is a function returning the subjects that have a higher level of abstraction than s and link to s directly or indirectly in the world knowledge base;. Descendant is a function returning the subjects that are more specific than s and link to s directly or indirectly in the world knowledge base[10].

Definition 2. Let WKB be a world knowledge base, which is a taxonomy constructed as a directed acyclic graph. The WKB consists of a set of subjects linked by their semantic relations, and can be formally defined as a 2-tuple WKB :¼ hSS; IRi,

where
. SS is a set of subjects SS :¼ fs1; s2; . . . ; smg;
. IR is a set of semantic relations IR :¼ fr1; r2; . . . ; rng
linking the subjects in SS.
A few theorems can be introduced, based on the subject analysis of specificity and
Exhaustivity[10],[11],[12].
Proof 1. As s is a leaf subject, we have desc(s)={s}, we have
Exh(s,T)= _ S'€des_ s€n-1)(s') str(i,T) × spea(s',T)
= spea(s',T) ×_ i€n-1(s)str(i,T)
= spea(s',T) × sper(s,T,LIR)
= spe(s,T)

Theorom 2.Let s1,s2, be two different subject in the s+ of _(T), s1€desc(s2), and n-1(s1)= n-1(s2), we always have spe(s1,T)>=spe(s2,T).
Proof 2. Spe(s1,T)-spe(s2,T)
=spea(s1) ×sper(s1,T,LIR)- spea(s2) ×sper(s1,T,LIR)
= spea(s1) ×_ *s€n-1)(s1)str(i,T)*- spea(s2) ×_ *s€n-1)(s1)str(i,T)*
Because there exists a path from s1,s2
S1-_s'_---- -_s''_s2
From algorithm 1 ,we have
spea(s1)>= spea(s')….. spea(s'')>= spea(s2);
therefore spea(s1)>= spea(s2). And spe(s1,T)-spe(s2,T)>=0.

input : a personalized ontology $\mathcal{O}(\mathcal{T}) := \langle tax^{\mathcal{S}}, rel \rangle$; a coefficient θ between (0,1).
output: $spe_a(s)$ applied to specificity.

set $k = 1$, get the set of leaves S_0 from $tax^{\mathcal{S}}$, for $(s_0 \in S_0)$ assign $spe_a(s_0) = k$;
get S' which is the set of leaves in case we remove the nodes S_0 and the related edges from $tax^{\mathcal{S}}$;
if $(S' == \emptyset)$ **then** return;*//the terminal condition*;
foreach $s' \in S'$ **do**
  if $(isA(s') == \emptyset)$ **then** $spe_a^1(s') = k$;
  else $spe_a^1(s') = \theta \times min\{spe_a(s) | s \in isA(s')\}$;
  if $(partOf(s') == \emptyset)$ **then** $spe_a^2(s') = k$;
  else $spe_a^2(s') = \frac{\sum_{s \in partOf(s')} spe_a(s)}{|partOf(s')|}$;
  $spe_a(s') = min(spe_a^1(s'), spe_a^2(s'))$;
end
$k = k \times \theta, S_0 = S_0 \cup S'$, go to step 2.

Algorithm 1: for web personalization.

IV. Ontology Design Patterns(Odp)

We have grouped ODP into six families as shown below[5].

1.1 Structural ODPs:

There are two subcategories of this design pattern as: Logical & Architectural.

1.1.1 Logical ODPs: Logical OPs help to solve design problems at the situation when the primitives of the representation language do not directly support certain logical construction. Logical OPs are content independent , on the other hand, and they are dependent on the logical formalism that is used for representation.

1.1.2 Architectural ODPs: It affects the overall shape of the ontology model. Their aim is to constrain 'how the model should look like'. Architectural ODPs originated as design choices promoted for fulfillment of specific needs, e.g. computational complexity constraints. They are useful as reference documentation for those initially approaching the design of an ontology.

1.2 Correspondence ODPs:

Correspondence OPs consists of Reengineering OPs and Alignment OPs. Reengineering OPs gives designs with solutions to the problem of transforming a conceptual model, which may be from a non-ontological resource, into a new ontology. Alignment OPs are patterns for creating semantic associations between two existing ontologies.

1.2.1 Re-engineering ODPs : Reengineering OPs are transformation rules to create a new ontology (target model) starting from elements of a source model. The target model is an ontology, while the source model can be either an ontology, or a non-ontological resource e.g., a thesaurus concept, a data model pattern, a UML model, a linguistic structure, etc.

1.2.2 Alignment ODPs: Alignment focuses to provide correspondences between ontologies modeling a similar domain. Alignment patterns are template representing frequent types of alignments occurring when aligning ontologies.

Example: Class correspondence with attribute value restriction

1.3 Content ODPs (CPs) :

They show the following characteristics: CPs encode conceptual, rather than logical design patterns. In other words, while Logical OPs solve design problems independently of a particular conceptualization, CPs propose patterns for solving design problems for the domain classes and properties that populate an ontology, therefore addressing con- tent problems. CPs are instantiations of Logical OPs (or of compositions of Logical OPs), featuring a non-empty signature. Hence, they have an explicit non-logical vocabulary for a specific domain of interest (i.e. they are content-dependent), they have to be implemented in some way. In the portal we mainly deal with CPs in a Semantic Web context, hence we currently support OWL as a reference formalism for representation.

1.4 Reasoning ODPs :

These are applications of Logical OPs focused to obtain certain reasoning results, based on the behavior implemented in a reasoning engine. Examples include: classification, subsumption, inheritance, materialization.

1.5 Presentation ODPs : Presentation ODPs concerns with usability & readability of ontologies from a user point of view. They are meant as good practices that support the reuse of patterns by facilitating their evaluation and selection.

1.5.1 Naming ODPs : Naming OPs are good to boost ontology readability and also for understanding by humans, by supporting homogeneity in naming procedures.

Examples include conventions for how to construct the namespace declared for ontologies.

1.5.2 Annotation ODPs: This ODPs provide to improve the understandability of ontologies and their elements.

Examples are the use of RDF Schema labels and comments (crucial for manual selection and evaluation).

5.6 Lexico-Syntactic ODPs : Lexico-Syntactic OPs are consist of certain types of words following a specific order, and that permit to generalize and that can extract some conclusions about the meaning they express. They are useful for making relationship between simple Logical and Content OPs with natural language sentences e.g., for didactic purposes.

V. WEB ONTOLOGY LANGUAGE (OWL) [6]

The Web Ontology Language is designed for use by applications that need to process the contents in the information rather than just presenting information to humans. OWL has much more interpretability of Web content than leads to support XML, RDF, and RDF Schema
(RDF-S) by providing additional vocabulary along with a formal semantics. OWL has three sublanguages: OWL Lite, OWL DL, & OWL Full.
The Semantic Web is the future of the Web, in which information is given explicit meaning, which makes easier for machines to automatically process and integrate meaningful information available on the Web. The first level above RDF required for the Semantic Web is an ontology language what can formally describe the meaning of terminology used in Web documents. If machines are expected to perform useful reasoning tasks on these documents, the language must go beyond the basic semantics of RDF Schema. OWL has been designed to meet this need for a Web Ontology Language.

- XML provides a surface syntax for structured documents, but imposes no semantic bindings on the meaning of these documents.

- XML Schema is a language for restricting the structure of XML documents and also extends XML with datatypes.

- RDF is a data model for objects and relations between them, it provides a simple semantics for this data model to represent in an XML syntax.

- OWL adds more vocabulary for describing properties and lasses: among others, relations between classes , cardinality (e.g. "exactly one"), equality, richer typing of properties, characteristics of properties (e.g. symmetry).

- OWL Lite provides assistance to users who primarily needs a classification hierarchy and simple rules. For example, while it supports cardinality constraints, it only permits cardinality values of 0 or 1. It should be simpler to provide tool support for OWL Lite than its more expressive relatives, and OWL Lite provides a quick migration path for thesauri and other taxonomies. Owl Lite also has a lower formal complexity than OWL DL.

- OWL DL helps users who want the highest expressiveness while retaining computational completeness (all conclusions are guaranteed to be computable) and decidability (all computations will finish in finite time). OWL DL includes all OWL language constructs, but they can be used only under certain restrictions.

  OWL DL is so named due to its correspondence with description logics, a field of research that has studied the logics that form the formal foundation of OWL.

- OWL Full is meant for users who want maximum expressiveness and the syntactic freedom of RDF with no computational guarantees. For example, in OWL Full a class can be treated simultaneously as a collection of individuals and as an individual in its own right. OWL Full allows an ontology to augment the meaning of the pre-defined (RDF or OWL) vocabulary. It is unlikely that any reasoning software will be able to support complete reasoning for every feature of OWL Full.OWL Lite uses only some of the OWL language features and has more limitations on the use of the features than OWL DL or OWL Full. For example, in OWL Lite classes can only be defined in terms of named superclasses (superclasses cannot be arbitrary expressions), and only certain kinds of class restrictions can be used. Equivalence between classes and subclass relationships between classes are also only allowed between named classes, and not between arbitrary class expressions[13].

Similarly, restrictions in OWL Lite use only named classes. OWL Lite also has a limited notion of cardinality - the only cardinalities allowed to be explicitly stated are 0 or 1.
We have the following Syntaxes of OWL as :
OWL2 Functional Syntax

```
Ontology(<http://example.com/tea.owl>
  Declaration( Class( :Tea ) )
```

)
OWL2 XML Syntax

```
<Ontology ontologyIRI="http://example.com/tea.owl" ...>
  <Prefix name="owl" IRI="http://www.w3.org/2002/07/owl#"/>
  <Declaration>
    <Class IRI="Tea"/>
  </Declaration>
 </Ontology>
```

RDF/XML syntax

```
<rdf:RDF ...>
   <owl:Ontology rdf:about=""/>
   <owl:Class rdf:about="#Tea"/>
</rdf:RDF>
```

Example of OWL reasoning

```
?p(?x,?y) :- a(?p, owl:SymmetricProperty), ?p(?y,?x).
?p(?x,?y) :- a(?p, owl:TransitiveProperty), ?p(?x,?z),

?p(?z,?y).

 ?invers1(?x,?y) :- owl:inverseOf(?invers1,?invers2), ?invers2(?y,?x).
?invers1(?x,?y) :- owl:inverseOf(?invers2,?invers1), ?invers2(?y,?x).
 ?equiv1(?x,?y) :- owl:equivalentProperty(?equiv1,?equiv2),

?equiv2(?x,?y).
?equiv1(?x,?y) :- owl:equivalentProperty(?equiv2,?equiv1),

?equiv2(?x,?y).
 ?p(?x,?y) :- rdfs:subPropertyOf(?p1,?p), ?p1(?x,?y).
```

VI. CONSTRUCTION OF ONTO WEB SEMANTIC MODEL

In real projects there might be various intentions for introducing ontologies. Here some of them will be considered. Construction of an ontology generally consists of the following steps . The basic concepts and their relationships for the chosen subject domain are detected, precise and unambiguous definitions are constructed for them. Concepts and relationships are discovered which are related to basic ones and they are added into the ontology too. Concepts are grouped by thematic classes and expressed in an ontological language. Several projects are known that create ontologies to define a given subject domain and share this knowledge among users for more coordinated interaction in the domain. TOVE [fox] and Enterprise[7] create ontologies for commerce and production organization, CIDOC develops an ontology for museums and cultural heritage, PhysSys creates an ontology in the area of physical systems. The project SYNTHESIS uses ontologies for semantic interrelating of object-oriented specifications for compositional development of information systems re-using heterogeneous sources as well as for registration of heterogeneous information collections in a mediator, integrating heterogeneous information collections. Projects OntoSeek and Plinus use ontologies for information retrieval [8].

Ontologies are used for context definition in a subject domain. Determination of exact difference between contexts helps to solve a problem of viewing onto an information resource from another context or changing of resource moving from one context to another [farqu]. Using of shared ontologies, establishing correspondence of data to ontological definitions, enhancing ontologies for new tasks allow to achieve correct interoperation between different information systems[9].

The idea of intelligent agents is based on the ontological specifications. For semantic interoperability any communication of such agents, all queries that agents formulate are expressed in terms of the ontology understandable to agents.

The Web needs ontologies for relating Web-information to concepts of ontologies. The project SHOE proposes to support HTML-pages by additional tags, which relate the information to ontological definitions. Semantic Web consolidating a set of workgroups and projects focuses on bringing semantics into XML technologies.

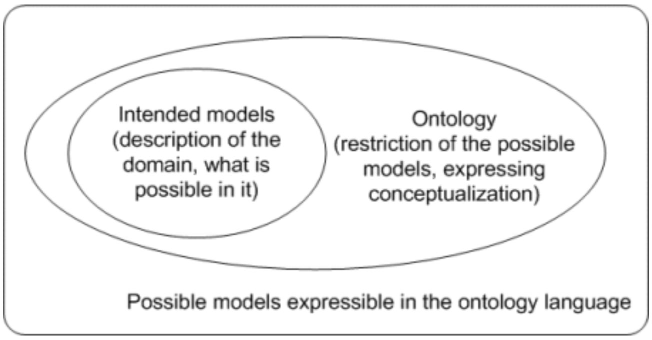


Fig 2.Possible Ontology Models

VII. METHODOLOGIES FOR WEB PERSONALIZATION

Web Mining is a mining of Data related to World Wide Web. This may be data actually present in the web pages or data related to web transactions. Web Mining Does the task of Personalization of Web Pages by Categorising into User Profiles.

Web Data can be classified into following classes:

- Content Of the actual web pages.
- The inter page structure includes HTML or XML codes.
- The Usage data includes how the web pages are accessed by users.
- User profile includes demographics and registration information collected about users. This also includes information found in Cookies.

Web Mining can be divided broadly into three types namely Web Content Mining, Web Structure Mining, Web Usages Mining.

The following figure 3. shows Web Mining Taxonomy[14].

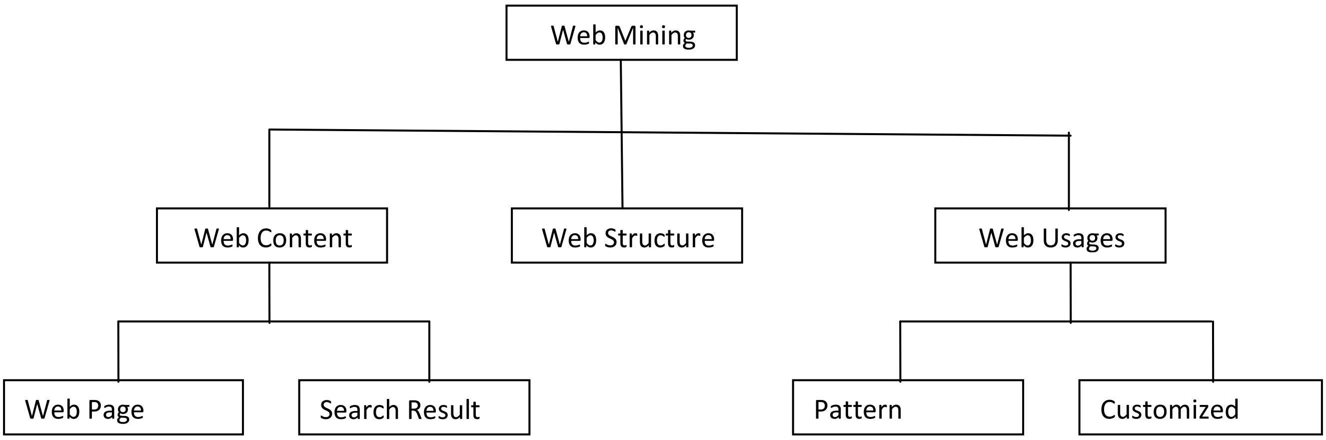


Fig 3.web mining taxonomy

Most search engines are keyword based. Web Content Mining Goes Beyond this traditional Information Retrival(IR) system. Web Mining can improve search techniques such as concept hierarchies, user profiles, synonyms, and analysing the linkage between pages.

Web Content Mining can be divided into two subtypes as : Agent Based & Database Based Approaches[15].

Agent Based approach have Software Agents that perform content mining. The search engine belongs to this class does information filtering, and personalized web agents[16].

Intelligent search agents goes beyond simple search agents and use other search techniques focuses on knowledge about percicular domain[17].

The Database Based approach view the Web data belongs to database.

Personalization By Web Content Mining:

With personalization , web access, or the content of the web pages are modified to better fit for user needs. This may involve actually creating web pages, that are unique per user or using the desires of a user to determine what web documents to retrieve.

With personalization , targeted marking to be done to a group of specific interested customers, based on the user visits to a websites. And the advertisement can be designed for that person.

Personalization includes techniques such as use of cookies, use of databases, and machine learning strategies.

Personalization can be viewed as a type of Clustering, Classification, or even prediction[19].

Page Rank:

This technique is designed to increase the effectiveness of search engine and to improve the efficiency. It is used to measure the importance of a page and to give the priority for pages returning from traditional keyword search engines. The page rank of a page is defined as[18]:

$$PR(p)=c \sum_{q \in Bp} PR(p)/Nq$$

Here, PR(p) is page rank, Bp is used to set pages that point to p, and Fpto be the set of links out of p, Nq=|Fp|. The constant ‘c’ is value between 0 and 1.

VIII. Advantages Of Ontology Model

- The Ontology model discovered user background knowledge from user local instance repositories, rather than documents read and judged by users.
- The Ontology profiles had broad topic coverage. The substantial coverage of possibly-related topics was gained from the use of the WKB and the large number of training documents.
- Compared to the web data used by the web model, the LIRs used by the Ontology model were controlled and contained less uncertainties.
- Additionally, a large number of uncertainties were eliminated when user background knowledge was discovered. As a result, the user profiles acquired by the Ontology model performed better than the web model.

IX. Conclusion

It can be deduced in accordance with the above mentioned Construction of web semantic ontology model and different definitions of the Ontology concept; it can be seen as fusion of user and interaction, their relationships. It presents a knowledge model. Consisting of World knowledge Base (WKB) & Local Instance Repository (LIR). The Ontology model had better recall but relatively weaker precision performance. The Ontology model discovered user background knowledge from user local instance repositories, rather than documents read and judged by users. The Ontology profiles had broad topic coverage. The substantial coverage of possibly-related topics was gained from the use of the WKB and the large number of training documents. Compared to the web data used by the web model, the LIRs used by the Ontology model were controlled and contained less uncertainties. Additionally, a large number of uncertainties were eliminated when user background knowledge was discovered. Thus, this paper gives efficient methodologies for Web Personalization using Ontology Models.

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