AVATAR: An Approach based on Semantic Reasoning to Recommend Personalized TV Programs*

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ABSTRACT

In this paper a TV recommender system called AVATAR (**A**d**VA**nce **T**elematic search of **A**udiovisual contents by semantic **R**easoning) is presented. This tool uses the experience gained in the field of the Semantic Web to personalize the TV programs shown to the end users. The main contribution of our system is a process of semantic reasoning carried out on the descriptions of the TV contents —provided by means of metainformation— and on the viewer preferences — contained in personal profiles. Such process allows to diversify the offered suggestions maintaining the personalization, given that the aim is to find contents appealing for the users, which are related semantically to their programs of interest.

Here the framework proposed for this reasoning is introduced, by including (i) the OWL ontology chosen to represent the knowledge of our application domain, (ii) the organization of the user profiles, (iii) the query language *LIKO*, which is intended to browse the ontology and (iv) the semantic relations inferred from the system knowledge base.

Categories and Subject Descriptors

H.3.3 [**Information Storage and Retrieval**]: Information Search and Retrieval

General Terms

Languages, Theory, Management

Keywords

Semantic Web, TV recommender system, ontologies, inference of semantic relations

1. INTRODUCTION

The Digital Television allows the users access a large number of TV programs and interact with applications transmitted along with the traditional audiovisual contents. In this scenario, the viewers could feel disoriented as they look for interesting programs among massive amounts of irrelevant information. For that reason, systems whose task is to recommend TV programs personalized according to the user preferences, are clearly necessary.

In last years, the TV recommender systems have become a relevant issue for the research community, causing the appearance of different approaches, such as Bayesian techniques, decision trees, expert systems and neural networks, among others. However, these inference strategies have a common drawback related to the capability of reasoning about the TV content semantics.

So, our approach proposes a recommender, called AVATAR, whose main contribution to the field of the TV personalization tools is the use of the Semantic Web technologies [1]. The goal is the development of an enhanced system by applying a reasoning process on the semantics of TV contens —provided by means of metadata— and on the user preferences. Such reasoning is able to discover semantic relations among different programs. This way, the viewers are provided with diverse and personalized recommendations. An overview of the architecture proposed for our prototype is described in [2], where the use of several knowledge inference methods is shown, mainly Bayesian techniques and the aforementioned semantic reasoning. For its relevance and novelty, in this paper we focus on this reasoning process.

This paper is organized as follows: Sect. 2 describes briefly the framework of reasoning proposed in AVATAR. This framework consists of four elements: (i) an OWL ontology that represents the knowledge about the TV domain, (ii) the user profiles, (iii) a query language for browsing the TV ontology and (iv) the inference of semantic relations from the knowledge base of the system. Finally Sect. 3 reports some conclusions and discusses the future work.

2. THE REASONING FRAMEWORK

2.1 The TV Ontology

To obtain a personalized TV recommender system based on semantic reasoning, a mechanism for representing formally the knowledge of our application domain is required. In the field of the Semantic Web, the ontologies are technologies that represent and share this knowledge efficiently. So, we have conceptualized the TV domain by implementing an ontology according to the OWL language. This ontology allows to identify —by hierarchies of classes and properties— entities related to the TV domain, such as different categories of programs, credits involved in them, etc.

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Table 1: Query operators of the LIKO language

Operators	Input	Output
$\triangleright$	A class defined in the ontology.	Direct subclasses related to the input class.
$\triangleleft$	A class defined in the ontology.	Direct superclasses referred to the input class.
$>>$	A property of the ontology.	Direct subproperties related to the input property.
$<<$	A property of the ontology.	Direct superproperties referred to the input property.
$>\Leftarrow$	Instances of classes defined in the ontology.	Properties where the input class appears as domain.
$>\Rightarrow$	Instances of classes defined in the ontology.	Properties where the input class appears as range.

To define specific information on which apply the precepts of our semantic reasoning approach, instances of the ontology classes have been included in this knowledge base. These instances are referred to specific TV programs extracted from databases that store abundant information about TV scheduling, such as *www.imdb.com*. Regarding the properties, note they establish *explicit* relations among the instances contained in the ontology. The reasoning process proposed in AVATAR takes as starting point these *explicit* relations and infers other *implicit* ones from them.

2.2 The User Profiles

As we said in Sect. 2.1, our system must reason on the viewer preferences. For that reason, a mechanism for representing formally the user profiles is required. Our approach proposes to reuse the knowledge contained in the TV ontology for that purpose.

So, we define the user profiles as OWL ontologies (which we will refer to as *ontology-profiles*), built incrementally as the system receives information about the user viewing behavior. This way, the *ontology-profiles* contain hierarchies of classes, specific instances and properties that are extracted from the TV ontology. In addition, the system also stores the level of interest for a user, referred to each instance defined in his/her *ontology-profile*.

A user modeling based on ontologies allows AVATAR to compare different profiles by applying the knowledge about the TV domain, beyond a simple syntactic comparison tackled in previous approaches. So, our recommender is able to find programs semantically similar to those ones that have been of interest for the user.

2.3 LIKO: A query language

AVATAR takes as starting point the user *ontology-profile* to offer him/her a personalized recommendation. Once the instances defined in this profile have been located in the TV ontology, it is necessary to explore this knowledge base for inferring relations among these programs and the remaining ontology instances. For that purpose, the LIKO query language is introduced in our proposal. Some of its query operators are shown in Table 1.

2.4 Inference of Semantic Relations

Our approach focuses on identifying several types of semantic relations among the instances contained in our knowledge base.

We are working on a semantic relation named *direct semantic path* which consists of a set of instances joined by Object properties. For example, assume a TV program presented by a person (instance of the *Credits* class) who has also taken part in other content as director, as shown in the following chain (the properties appear in square brackets):

Quiz-Show [*hasPresenter*] $Credits$ [*DirectorOf*] *Comedy-Movie*

Even though there does not exist an explicit Object property between the quiz show and the aforementioned comedy movie, it is not hard to see these contents are related, because the same person is involved in both of them.

After the inference process, the goal is to rank the *semantic paths* detected by extracting the most relevant ones. The most significant relations involve the instances contained in the user *ontology-profile* and other instances related to the former ones from a semantic point of view. We refer to this new relation as *semantic nexus*. So, there exists a *semantic nexus* between two instances of classes (or two properties) when these classes (properties) are siblings or are related by the subsumption principle (relations "is-a").

The relations defined here, which are easily discovered by the LIKO query operators shown in Table 1, support the proposed reasoning process and improve the personalized recommendations presented the users.

3. CONCLUSIONS AND FURTHER WORK

In this paper a TV recommender system has been presented. The main contribution of our tool is the application of a semantic reasoning process on the descriptions of the programs and the user preferences. This approach allows to infer hidden relations in the system knowledge base, taking as starting point the instances contained in an OWL ontology about the TV domain, and the properties that define explicit relations among them.

The existing approaches do not reason about the semantics of the offered programs. This way, the inference and reasoning processes are greatly hampered. Our proposal provides the users with varied and personalized recommendations, by discovering semantic relations among the programs of interest for them and other ones contained in our knowledge base.

On the other hand, note that our proposal of semantic reasoning is not only valid for a TV recommender system like AVATAR, but also it is easily generalizable to other applications of the Semantic Web. It is only necessary a correct conceptualization of the new application domain by an ontology containing specific instances, over which to apply the semantic reasoning process sketched here.

Our future work is focused on detecting new semantic relations and improving their ranking process, so that high quality recommendations can be offered to the end users.

4. REFERENCES

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