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Towards an Ontology-based Recommender System for the Vehicle Domain

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Abstract. In the vehicle domain, a recommender system (RS) helps vehicle items to be displayed and selected based on the parameters that are the most relevant to specific users. In other words, users can meet with vehicle items suited to their profile, preference, or interest. Therefore, users will not spend much time searching and retrieving what corresponds to their needs and capacities, as well as against the ever-growing volume of information in the application. In this paper, we analyze the particular characteristics of users and vehicle items in vehicle recommendations. As a result, we propose our approach for building an RS based on ontologies in the vehicle domain.

Keywords: Recommender System · Ontology · Vehicle Recommendation.

1 Introduction

In today's era of instant information, more users around the world are becoming more reliant upon RSs to have better advice, suggestions, and inspire them. From e-commercial systems to online advertisements, RSs increasingly influence user's decisions to choose products or services and spend their money, time. Besides, they help users to enhance their experiences on different platforms. The relevant recommendation at the right moment for users is exactly what the technology companies such as Google, Amazon, Netflix, and LinkedIn pursue. These ambitions have been fulfilled with the directly integrated module on their online system and they bring positive evaluations and experiences from users. These systems nudge users to explore new opportunities and suggestions matching their preferences that may never have crossed their minds [12].

In response to this trend, we desire to improve and strengthen user's interactions and experiences by a recommendation engine that will be able to assist users in searching for a vehicle as well as suggesting relevant vehicles to them according to their preferences, history, and needs. The research, analysis, and construction of an effective RS for the purchase/sales of vehicles thus becomes our main objective.

2 State of the arts

One of the main purposes of ontology is to capture knowledge about a domain and represent them in a machine-readable and interpretable form. Thus, the usefulness of ontologies is relied on organizing data, improving search, and integrating data [1]. Various ontologies are designed for knowledge representation in the vehicle domain [2], [4]. These ontologies helped to improve the semantic search of applications.

The construction of recommender systems based on using ontologies as a knowledge base has been implemented and experimented within various domains such as course recommendations in e-learning systems [5], [10], tour recommendations in tourism applications [7], or product recommendation in e-commercial systems [3]. The use of ontology-based RS has been emerging in terms of the vehicle domain [9], [11]. These works have improved RSs by design and use integrated ontologies based on hierarchical relations. The purpose is to help vehicle buyers in finding the most relevant vehicles corresponding with their user profiles.

3 Needs for building an explainable RS in the vehicle domain

In the vehicle sales domain, ordinary users do not tend to buy, sell and exchange their vehicle as often as other products. Thereby, gathering interaction data as rating data, reviewing information of users for vehicle items might become more difficult than other domains. The rating data on vehicle items are quite divergent and carry a lot of individual characteristics. On the contrary, vehicle items descriptions richly contain information about the vehicle's parameters and their current condition.

User profiles can be categorized by demographic, social, or psychological information. For example, user profiles can be divided into five groups such as junior driver, amateur, professional, parent, senior person. Each group owns special characteristics and this can be linked to a particular kind of vehicle that they want. For instance, the group of junior drivers is usually young or new drivers like students or just starting to work. Thereby most of them will choose low-budget and large-size models. In another example, safety and comfort play an important role in choosing a car with a group of senior drivers. This analysis can be employed to build an ontology for user profiles or re-use to define rules for grouping users by their profiles.

Knowledge bases can be employed to construct an explainable intelligent system. Based on the fundamentals of mathematical logic, systems using a knowledge base can make deductive reasoning provide new information through mathematically proven ways. The construction of an explainable RS in the vehicle domain needs also be carefully considered in the case of helping users better understand the results they receive.

With RSs, each approach always has advantages and inconveniences. Using only one approach benefits the time and cost of the construction of an RS. However, the RS developed will have shortcomings in some aspects. Therefore,

a hybrid system can be a reasonable choice to trade off the limitations of each approach. Although deep neural network models are playing increasingly crucial roles across a wide range of decision-making problems [6]. However, the use of content-based or collaborative filtering (CF) associated with the deep learning approach perhaps is not the most suitable option in the current condition of data. With special characteristics in the vehicle sales domain, the use of knowledge base as ontology in the combination with content-based and CF approach in a hybridization design reaches an acceptable solution.

4 Ontology-based Vehicle Recommender System

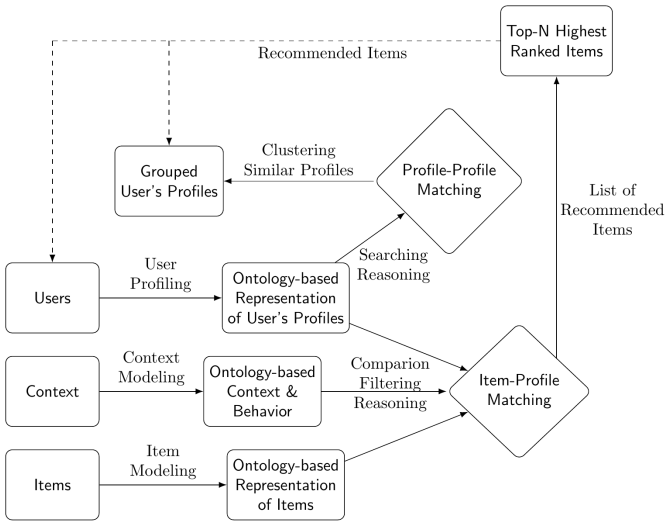

Fig. 1. The recommendation process of the proposed recommender system

The proposed approach is a recommender hybrid system that combines collaborative filtering, content-based approaches, and ontologies. A combination of both content-based and CF approach limits shortcomings about cold start problem data sparsity. Besides using ontology reinforces the accuracy in computing semantic similarity measures about vehicle descriptions, user profiles, and contextual information. As shown in figure 1 the process is divided into five steps started by gathering and modeling data to finding the recommendation items for each special user, and terminated by filtering and ranking recommendation results as follows:

- Gathering data from different sources and building a knowledge base for users, vehicle-items, context, and rating data of items based on ontologies.
- Organizing and mapping different ontologies in order to link the user profile, context, and item profile descriptions based on the existing data, mapping the relational database to RDF triples for user profile, item descriptions, contextual information, and interaction data of users for items.

- Analyzing user queried history and calculating the similarity between the user profile and item descriptions by vectorization of user profiles and similarity calculation algorithms.
- Clustering ontology-based user profile in order to obtain top N users that are similar to the current user [8].
- Ranking and filtering a list of relevant items to a user

5 Conclusion and Perspective

The objective of this study is the development of an RS that is able to generate personalized vehicle recommendations matched with the needs and capacities of users. Using ontologies of user profiles and vehicle descriptions will help enrich information as well as semantic relationships between users, between vehicles, and between users and vehicles. Towards a personalized RS in which ontologies are used to improve information representation and capabilities of implicit information inference from data become our main prospect.

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