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Representation Mode for Automobile-Oriented Customer Knowledge about After-sale Service

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Yu Li

Qingyuan Polytechnic, Qingyuan, Guangdong 511510

*Corresponding author's e-mail: yuliqy@139.com

Abstract. From the view of automobile after-sale service industry, this paper analyzes the connotation and characteristics of customer knowledge of this field, discusses on the method for acquiring customer knowledge of automobile after-sale service, and presents the ontology-based customer knowledge representation mode, thus ensuring the re-usability and consensus of automobile after-sales service knowledge.

1. Introduction

In automobile after-sale service, effective utilization of customer knowledge in corporate process application is a potential factor for enterprises to develop core competitiveness. Predicates are precise, accurate and natural in knowledge representation, while its processing efficiency is low and it can only express definite knowledge. The functions of productive system are more extensive than predicates but it is unable to indicate the knowledge that is more structural, thus a knowledge expression language which is more indicative and inferential is necessary[1]. Through ontology knowledge management, ontology can realize knowledge service at semantic level, improve the depth of knowledge application, support the reasoning of tacit knowledge, and promote the interoperability between heterogeneous knowledge[2]. It will be beneficial to structural establishment of field expert knowledge and experience, ensuring re-usability of knowledge.



Figure 1 Significance model of the variants affecting "normalized-losses"

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2. Retrieval of knowledge about automobile after-sale service customers

Automobile wearing is a key factor to adjustment of maintenance level. Taking the service data set of an enterprise as an example, this data set comprises four types of data: the first type is static attribute data describing automobile specification and characteristics, for example, automobile brand, price, type of fuel, type of engine, etc.; the second type is dynamic data about driver behavior, such as total mileage, compression ratio, max speed and urban mileage etc.; the third type is average annual loss that automobile insurance company has paid to the insurance; the fourth type is data about automobile maintenance level. Each type of automobile will be allocated to an initial insurance maintenance level on the basis of its price. Its maintenance level will be amended on the basis of trouble times within a certain period. The significance of other input fields was analyzed by means of Clementine nerve node modeling with "normalized-losses" defined as the output field. See Figure 1 for the data result.

Among the input fields, field "engine-type" affects automobile wearing filed "normalized-losses" most. Other fields "drive-wheels", "fuel-system", "body-style" are sequenced by their respective degrees of significance. See Table 1.

Nodes	Importance	Nodes	Importance
curb-weight	0.0187	city-mpg	0.0473
width	0.0194	peak-rpm	0.0481
Aspiration	0.0211	height	0.0585
engine-size	0.0232	num-of-doors	0.0687
highway-mpg	0.0243	body-style	0.096
horsepower	0.0267	fuel-system	0.1204
num-of-cylinders	0.0405	drive-wheels	0.1248
length	0.0411	engine-type	0.1307

Table 1	Significance s	equencing	of the	fields	affecting	"normalized-losses"
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The correlation between other fields oriented by "normalized-losses" field is revealed from the network diagram nodes. The network diagram indicates the correlation between degrees and reveals the knowledge correlation by various types of lines. See Figure 2.



Figure 2 Network Diagram of the Correlation of variants affecting "normalized-losses"

Without taking account of the 3rd level nodes in "normalized-losses", it is revealed in Figure 5-9 that the correlation between this node and other main variants is weak. If we connect relevant 1st and 2nd level nodes in "normalized-losses" by heavy lines, fine lines and dotted lines as per their respective degrees of relationship, we can get a grid diagram as shown in Figure 3.



Figure 3 Grid chart of the correlation of variants affecting "normalized-losses"

According to above analysis, by defining "normalized-losses" as the output field, and the four fields "engine-type", "drive-wheels", "fuel-system" and "body-style", whose effects are greatest, as the input fields, a C5.0 decision tree model was established. The following rule set was generated after executing the model:

Engine-type in ["dohc" "rotor"] [model: 2] => 2 (12; 0.667) Engine-type in ["ohc"] [model: 1] (125) Body-style in ["convertible" "hardtop"] [model: 2] => 2 (6; 0.833) Body-style in ["hatchback"] [model: 1] (46) Drive-wheels = 4wd [model: 2] => 2 (0) Drive-wheels = fwd [model: 2] => 2 (4; 1.0) Body-style in ["sedan" "wagon"] [model: 1] => 1 (73; 0.795) Engine-type in ["ohcf"] [model: 1] => 1 (12; 1.0) Engine-type in ["ohcv"] [model: 2] (15) Body-style in ["convertible" "sedan"] [model: 2] => 2 (11; 0.727) Body-style in ["hardtop"] [model: 2] => 2 (0) Body-style in ["hardtop"] [model: 2] => 3 (3; 1.0)

3. Ontology-Based Automobile After-Sale Service Customer Knowledge Presentation

This rule set can be taken as the ontological domain of the effect of the characteristics of customer's automobile on its standard wearing. Domain ontology describes the knowledge of specific fields. Such ontology provides a detailed concept description of limited domain and can be set up manually [3] [4]. To develop a domain is not the purpose. From another view, ontology is the model of a specific domain set up for a specific purpose. Ontology must be abstraction of a specific domain, and the content of abstraction depends on how this domain will be applied and the anticipated extension [5]. After relevant terms are determined, they should make up a hierarchical structure. It is very important to ensure this hierarchical structure and the hierarchical structure of its sub-classes. That is to say, if A is a subclass of B, each case of A must also be a case of B, as shown in Table 2. A representation model for the ontology was built as shown in Figure 4.

of the characteristics of customer's automobile on its standard wearing								
The first terms	normalized-losses	Engine type	Body_syle	Custom type				
The second terms	Class_01	Dohc	hatchback	Custom_01				
	Class_02	Rotor	wagon	Custom_02				
	Class_03	Ohcv	sedan	Custom_03				
		Ohcf	convertible	Custom_04				
		ohc		Custom_05				
				Custom 06				

Table 2 Terms for the ontological domain of the effect

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Figure 4 Model for Ontology of the Correlation of Factors Affecting Standard Wearing of Customer's Automobile

The design of the inference engine is related not only to knowledge representation but also to the user and his profession, etc. The inference of the ontology concentrated more and more on several standard ontological languages, such as OWL, DAML, RDFS/RDF, and etc., so that inference engines that are more efficient relevant for specific applications were presented. RACER, FaCT, Pellet are examples of such specific and highly relevant inference engines. In this paper, the classification of customers concerning standard wearing is inferred with RACER inference engine, and the inference model as shown in Figure 5 was built.



Figure 5 Inference Model for Ontology of the Correlation of Factors Affecting Standard Wearing of Customer's Automobile

On the basis of RDF and RDFS, OWL uses XML-based RDF grammar and also defines some other grammatical forms of OWL, making OWL more terse and easy to understand than XML or RDF/XML grammars.

4. Conclusions

The customer knowledge base for automobile after-sales service shall be a set of correlated knowledge slices saved, organized, managed and applied in computer with specific knowledge representation mode according to the enterprise's need for solving problems concerning customer service [6]. Ontology-based customer knowledge representation can ensure the re-usability of knowledge, facilitate common understanding on knowledge about automobile after-sale service, define terms commonly accepted in the field and give clear definitions to the correlations among these terms in the mode of formalization at different hierarchies.

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