ONTOLOGY-BASED GENERIC TEMPLATE FOR RETAIL ANALYTICS

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ABSTRACT. The retail industry in Malaysia and in the world at large is growing at a fast pace. The ability to make informed decision is the key for retailers' survival. The wealth of customer data available for retailers is a key asset, which should provide retailers with information that guides their decisions. Retailers have not been able to use this data effectively to make better predictions on customer buying behaviour and marketing decisions because of the difficulty involved in processing large amount of data. The focus of this research is to derive a generic retail ontology template and then customize it for grocery store owners. The method used for developing the ontological tool retail analytics is based on Grüninger and Fox method, which was adopted due to its simplicity yet, provides a vivid explanation of the processes involved. Our research findings show that the generic ontology template can be customized for specific purpose in data-oriented decision support systems. This paper will illustrate how the generic template can be customized to segment the customers into various categories which provide managers with interfaces to better monitor their business processes and marketing programs.

Keywords: Ontology, retail analytics, customer lifetime value (CLV), Grüninger and Fox method, and Association for Retail Technology Standards (ARTS)

INTRODUCTION

It is apparent that the retail industry is in a very competitive business environment, with competitors working all day to gain a chunk of the market share, with all efforts geared towards retaining and acquiring new customers. On the other hand, customers are presented with various "mouthwatering" offers or marketing programs that suits their needs, thereby resulting to a rapid change in customer buying behaviour. The ability to make right decisions is a cornerstone for the survival of the retail organization in their business environment. It is no longer news that analytics is needed in the retail industry to enable them make right decisions. A survey conducted by Grüninger (Grüninger, 2004), indicated that respondents who are yet to adopt predictive technologies experienced 2% decline in their profit margins, and 1% drop in their customer retention rate. With the above information, it is evident that non-users of predictive analytic experienced a decrease in their profit margin and customer retention, while users of predictive analytics, the positive side as described in the survey information.

Understanding and predicting customers purchasing behaviour will require the use of historical data of the customers, that is, his or her business interactions; retailer's data may come from multiple sources, exist in different file formats, and have different underlying structures. This occurrence has triggered a problem for retailers on how to harness their data

to their own advantage amidst other retailers in the highly competitive business environment. For a retailer who is determined to edge out his or her competitor, he or she needs analytic tools and skills to enable them make effective decisions that are vital to survival of their organization. Retail organizations need to continually assess and redirect their actions in order to stay ahead of the market. As customers continue to look for product customization that best suits their needs, the precision of a decision with regard to which potential customers engage into a relationship is vital to a retail organization. The main challenge to a retailer is how to build and retain which customer.

This research aims at building retail analytic ontology-based tool that can be used in retail stores. This study will describe a tool that should be able to deal efficiently with the huge amount of data available in retail industry, that is, it should automatically deduce answers to retail queries based on the system's general knowledge of retailing and actual data. Ontology will be used to capture and represent the business semantics. By assuming deductive capability as provided by an inference engine, it is possible to explore the terminology and generate further knowledge in trying adopting a generic retail ontology template, to customize it for grocery store owners and to show how it could be used for decision making, for instance, segmentation customers into various categories.

LITERATURE REVIEW

Predictive analytics has come of age as a core enterprise practice necessary to sustain competitive advantage.

Importance of Predictive Analytics

Grüninger conducted a survey in early January 2009 (Grüninger, 2004) with 47 corporate organizations that have not used predictive analytics. Among them, more than half (51.5%) has never deployed predictive analytics. However, majority (15.2%) has plans to do so within the next five years, (51.5%) are planning to do so very soon, i.e. in the next six months. Among the organizations, the top three reasons that informed their decision to use analytical tools include 75% for strategic insights, 57.1% for decision support, and 46.4% for decision automation. Some 90.1% of respondents who have deployed predictive analytics attained a positive ROI from their most successful initiative. In all, the survey results promised positive results for users' growth of predictive analytics (Siegel, 2010).Rather than relying on intuition when pricing products, strategizing customer retention, maintaining inventory, direct marketing, email targeting, managers are using data, analysis and systematic reasoning could improve efficiency, reduce risk, and increase profits (Rich & Harris, 2010). In predictive analysis, each customer's score informs what action to be taken with that customer (Predictive Analytic World, 2009).

The Concept of Ontology

Ontology is a formal description of a set of objects, concepts, and other entities that are assumed to exist in a domain of interest along with their properties and the relationship that hold among them (Siegel, 2009). Ontology can be used in different problem solving situations, which informs the manner which the meaning and the relationship that exit between the terms are specified, resulting in a continuum of kinds of ontology. For any system using ontology to work properly, it must capture the right concepts of interest. It is therefore important to lay more interest on concepts, rather than the words representing them (Gruber, 1993). For instance, the proposed system for retail stores should capture specific concepts and attributes that relate to the problems to be solved, by deducing information from

their data. Our ontology design will define concepts that would be used to predict CLV of customers.

Customer Lifetime Value

Customer Lifetime Value (CLV) model is used in the field of marketing to evaluate the lifetime value of customers in conventional businesses. A comprehensive CLV model must address two main questions: (1) what are the sets of customer attributes relevant to customer value? (2) How are these attributes used to predict customer lifetime value? However, a more general model that places its emphasis on the precise specification of the inputs required for profitability analysis was suggested. This model joins profit from a customer over a sequence of separate time periods. For each period, the contribution of all purchases is computed, and the variables on marketing costs are identified. All revenues and costs are then adjusted to remove the time value of money and then summed together to provide the lifetime value of a customer.

Grüninger and Fox Method

According to (Fernández, 1999), Grüninger and Fox method involves building a logical model of knowledge that is to be specified by means of the ontology. This model is not constructed directly. It is constructed from exiting ontology, because exiting ontology may not adequately address the specific problem at hand. Exiting ontology are Modified to address specific problems. Presently, the exiting ontology cannot be queried to make specific predictions to enable the retailers make informed decisions concerning customers. Therefore, we will adopt the ACTS ontology template and modify it to meet our needs.

METHOD

The Grüninger and Fox method for developing ontology has been adopted for its simplicity and vivid explanation of the processes involved. Figure 1 describes the processes.

Figure 1. Adopted Method for Developing Ontological Tool

Step I: Determine the scope of the proposed ontology.

This step of ontology derivation should start by defining its domain and scope. This is done by answering the basic questions of "What is the domain that the ontology will cover?" In our case, the ontology will cover CLV of purchasers in grocery stores. In regard of this, we need to specify our tool to derive the approximate quantity of perishable goods that will be consumed by the customers, within a certain period, high peak or low peak period. Perishable goods are meant to be consumed fresh. Therefore, grocers need to ensure availability, while avoiding wastage, which will incur loss of revenue on products. Grocers must make projections based on the customer value derived from past purchased data. We found CLV as a suitable tool that could be exploited to bring out the appropriate quantity of purchases within a time frame. We have adopted a basic RFM model to drive the right quantity. Our ontology should be able to provide answers to grocers on customers demand for a grocery product, when they are required, and how recent does each customer demand for such

products, to determine the volatility of a particular product. Certain products sell very fast on certain periods of the day and on certain occasions of each month. One of the ways to determine the scope of the ontology is to sketch a list of competency questions that the ontology could answer.

Step II: Consider reusing existing ontology templates

Figure 2 is a screen shot ARTS. We considered using ARTS because it has a comprehensive definition and outline of retail concepts and properties which makes it easier for us to customize without difficulty. ARTS ontology provides the basic standards for retail stores to build specific functionalities. ARTS ontology provides a general framework that could be used to develop functions peculiar to the domain being modelled, and the functions or tasks it should exhibit. From the template we choose to modify the customer relationship management component to enable us to predict the CLV of a customer.

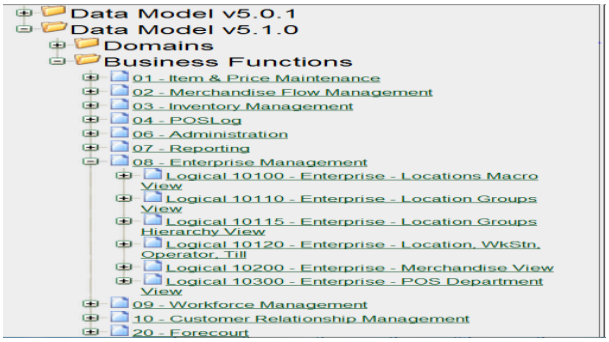

Figure 2. Screen Shot ARTS Ontology

Step III: Enumerate important terms in the ontology

It is useful to write down a list of all terms that make statements about the phenomenon. What are the terms that are of interest? What properties do those terms have? What would we like to achieve from those terms? Do they really meet the objectives for the creation? Ours is to predict customers CLV. In Table 1 we listed the terms that are of concern and define them as they relate to our aims.

Table 1. Key Fields for CLV Computation

Field Name	Description
Recency	The most recent date of purchase.
Frequency	The number of past purchases.
Monetary Value	The average purchase amount for customer transaction.
Volume	The quantity of a grocery item in certain unit of measure.
Product	Goods or services for sale.
Grocery	A food market.
Frozen Food	A preserved food for retaining its flavor and nutritional value.
Ingredient	A food items that is a component of a mixture of cooking.
Fruits	Any sweet, edible part of a plant that resembles fruit.
Supply	An offer of goods or services for sale.
Weight	The mass of a grocery item.
Price	The value of a product or service.

Step IV: Define the classes and the class hierarchy.

We adopt a top-down approach that starts with the description of the most general concepts (customer relationship management) in the grocery industry. Subsequently with specific concepts (customer lifetime value) as shown in Figure 3, the diagram shows the relationship of concepts within the grocery stores.

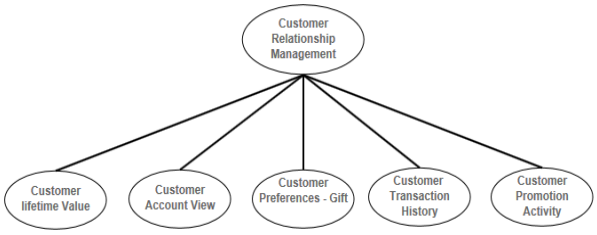

Figure 3. Ontology Model for Grocery Store

Step V: Define the properties of classes – slots.

The classes alone will not provide enough information to answer the competency questions. Once we have defined some of the classes, we must describe the internal structure of the concepts. Customer lifetime value (CLV) has the following internal structure: recency, frequency and monetary value as indicated in Figure 4.

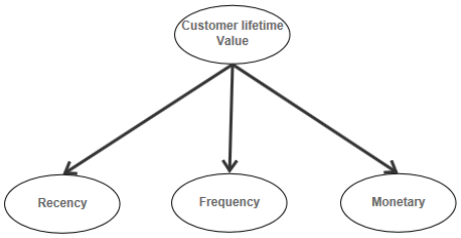

Figure 4. Ontology-based Hierarchical Model for Grocery Store

Step VI: Define the facets of the slots.

Slots can have different facets describing the value type, allowed values, the number of the values (cardinality), and other features of the values the slot can take, such as Boolean, integer, string, and so on.

Table 2: Ontology for Customer lifetime Value (CLV)

Concept	Property	Facet
CLV	Recency	Integer
CLV	Frequency	Integer
CLV	Monetary	Integer
Grocery	Frozen	String
Grocery	Ingredient	String
Grocery	Fruits	String
Supply	Quantity	Integer
Supply	Product	String
Supply	Quality	String
Supply	Goods Delivered	String

Step VII: Create instances.

The last step is for creating individual instances of classes in the hierarchy. Defining an individual instance of a class requires (1) choosing a class, (2) creating an individual instance of that class, and (3) filling in the slot values.

Table 3. Attributes of Customer Lifetime Value

Customer Lifetime Value		
Attribute	**Instance**	**Description**
Recency	Little, low, average, high highest	Recency has a scale from 1-5, 1 being the lowest value.
Frequency	Little, low, average, high highest	Frequency is also computed on a scale from 1-5, 1 being the lowest value.
Monetary	Little, low, average, high highest	Monetary value is also computed on a scale from 1-5, 1 being the lowest value.
Customer		
Attribute	**Instance**	**Description**
Name	James, Aziz, Chong	Names of individuals who have been recorded as customers.
Customer type	Gold, silver and bronze	Categories of customers that are differentiated for the value they bring to the grocery store.
Income	Little, low, middle, high	Another form of characterization of customers according to the level of their personal income.
Product		
Attribute	**Instance**	**Quality**
Price	Very cheap, cheap, appropriate, expensive, very expensive	The price of products according to the perceived value of the customers.
Zone of influence	Regional, national, international	Products that are most wanted in a place where the retail stores are located.
Quality	Poor, middle, good, very good	Customers' view on the product's quality.
Supply		
Attribute	**Instance**	**Quality**
Time of delivery	Very deferred, deferred, on time	The delivery time of a product as promised by the supplier.
Grade of product	Very weak, weak, neutral, strong, excellent	Grade of grocery item supplied.
Price	Appropriate, expensive, very expensive	The price charged by a supplier.

Table 3 represents the concepts, property and instances that are defined for use in the ontology. The basic concepts for this portion of ontology include the customer lifetime value, customer, product, and supply, with their corresponding attributes and instances defined to show the values that will build up the information for predictions and subsequent processing.

CONCLUSION

In this paper, we are able to adopt a generic ontology template from ARTS (Association for Retail Technology Standards) for the retail industry and modify the customer relationship manage component, to enable retailers predict the customer lifetime value from large amount customer data. The generic ontology template was narrowed down to automatically deduce

specific answers from queries to enable grocers to make informed decisions based on information generated from the system.

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