

A Marketing Strategies Auto-reasoning Model based on Semantic Web

Yiqing Lu

School of Information Management, Beijing Information Science and Technology University,

Beijing, 100192, China

luyiqing@126.com

Abstract: This paper analyzes auto-reasoning mechanism of marketing strategies based on ontology and rules. The domain knowledge is researched for different marketing strategies and analytic approach. With an example of enterprise, the ontology is proposed and described in detail. Association rule is used to mining rules of strategies, and create the rules file. On that basis, an auto-reasoning process of marketing strategies is described. Because the ontology is standard, explicit and formalized description for shared conceptual model, the automation and Intelligent of enterprise marketing can be realized by applying semantic express, shared knowledge described by ontology and auto-reasoning mechanism.

Keywords: Marketing; Reasoning; Ontology; Rule; Semantic.

1. INTRODUCTION

In today's world economy is unstoppable trend towards global economic integration, enterprise survival digital, commercial competition, an international direction. Increasing degree in business today, more and more intense competition between companies, marketing has become the company's operation and management of an important part of more and more attention to the company manager, marketing battle is intensifying. Marketing and content development is to improve the competitiveness of the enterprise market the most fundamental and most effective way, so variety of marketing methods, and the constant updates are triggered into a new pattern of marketing.

Marketing strategy includes company's market area and competition advantages. Market areas refer to those trades or markets that company target, market areas can be grouped as customer type, customer requirement, company's products or the technologies used by the company. Competition advantages refer to the properties, technologies, resources and specific advantages owned by the company, competition advantage will determine a company can have good performance or not.

By usage of data mining, a company can find and predict customer value, subdivide market, find customer interest, predict customer loss rate and make corresponding marketing strategies [1]. However, because of the complication and dispersion of company, and the dependency and restriction relationship between information, table-based database can only express structure information but not semantic information, and cannot implement the automatic marketing strategy [2-3].

Because the product homogenization degree is high, the enterprise is very difficult through the product variation to gain the competitive advantage, the terminal customer resources therefore become the focal point which various enterprises compete. Started from 2004, the personalized service market mode which based on target customer database is becoming the mainstream business model in healthy product market. To gain the most valuable customer becomes an important attention spot for enterprise to perform more effective goal marketing activity.

2. KNOWLEDGE OF MARKETING STRATEGIES

2.1 Technique and knowledge

The ontology should include enough knowledge, so that the knowledge base is effective for reasoning. In a general way, the customer data, the commodity price and sales detailed are basic information. There is other information required for different requirement. Further more, the technique of analysis is different.

For market segmentation, if using the customer's general population statistics characteristic (for example age, nationality, educational background either income and so on) or the purchasing behavior characteristic (for example purchasing volume, purchase product type structure, purchase frequency and so on) to divide market, the corresponding statistics characteristic or the purchase behavior characteristic should be considered when building ontology. If using cluster, decision tree, neural network to divide market, the attribute used in data mining should be considered.

Since association rule can be used in those marketing strategy such as hopping cart analysis based on customer interests, bundle sale, and gift send, customer interest variable and marketing strategy attribute should be included in knowledge description.

For the marketing strategy in view of customer loss rate, it should build customer loss classification and strategy attribute based on customer loss rate and profit loss which determined by statistics method.

Similarly, when the marketing strategy's formulation needs to consider the customer value, the personalized recommendation, the customer degree of satisfaction and so on question, should also contain the corresponding knowledge.

Table 1. Domain Knowledge

Issue of market strategies	Analysis technique	Knowledge
market segmentation	statistics, cluster, decision tree, neural network	statistics characteristic or the purchasing behavior characteristic, attributes for data mining
hopping cart analysis based on customer interests, bundle sale, and gift send	association rule	customer interest variable and marketing strategy attribute
customer loss rate	statistics	customer loss classification and strategy attribute

2.2 Construction of ontology

Ontology is used to describe thing existing and the relations between things, describe domain knowledge by defining common word and concept [4]. Some tools like Protégé, OWL can be used in ontology building [5-6].

Company D in this study is a famous company which product honey, the bee pollen, the propolis, the royal jelly from 1998.

This company’s marketing strategy is, In order to promote the royal jelly, present royal jelly sample to some customer to promote the overlapping purchase (to carry on association rule analysis, according to the sales combination which meet the rules, determine bundle-sale product).

The architecture of ontology class is as figure 1. Here only considers and the fore-mentioned marketing strategy related knowledge, the classes are Customer, Product, and Product includes subclass of Hone, Pollen, Propolis, Royal Jelly.

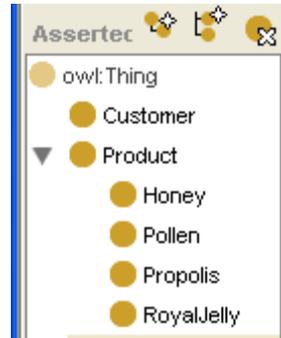


Fig 1. The architecture of ontology class

Class properties include Datatype property and Object property. Datatype property connects the object and the data type value. Class Customer's Datatype property should include the customer basic information, like ID, name, sex, age and so on. Class Product’s Datatype property should include the commodity price, as figure 2.

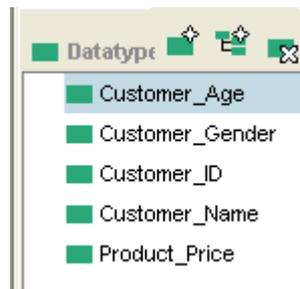


Fig 2. Datatype Property

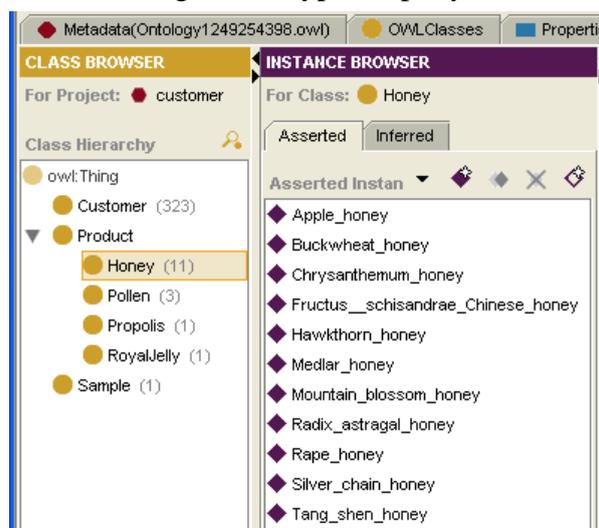


Fig 3. Instance

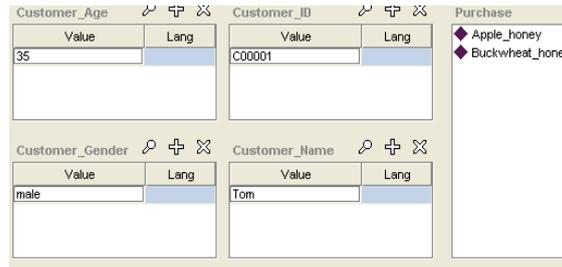


Fig 4. Property

Object property builds the connection between objects. Here need to consider the purchasing relations between class Customer and Object. Object’s domain is Customer, Rang is Product.

Class instance can be established after class property is set. For example, class Honey’s instance include apple honey, buckwheat honey, Chinese matrimony-vine honey and so on, Figure 3 and figure 4 show the instance and property setting.

3. REASONING BASED ON RULES

3.1 Mining association rule

For target-oriented sale, we need firstly determine the target customer to sent present, through association rule data mining.

Company D has more than 30,000 long-term customers and numerous fortuitous customers. This research selects Beijing area the customers as the sample. The corresponding data collection to these samples have 521 records, each record includes customers’ basic statistics information and the commodity purchasing data between 1/1/2003 and 1/30/2005, after exclude some unused data, we get 323 valid customer samples.

Use Apriori algorithm to mine sample’s purchasing history.

Apriori algorithm is described as:

- (1) $L_1 = \{\text{large 1-item sets}\};$
- (2) For $(k = 2; L_{k-1} \neq \emptyset; k++)$ do begin;
- (3) $C_k = \text{apriori_gen}(L_{k-1});$
- (4) for all transactions $t \in D$ do begin;
- (5) $C_t = \text{subset}(C_k, t);$
- (6) for all candidates $c \in C_t$ do;
- (7) $c.\text{count}++;$
- (8) end;
- (9) end;
- (10) $L_k = \{c \in C_k \mid c.\text{count} \geq \text{minsup}\};$
- (11) end;
- (12) $\text{answer} = \bigcup_k L_k$

After process the total 323 sample with Apriori algorithm, we get the following result:

Purchasing honey => Purchasing royal jelly, the supporting rate is 23%, the confidence rate is 31%.

Purchasing propolis => Purchasing royal jelly, the supporting rate is 22%, the confidence rate is 30%.

So we conclude marketing strategy is, sent present to the customer who ever purchased honey or

propolis.

3.2 Establish rules for reasoning

Based on the conclusion of section III, we can establish rules as below.

R1: purchase (X, Y), Y ∈ honey -> sample(X)

R2: purchase (X, Y), Y ∈ propolis -> sample(X)

Jena supports to put rules in a separate rule file for calling, this can avoid source code change when the rules changes. Below is the part of marketing rule file content.

```
#rule file
@prefix LO:
<http://www.owl-promotion.com/promotion.owl>
[First Rule :(? x rdf: type LO: purchase? y)
(? y rdf: type LO: Honey) ->
(? x LO: get sample)]
[Secont Rule :(? x rdf: type LO: purchase ? y)
(?y rdf: type LO: Propolis) ->
(? x LO: get sample)]
```

Rule file is independent on application, so rule file support dynamic adds, delete and modify without any impaction to application. Also, we can establish different rule file for different marketing strategy.

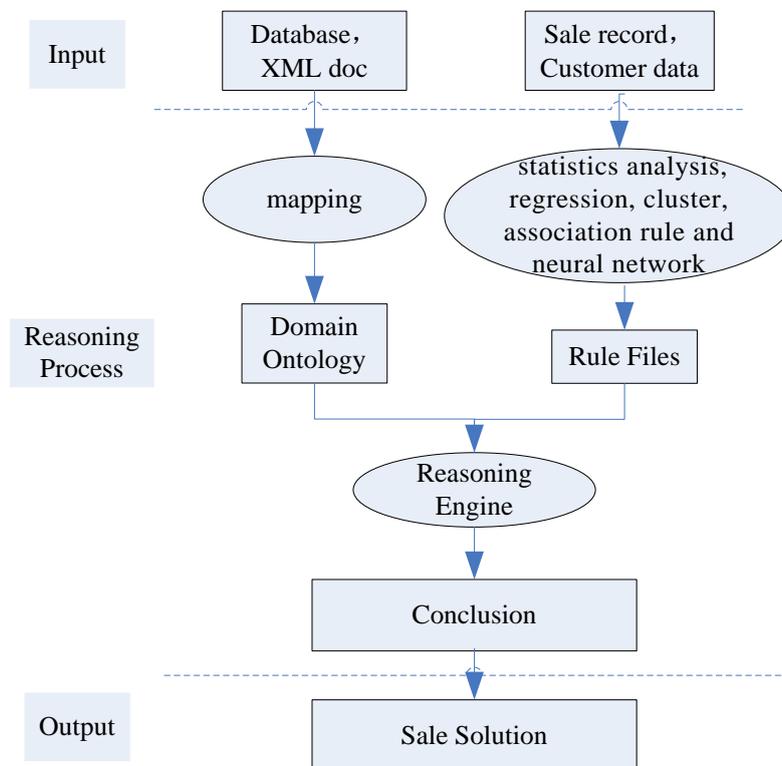


Fig 5. Auto-reasoning model of marketing strategies

4. AUTO-REASONING

The data size of customer data and sales detailed is great and marketing strategies often changes. So, the manual work takes time and easy to make mistakes. Auto-reasoning by reasoning engine can

improve efficiency and reduce mistakes. Furthermore, the marketing strategies can change swiftly for the storage and reuse of rule file.

We use protégé to building ontology and use Jana to building rules. Figure 5 shows the modularization structure and application framework of the auto-reasoning model. The auto-reasoning flow includes 4 steps.

(1) Build knowledge base

Build domain knowledge base based on the information stored in database and XML document.

(2) Build rule file

Perform data mining to sale records and customer data by statistics analysis, regression, cluster, association rule and neural network.

(3) Reasoning engine generates marketing strategies.

Reasoning engine performs automatic analysis via ontology and rule to draw a conclusion.

For example, customer C000001’s record shows in table 2 as below, and:

Table 2. customer information

Customer_ID	Customer_name	Customer_age	Customer_gender	Purchase
C000001	Tom	35	Male	Apple honey, Buckwheat honey
.....

Apple honey ∈ Honey

Buckwheat honey ∈ Honey

There’s rule in rule base:

[First Rule : (? x rdf: type LO: purchase? y)

(? y rdf: type LO: Honey) ->

(? x LO: get sample)]

Then can get the conclusion: Should sent honey sample to C000001.

(4) Display strategies listing

System displays the conclusion as sale solution to sales.

5. CONCLUSION

This paper merely uses association rule to establish marketing strategies. As we discussed in section II, there are other data mining technique can be used. For example, we can compute the potential value of customers by logistics regression and infer key factors by decision tree or neural network, for the further discussing.

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