



## Ontology-based data mining approach implemented on exploring product and brand spectrum

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### ABSTRACT

In physics, a spectrum is, the series of colored bands diffracted and arranged in the order of their respective wave lengths by the passage of white light through a prism or other diffracting medium. Outside of physics, a spectrum is a condition that is not limited to a specific set of values but can vary infinitely within a continuum. In commerce, an effective visualization tool, especially for stakeholders or managers, is a brand spectrum diagram highlighting where the company's brands and products are situated compared to other competitors. This paper investigates the research issues on product and brand spectrum in the beverage product market of Taiwan, which proposes using the Apriori algorithm of association rules, and clustering analysis based on an ontology-based data mining approach, for mining customer and product knowledge from the database. Knowledge extracted from data-mining results is illustrated as knowledge patterns, rules, and maps in order to propose suggestions and solutions to beverage firms for possible product development, promotion, and marketing.

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### 1. Introduction

In physics, a spectrum is, the series of colored bands diffracted and arranged in the order of their respective wave lengths by the passage of white light through a prism or other diffracting medium. Shading continuously from red (produced by the longest visible wave) to violet (produced by the shortest visible wave), these frequencies exist in a continuous range and have a common characteristic. A spectrum may be inclusive of many smaller spectrums, for example, the electromagnetic radiation spectrum includes the light spectrum, radio spectrum, infrared spectrum, etc. Astronomical "spectroscopy," the study of the spectra of astronomical objects, is a very powerful tool for determining many characteristics of stars, nebulae, and other bodies. Details of their spectra can reveal the materials they are made of and many of the physical conditions (temperature, pressure, and so on) within them. The term spectrum is also applied to other waves, such as sound waves, and most generally applies to any signal that can be decomposed into frequency components. A spectrum is a usually expressed as two-dimensional plot, of a compound signal, depicting the components by another measure. Sometimes, the term spectrum refers to the compound signal itself, such as the "spectrum of visible light", a reference to those electromagnetic waves which are visible to the human eye.

Outside of physics, a spectrum is a condition that is not limited to a specific set of values but can vary infinitely within a continuum. Since the word saw its first scientific use within the field of optics to describe the rainbow of colors in visible light when separated using a prism, it has been applied by analogy to many other fields. Thus one might talk about the spectrum of political opinion, or the spectrum of activity of a drug, or the autism spectrum. In these uses, values within a spectrum are not necessarily precisely defined numbers as in optics: exact values within this type of spectrum are not precisely quantifiable. Such use implies a broad range of conditions or behaviors grouped together and studied under a single title for ease of discussion. In most modern usages of spectrum there is a unifying theme between extremes at either end. Some older usages of the word did not have a unifying theme, but they led to modern ones through a sequence of events set out below. Accordingly, to obtain a spectrum, the measured function must be transformed in their independent variable to frequencies and the dependent variable has to be reduced in regions, over which the independent variable extends.

In commerce, businesses use branding to differentiate their product and service offerings from those of their competitors (Baker, 1996; Dibb, Simkin, Pride, & Ferrell, 1997; Kotler, 1997). The brand incorporates a set of product or service features that are associated with that particular brand name (Baker, 1996) and identifies the product/service in the market (Cooke, 1996). As Pearson (1996) explains, the concept of brand lies at the heart of marketing theory and practice. A brand is a combination of features (what the

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product is), customer benefits (what needs and wants the product meets) and values (what the customer associates with the product). A brand is created when marketing adds value to a product and in the process differentiates it from other products with similar features and benefits. For both services and tangible products, customer stance towards the brand and product is a crucial element in the success of marketing (Chernatony & Harris, 2000). The brand mantra (a short expression explaining the brand positioning and core brand values) is a particularly valuable instrument for conveying the essence of the brand to customers (Keller, 1999). The literature confirms the powerful position of branding in marketing activities. Brands are part of consumers' lives and organizations' strategies. It is widely accepted that consumers buy brands rather than products. Competition no longer occurs at the core-product level but according to the added attributes that the brand represents. These attributes are diverse in nature and can be physical or psychological. Nevertheless, they are ultimately the reason why the customers buy Nike instead of Reebok or vice versa in a specific market segmentation. Thus, we ask: does a customer have a spectrum of brands or products as preference frequencies in their purchasing decision?

An effective visualization tool, especially for stakeholders or managers, is a brand spectrum diagram highlighting where the company's brands and products are situated compared to other competitors. Some businesses have a difficult time understanding their brand attributes and how their companies should fit their products into the retail landscape. Often, when questioned, companies would like to fulfill all promises to all people. However, this approach is often limiting, as a strategy, lacking in targeted vision and segmentation. Therefore, we ask: can a business better understand its customers by realizing its own position of specific segmentation in the industry?

Most of the businesses involved in marketing activities such as customer profiling, advertising, media broadcasting, promotion, and endorsements are aware of the importance and need for marketers to acquire and share better knowledge of their customers. However, this is easier said than done since customer knowledge is concealed in customers. It is available but difficult to access, and without an effective method there is little possibility to explore the full volume of data that should be collected for its potential value. Thus, how to effectively process and use data is becoming increasingly important. This calls for new techniques to help analyze, understand or even visualize the huge amounts of stored data gathered from business and scientific applications (Liao & Chen, 2004). Among the new techniques developed, data mining is the process of discovering significant knowledge, such as patterns, associations, changes, anomalies and significant structures from large amounts of data stored in databases, data warehouses, or other information repositories (Liao, Chen, & Wu, 2008a). In the literature, there are many data mining models such as classification, estimation, predictive modeling, clustering/segmentation, affinity grouping or association rules, description and visualization, as well as sequential modeling. Similarly, there are also many application methods, including association rule, sequential pattern, grouping analysis, classification analysis and probability heuristic analysis (Musaeu, 2004; Liao, 2005; Anita & Dirk, 2005; Arie & Sterling, 2006; Liao, Hsieh, & Huang, 2008b). Therefore, knowledge of customers extracted through data mining can be integrated with customer profiles, brand preferences, purchased products, and marketing knowledge from research. It can then be provided to understand customers as well as the brand and product spectrum in a market.

Accordingly, this paper investigates the following research issues on product and brand spectrum in the beverage product market of Taiwan. They are (1) introducing the beverage product market in Taiwan, (2) according to Bernaras, Laresgoiti, and Corera

(1996), an ontology provides the means for describing explicitly the conceptualization behind the knowledge represented in a knowledge base. Based customer and beverage product ontology development, collecting information using questionnaire to construct a physical database for recording consumer basic data, consumer behavior, brand preference, and purchasing of beverage products; (3) implementing a data mining approach to acquire customer information; and (4) understanding customer knowledge using association rules and clustering analysis; and (5) depicting the product and brand spectrum of beverage product market in Taiwan. The rest of this paper is organized as follows. In Section 2, we present the background of beverage product market in Taiwan. Section 3 describes the methodology, including research framework, customer and beverage product ontology design and development, system architecture and database design, questionnaire design and collection, association rules and clustering analysis. Section 4 illustrates the data mining analysis results. Section 5 presents research findings and discussions, including a knowledge map for product and brand spectrum, and suggestions for beverage firms. Finally, Section 6 contains a brief conclusion.

## 2. Beverage product market

The beverages considered in this study are based on definitions by the Industrial Development Bureau, the Intellectual Property Office, the Ministry of Economic Affairs, and the Food Industry Research and Development Institute in Taiwan. Beverages are classified in eight main categories: tea drinks, soda drinks, coffee drinks, fruit and vegetable juices, sports drinks, packaged water, energy drinks, and other beverages (including drinks containing milk, yogurt drinks, soybean milk, rice milk, fruit vinegar, etc.). Alcoholic beverage products were classified in the three categories of brewed wine, liqueurs, and distilled wine. "Non-alcoholic beverages" and "alcoholic beverages" were combined in the beverage market in this research.

Based on predictions in the Taiwan Food Institute's ITIS Plan, the non-alcoholic beverage industry still has opportunity for growth in 2008. Output value is slightly higher than last year's and is projected to grow to NT\$45.7 billion. The growth rate of output value is 4.65%, with the value added greater than NT\$20.1 billion, which represents the highest value-added category in all the categories shown in Table 1. Tea drinks are the best selling item among all domestic beverage products, while soda drinks are declining and coffee drinks are growing. Beverages are one of the necessities of modern life, with a huge market scale. Merchants utilize healthy and natural lifestyles, which have become part of the beverage environment, to propose product designs and appeal to themes such as diet, beauty, nutrition, reducing the risk of illness, and so on. However, good taste and good "mouthfeel" are the most essential factors for presenting food products. The idea of promoting product value through added functions is logical, though it is of less influence with consumers, who instead follow fashion. Therefore, how to integrate lifestyles and beverage-consuming habits from the beginning of product design is an important point. Based on the predictions in the Taiwan Food Institute's ITIS Plan, non-alcoholic beverages in 2008 will grow 4.65%, beer products will drop 0.55%, and fermented alcoholic beverages will grow 2.8%. Thus the beverage market is a growing market in Taiwan. The output values are shown in Table 1.

## 3. Methodology

### 3.1. Research framework

Because customer and product sales databases are unavailable, the data was acquired through questionnaires and linked with

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