Chapter 10
Fuzzy Data Warehouse for Performance Analysis

Daniel Fasel
University of Fribourg, Switzerland

Khurram Shahzad
Royal Institute of Technology (KTH), Sweden

ABSTRACT
The numeric values retrieved from a data warehouse may be difficult to interpret by business users, or may be interpreted incorrectly. Therefore, for more accurate understanding of numeric values, business users may require an interpretation in meaningful, non-numeric terms. However, if the transition between non-numeric terms is crisp, true values cannot be measured, and smooth transition between classes may not take place. To address that problem, the authors employ a fuzzy classification-based approach for data warehouse. For that, they present a fuzzy data warehouse modeling approach, which allows integration of fuzzy concepts without affecting the core of a classical data warehouse. The essence of the approach is that a meta-tables structure is added for relating non-numeric terms with numeric values. This enables integration of fuzzy concepts in dimensions and facts, while preserving the time-invariability of the data warehouse. Additional to that, the use of fuzzy approach allows analysis of data in both sharp and fuzzy manners. The proposed approach is demonstrated through a case study of a movie rental company.

INTRODUCTION
In enterprises, data is spread across a number of heterogeneous sources and is not available for analysis and decision-making. In order to analyze enterprise-wide data, data warehouses are implemented (Chaudhuri, 1997) and data from transactional sources are transferred into it for analysis and decision making in enterprises to achieve competitive advantages.

Typically, output from data warehouse is a set of numeric values (called fact) based on the input given to it in the form of dimensions (Inmon, 2005).

DOI: 10.4018/978-1-4666-0095-9.ch010
These numeric values can be difficult to understand or can be interpreted differently by different users, which could lead to different decisions. Consider the example of a movie rental company, in which movies are in service for a certain period of time. Given the movie discarding principle, discard old movies, there is a possibility that different users or a single user (at different occasions) may end up discarding movies after different years of service. A solution to this problem is adding linguistic terms and explicit classification of movies into new and old movies. Figure 1(a) shows the classification of movies in accordance with the given principle i.e. a movie is considered as new if its service time is less than 10 year and old if its service time is 10 or more years. This manner of classification is called crisp classification.

If the classification between linguistic terms is crisp, true values cannot be measured and smooth transition between classes cannot take place (Fasel, 2010). The movie classification example discussed above, does not offer smooth transition between classes (new and old) i.e. a movie in service for 9 years 365 days is new and the one in service for 9 year 366 days is old, although the difference is only 1 day. To understand the inability of crisp approaches to measure true values, consider another example of movie classification. This classification is based on the content of a movie, using the linguistic terms humorous, love story and war movie. Given a movie, that has both humorous and love story content mixed in some ratio, it is not possible to classify it correctly using the crisp approach. To address the discussed problems, a fuzzy approach has been used to classify values using linguistic terms. Figure 1(b) shows the smooth classification of movies into humorous, love story and war movie using a fuzzy based approach.

In this chapter, a fuzzy data warehouse modeling approach is discussed, which allows integration of fuzzy concepts as meta-tables without affecting the core of a classical data warehouse. The essence of the approach is that a meta-tables structure is added to data warehouse for classification, which enables integration of fuzzy concepts in dimensions and facts, while preserving the time-invariability of the data warehouse. Also in this chapter, we present a method, which includes some guidelines that can be used to convert a classical warehouse into a fuzzy data warehouse. The key benefit of integrating fuzzy concepts is that it allows analysis of data in both sharp and fuzzy manners. In addition to that, the aggregation, propagation of fuzzy concepts and typical operations of a classical data warehouse are discussed for the fuzzy data warehouse. The use of the proposed approach is demonstrated through a case study of a movie rental company and the benefits of integrating fuzzy concepts in performance analysis are illustrated.

The rest of chapter is organized as follows, a brief overview of basic concepts given in the basic concepts section. We review relevant work in the existing approaches of fuzzy data warehouse section. The proposed approach fuzzy classification is given in Fuzzy Data Warehouse – integrating fuzzy concepts in meta-tables structure section. Also, this section contains classification of fuzzy concepts. A method for converting a classical data warehouse to fuzzy data warehouse is presented in method for modeling Fuzzy Data Warehouse section. Operations on fuzzy data warehouse are defined in operations, aggregation and propagation of fuzzy concepts section and the demonstration of the proposed approach is depicted in a case study in performance analysis of a movie rental company section.

**BASIC CONCEPTS**

Data warehouse (DWH) has been defined by a number of authors, however Inmon’s definition has received most reception over the years. According to Inmon (2005), ‘a data warehouse is a subject oriented, non volatile, integrated and time variant data in favor of decision making’.
Related Content

Confronting the Challenges of Asymmetry of Information and Competition: The Rise of eBay
www.igi-global.com/chapter/confronting-the-challenges-of-asymmetry-of-information-and-competition/139922?camid=4v1a

Value Creation
www.igi-global.com/chapter/value-creation/75610?camid=4v1a

Explaining Young Consumers' Online Purchase Behavior under Risky Conditions: Perspectives from Mental Accounting
www.igi-global.com/article/explaining-young-consumers-online-purchase-behavior-under-risky-conditions/141486?camid=4v1a

Does Demographics Affect Purchase Frequency in Online Retail?
www.igi-global.com/article/does-demographics-affect-purchase-frequency-in-online-retail/181557?camid=4v1a