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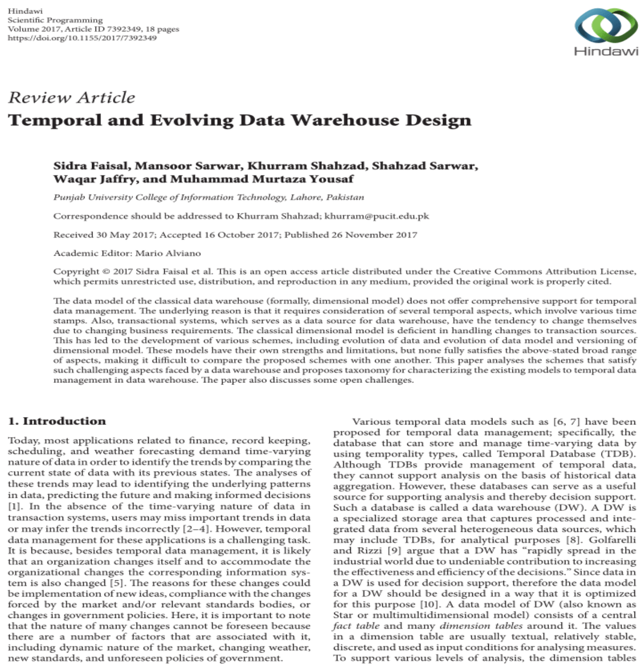

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Review Article

Temporal and Evolving Data Warehouse Design

Sidra Faisal, Mansoor Sarwar, Khurram Shahzad, Shahzad Sarwar, Waqar Jaffry, and Muhammad Murtaza Yousaf

Punjab University College of Information Technology, Lahore, Pakistan

Correspondence should be addressed to Khurram Shahzad; khurram@pucit.edu.pk

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The data model of the classical data warehouse (formally, dimensional model) does not offer comprehensive support for temporal data management. The underlying reason is that it requires consideration of several temporal aspects, which involve various time stamps. Also, transactional systems, which serves as a data source for data warehouse, have the tendency to change themselves due to changing business requirements. The classical dimensional model is deficient in handling changes to transaction sources. This has led to the development of various schemes, including evolution of data and evolution of data model and versioning of dimensional model. These models have their own strengths and limitations, but none fully satisfies the above-stated broad range of aspects, making it difficult to compare the proposed schemes with one another. This paper analyses the schemes that satisfy such challenging aspects faced by a data warehouse and proposes taxonomy for characterizing the existing models to temporal data management in data warehouse. The paper also discusses some open challenges.

1. Introduction

Today, most applications related to finance, record keeping, scheduling, and weather forecasting demand time-varying nature of data in order to identify the trends by comparing the current state of data with its previous states. The analyses of these trends may lead to identifying the underlying patterns in data, predicting the future and making informed decisions [1]. In the absence of the time-varying nature of data in transaction systems, users may miss important trends in data or may infer the trends incorrectly [2–4]. However, temporal data management for these applications is a challenging task. It is because, besides temporal data management, it is likely that an organization changes itself and to accommodate the organizational changes the corresponding information system is also changed [5]. The reasons for these changes could be implementation of new ideas, compliance with the changes forced by the market and/or relevant standards bodies, or changes in government policies. Here, it is important to note that the nature of many changes cannot be foreseen because there are a number of factors that are associated with it, including dynamic nature of the market, changing weather, new standards, and unforeseen policies of government.

Various temporal data models such as [6, 7] have been proposed for temporal data management; specifically, the database that can store and manage time-varying data by using temporality types, called Temporal Database (TDB). Although TDBs provide management of temporal data, they cannot support analysis on the basis of historical data aggregation. However, these databases can serve as a useful source for supporting analysis and thereby decision support. Such a database is called a data warehouse (DW). A DW is a specialized storage area that captures processed and integrated data from several heterogeneous data sources, which may include TDBs, for analytical purposes [8]. Golfarelli and Rizzi [9] argue that a DW has "rapidly spread in the industrial world due to undeniable contribution to increasing the effectiveness and efficiency of the decisions." Since data in a DW is used for decision support, therefore the data model for a DW should be designed in a way that it is optimized for this purpose [10]. A data model of DW (also known as Star or multimultidimensional model) consists of a central *fact table* and many *dimension tables* around it. The values in a dimension table are usually textual, relatively stable, discrete, and used as input conditions for analysing measures. To support various levels of analysis, the dimension tables

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