
A Measurement-Theoretic Foundation of Rule Interestingness Evaluation

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Summary. Many measures have been proposed and studied extensively in data mining for evaluating the interestingness (or usefulness) of discovered rules. They are usually defined based on structural characteristics or statistical information about the rules. The meaningfulness of each measure was interpreted based either on intuitive arguments or mathematical properties. There does not exist a framework in which one is able to represent the user judgment explicitly, precisely, and formally. Since the usefulness of discovered rules must be eventually judged by users, a framework that takes user preference or judgment into consideration will be very valuable. The objective of this paper is to propose such a framework based on the notion of user preference. The results are useful in establishing a measurement-theoretic foundation of rule interestingness evaluation.

Key words: KDD, Rule Interestingness, Evaluation, Measurement Theory, User Preference

1 Introduction

With rapidly increasing capabilities of accessing, collecting, and storing data, knowledge discovery in databases (KDD) has emerged as a new area of research in computer science. The objective of KDD systems is to extract implicitly hidden, previously unknown, and potentially useful information and knowledge from databases [7, 10]. A core task of the KDD field, called data mining, is the application of specific machine learning algorithms, knowledge representations, statistical methods, and other data analysis techniques for knowledge extraction and abstraction. The discovered knowledge is often expressed in terms of a set of rules. They represent relationships, such as correlation, association, and causation, among concepts [48]. For example, the well-known association rules deal with relationships among sale items [1, 3]. Some fundamental tasks of data mining process in KDD are the discovery, interpretation, and evaluation of those relationships.

There are many types of rules embedded in a large database [46]. Furthermore, the number of rules is typically huge and only a small portion of rules is actually useful [36]. An important problem in data mining is the evaluation of the *interestingness* of the mined rules and filtering out useless rules [36]. Many measures have been proposed and studied to quantify the interestingness (or usefulness) of rules [11, 15, 35, 36, 48]. The results lead to an in-depth understanding of different aspects of rules. It is recognized that each measure reflects a certain characteristic of rules. In addition, many studies investigate and compare rule interestingness measures based on intuitive arguments or some mathematical properties. There is a lack of a well-accepted framework for examining the issues of rule interestingness in a systematic and unified manner.

We argue that measurement theory can be used to establish a solid foundation for rule interestingness evaluation. The theory provides necessary concepts and methodologies for the representation, classification, characterization, and interpretation of user judgment of the usefulness of rules. A measure of rule interestingness is viewed as a quantitative representation of user judgment. The meaningfulness of a measure is determined by the users' perception of the usefulness of rules.

Existing studies of rule interestingness evaluation can be viewed as measure-centered approaches. Measures are used as primitive notions to quantify the interestingness of rules. In contrast, our method is a user-centered approach. User judgment, expressed by a user preference relation on a set of rules, is used as a primitive notion to model rule interestingness. Measures are treated as a derived notion that provides a quantitative representation of user judgment.

The rest of this chapter is organized as follows. In the next section, we introduce the basic notion of evaluation and related issues. A critical review of existing measures of rules interestingness is presented, which reveals some limitations with existing studies. The third section provides motivations to the current study. The fourth section presents an overview of measurement theory. The fifth section applies measurement theory to build a framework of rule interestingness evaluation. Finally, the conclusion in the sixth section gives the summary of this chapter and discusses the future research.

2 Introduction of Evaluation

The discussion of the basic notion of evaluation is aimed at improving our understanding to the rule interestingness evaluation methodologies.

2.1 What is the Evaluation?

Many approaches define the term of evaluation based on specific views [13, 32], such as qualitative assessments and detailed statistical analysis. Suchman analyzes various definitions of evaluation with regard to the conceptual and