



Data mining applications in accounting: A review of the literature and organizing framework



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ABSTRACT

This paper explores the applications of data mining techniques in accounting and proposes an organizing framework for these applications. A large body of literature reported on specific uses of the important data mining paradigm in accounting, but research that takes a holistic view of these uses is lacking. To organize the literature on the applications of data mining in accounting, we create a framework that combines the two well-known accounting reporting perspectives (retrospection and prospection), and the three well-accepted goals of data mining (description, prediction, and prescription). The framework encapsulates a taxonomy of four categories (retrospective-descriptive, retrospective-prescriptive, prospective-prescriptive, and prospective-predictive) of data mining applications in accounting. The proposed framework revealed that the area of accounting that benefited the most from data mining is assurance and compliance, including fraud detection, business health and forensic accounting. The clear gaps seem to be in the two prescriptive application categories (retrospective-prescriptive and prospective-prescriptive), indicating opportunities for benefiting from data mining in these application categories. The framework presents a holistic view of the literature and systematically organizes it in a structurally logical and thematically coherent manner.

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1. Introduction

In the era of rapidly changing, globalized economies, and highly competitive markets, organizations, to become competitively relevant, need to consider, and, many a times, adopt or implement a wide variety of innovative management philosophies, approaches, and advanced information technologies (Dorsch and Yasin, 1998). In particular, artificial intelligence (AI) is important to the future of the accounting profession (Elliott, 1992), and intelligent systems have empowered many enhancements in multidimensional analytical power and efficiency of the accounting processes (Granlund, 2011). Thus, there are clear calls that AI deserves added attention (Debreceeny, 2011), and the existence of opportunities of massive scale for companies to better fully leverage the analytical capability of their enterprise systems (White, 2004). An open question is: could the lack of full utilization of these analytical capabilities be explained by the complexity of these systems as suggested by Kim et al., 2009, or could it be due to other factors such as features specific to data mining techniques, or the nature of the intelligent accounting applications themselves?

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Data mining is one of the most important current paradigms of advanced intelligent business analytics and decision support tools. Such significance is acknowledged by the major accounting professional bodies. The American Institute of Certified Public Accountants (AICPA) has identified data mining as one of the top ten technologies for tomorrow, and the Institute of Internal Auditors (IIA) has listed data mining as one of the four research priorities (Koh and Low, 2004). In addition, the Chartered Global Management Accountants (CGMA) has reported that >50% of corporate leaders rank big data and data mining among the top ten corporate priorities that are fundamental for the data-driven era of business (CGMA, 2013). Data mining has been defined as the process of identifying valid, potentially novel, and ultimately understandable patterns in data (Pujari, 2001). It is also known as the process of extracting or mining knowledge from massive amounts of data (Han et al., 2006) to improve decisions in a particular discipline. The key focus of data mining is, therefore, to leverage the data assets of an organization to derive financial or non-financial benefits. Thus data mining has been applied to almost all non-business as well as business disciplines, including accounting.

Data mining is reported to afford organizations a wide array of benefits and capabilities; including effectively predicting future trends of corporate development, helping managers make better decisions, and raising competitiveness of an enterprise (Xiao et al., 2010; Yigitbasioglu and Velcu, 2012). It can also provide managers with logical and causal connections within a company's figures so that issues can be proactively tackled (Yigitbasioglu and Velcu, 2012). In addition, data mining can contribute towards significantly improving judgment, transaction, and compliance in auditing (Vasarhelyi et al., 2004), improve the quality of evidence supplied to auditors (Brown et al., 2007), and contribute to the efficiency of the overall audit (Chan and Vasarhelyi, 2011). Furthermore, data mining can facilitate electronic (Liang et al., 2001) and continuous (Brown et al., 2007; Vasarhelyi et al., 2012) auditing, and has the potential to radically alter the managerial control systems' role and execution in organizations (Sutton et al., 2011; Granlund et al., 2013). Data mining enables organizations to more easily identify statistical relations among performance measures (Ittner and Larcker, 2001), estimate the likelihood an event will occur, thereby supplementing managers' qualitative judgments (Rezaee et al., 2002), and provide a vehicle of control for both accuracy of the data and legitimacy of data requests. Not least, data mining can help organizations quickly discern patterns in data that would take years to discover using older techniques (Mauldin and Ruchala, 1999), identify disgruntled employees from patterns of their email exchanges (Huerta et al., 2012), and empower regulatory agencies with real-time market surveillance and risk profiling of market players (Williams, 2013).

Accounting is a bedrock of any enterprise and spans a wide range of tasks including internal and external reporting, costing, estimating, evaluating, analyzing, and auditing. Many of these tasks involve a great deal of uncertainty and risk complexities. Accounting has a history of intelligent applications dating back more than three decades (Baldwin et al., 2006), and was one of the earliest business disciplines to utilize data mining to better address these risks and complexities. A large body of research has been published describing applications of data mining in accounting. Although many researchers offered literature reviews of such research, these reviews have generally focused on a specific accounting domain and/or data mining technique (Coakley and Brown, 2000; Yang, 2006; Calderon and Cheh, 2002; Wang, 2010; Ngai et al., 2011).

A more encompassing approach is a review that presents this body of knowledge in a manner that simultaneously takes into consideration the multi-faceted nature of the two underlying disciplines of accounting and data mining. This approach can help in addressing effectively questions such as: what is the current status of the amalgamation of accounting, a fundamental business discipline, and data mining, a top ten future information systems technology? How pervasive is this critical technology in accounting, and is it uniformly used across all branches of accounting or is it limited to some and not others? When used, is it used with similar or varying intensities across the different accounting domains, and what are the plausible explanations if there is variability in usage intensity? How much has accounting adopted of the various powerful capabilities (including goals, tasks, and techniques) that data mining has to offer? These questions cannot be answered by the existing reviews individually. In addition, such an approach may provide a mechanism to organize the research on the applications of data mining in accounting in a structurally logical and thematically coherent manner. It is the purpose of this research to attempt to answer these questions, and to propose an organizing framework for the literature on data mining applications in accounting. In so doing, the paper, contributes to extant literature: first, a better understanding of the intersection of these two important disciplines; second, a macro-level perspective of the current status of research and practice on data mining applications in accounting; and third, a direction to potential opportunities for future research in this important domain. In addition, using a framework that succinctly organizes the literature and summarizes its overall topology reveals the main research themes and patterns, provides deeper insights into the underlying conceptual underpinnings and relationships, thereby leading to a better informed research and practice agenda. Without such a reflective well-organized literature review, one is left with a fragmented landscape without a solid handle on the true topography of the literature. Under such disjointed circumstances, it will be difficult, at best, to ascertain the extent to which the capabilities of a crucial technology of the 21st century have been leveraged in the core business discipline of accounting. The contributions of the paper are relevant to both researchers and practitioners with an interest in the application of data mining in accounting.

The objective of this paper is thus to systematically examine published research on data mining applications in accounting to understand the current status of, discern any central themes in, and offer an organizing framework for, this research. We propose a framework that provides a comprehensive view of what has been accomplished by using data mining in accounting, what areas in the accounting discipline have more and which ones have less utilization of this technology. The paper relies on interpretative research using content analysis to understand the relevant literature. Extant research that describes applications of data mining in accounting served as the primary data for understanding the nature of these applications and for mapping them into the organizing framework. The rest of the paper is organized as follows: section 2 provides a background and literature review, section 3

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