Management accounting and the concepts of exploratory data analysis and unsupervised machine learning

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Abstract

In this article, the potential applications of machine learning (ML) techniques and fresh data sources in management accounting (MA) research are examined. According to a survey of recent accounting and related research, ML techniques in MA are still in their infancy. However, a study of recently released ML research from related domains identifies a number of fresh potentials to apply ML in MA research. We argue that the most fruitful applications of ML techniques in MA research are (1) the full utilization of the rich potential of various textual data sources, (2) the quantification of qualitative and unstructured data to produce new measures, (3) the development of better estimates and predictions, and (4) the application of explainable AI to interpret ML models in depth. By inventing, expanding, and improving theories through induction and abduction, as well as by offering instruments for interventional investigations, ML approaches can play a significant role in MA research.

Keywords: management accounting, EDA, machine learning, bookkeeping

DOI Number: 10.14704/nq.2022.20.12.NQ77046 **NeuroQuantology 2022; 20(12): 619-633**

Introduction

Businesses are increasingly searching for fresh approaches to generating value from data. Numerous industries have seen significant changes as a result of the growth in data volume, its increasing significance, and the application of ML and AI approaches in particular. ML is a branch of AI that seeks to develop intelligent systems by learning from the data rather than by using pre-established rules This learning process has been greatly improved by deep learning, a kind of machine learning. Deep learning models typically operate very effectively with unprocessed data and do not require complex feature engineering that requires specialized knowledge. Many of the recent success stories of ML are due to this characteristic of deep learning. As a result, businesses are emphasizing technical development and investing in AI/ML applications to add value through enhanced customer service, enhanced operational efficiency, and raised sales. In general, the second digital revolution is altering whole corporate environments, with significant ramifications for business processes within businesses.

The variety of data available has substantially increased as a result of the increased usage of digitization in various administrative activities. In addition to the non-financial and financial data generated by the business operations of an

organization, examples of continuously collected individual-level data in organizations include data related to personnel selection and assessment, such as psychological tests and selection interviews, and HRM data, such as salary, performance evaluations, promotion records, sick leave reports, and employee turnover data. For MA researchers, this significantly expanded data availability opens up a wide range of new study opportunities, which may be explored using supervised and unsupervised ML techniques. ML approaches are generally known to be particularly beneficial for utilizing massive volumes of data more efficiently than traditional statistical methods, in addition to helping to process data from these unique sources. The advancement of technology, namely in the form of graphics processing units, has also expedited the use of ML and machine learning techniques. Applying ML approaches has become easier as a result of the ML research community's active development of new tools and algorithms for users, which includes both academics and practitioners.

Using Machine Learning in Accounting

You've utilized machine learning technology if you've ever used a chatbot on a website or asked Alexa a question. By learning coding behaviors and accelerating a number of business procedures, machine learning is revolutionizing the accounting industry.

Because ML, at its heart, saves businesses time and money, a poll by Sage found that clients now anticipate more creative services and technical practices from their accountants than in past years. A few of the reasons accountants use machine learning in their daily routines include using AI to automate tedious and time-consuming operations, enhance functionality, and raise productivity. By adopting robotic process automation (RPA), ML can help accounting firms become more competitive by cutting the time it takes to perform audits from months to just a few weeks. The ability of an accountant to recognize and evaluate data is combined with artificial intelligence in automated bookkeeping. Accounting organizations rely on robots for speed, security, and accuracy in financial services but still favor human involvement for creative aspects. These developments in AI will influence reporting, auditing, and attestation in the future.

How Machine Learning Will Impact Accounting in the Future

Machine learning is being investigated by experts for application in financial statement audits and risk assessment procedures. Speech recognition technology, for example, might be used to spot potentially dishonest answers and notable pauses and lags in responses. In fraud interviews, facial recognition software may also pick up on facial expressions that hint at deceit or stress. By combining machine learning and business intelligence, it will be easier to convert data into high-quality information that can be adjusted to various data sets. By providing user-friendly interfaces to enable in-depth data insights, ML may also facilitate business intelligence tools.

Big data and ML and AI technology are being used more and more in the business activities of accounting professionals.

Literature Review

Anthony's classic framework may be the most reliable and early description of the notion of management control system by foreign researchers. The management control system is defined as "the methods used by managers to ensure the efficient use of resources for the organization to achieve the intended objective." Anthony also modified the management control system to serve as a management accounting control system by adding strategic theories, psychology, and control systems. To rectify the behavior of the business subjects, this system

eISSN 1303-515

breaks down the corporate goals into the goals of several subjects, compares each subject's actual performance to their budget performance, and inputs these data information into the management control system.

Contrary to earlier ideas, the literature held that management accounting appeared to be a strategic tool requiring loosely organized firm supervision and that it was possible to implement a defender strategy in a given competitive and technical environment. According to the literature, the accounting information system is the most crucial component of the management information system, and getting accounting information from this system is the cornerstone of a successful management system. The foundation for the growth of management accounting informatization has been created by the development of accounting information systems. The literature utilized e-commerce accounting information systems to preserve firms' competitive advantages, which has turned into a trend in company development, and inputs these data information into the management control system.

Unsupervised Learning

When you wish to examine your data but do not yet have a defined aim or are unsure of the informational quality of the data, "unsupervised learning" can be helpful. The algorithm will investigate input data in a "unsupervised learning" method without being provided with a specific response variable (e.g., it studies consumer demographic information to spot trends). The decision maker in this instance desires the algorithm to Analyze trends to categories the customers. We can use the metaphor of a fruit bowl to describe the concept of "un-labelled" data. Let's say the computer software is trained to recognize the three various types of fruit: bananas, grapes, and apples. If the data The machine learning programme operates from that perspective and matches the labels in the initial training set photos to one of those three categories in succession. However, in the event that none of the data items are marked with the Apples, bananas, and grapes are three examples of fruits. The computer application will have to function by evaluating examining each image's elements, such as colour (yellow, red, and purple), shape (long and narrow, circular), and size or clustered), as well as other traits. This example makes it clear how much labelled data may provide improved possibilities for using machine learning algorithms to make decisions. Nevertheless, sophisticated with unlabeled data, unsupervised machine learning techniques can yield remarkably accurate and exact outcomes as well. One thing to keep in mind is that some of the methods may be applied to both unsupervised and guided instruction

EDA

The data analysis method known as exploratory data analysis (EDA), which has been around for millennia, places a strong emphasis on pattern detection and hypothesis creation from raw data. It has been used in numerous fields, including geography, marketing, and operations management, and is recommended as the initial step in any data analysis activity for examining and interpreting data. However, despite the fact that some auditing procedures have included EDA techniques like data mining and data visualization, systematic EDA use in auditing has not yet been established. Three pieces make up this dissertation, which explores how EDA is used in audit research. The paper adds to the auditing literature by highlighting the value of EDA in auditing, outlining a framework for auditors to use when using EDA to auditing, and utilizing two examples to show

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the advantages auditors can get from EDA when adhering to the suggested framework.

The nature of EDA varies as new data analysis techniques appear.

EDA and other approaches, including data mining, are convergent. Massive amounts of data can be automatically mined for meaningful information and relationships using a variety of ways. Data mining, like EDA, is entirely data-driven because it begins with no predetermined hypotheses and instead seeks to identify patterns that already exist in the data. The majority of data mining techniques can therefore be applied to EDA. Additionally, EDA tasks like outlier detection, variable selection, and pattern recognition can be accomplished via data mining techniques. Data mining is therefore seen as a development of conventional EDA.

Virtualization

The digitization of data and other recent technological developments, such cloud computing, make it possible for business organizations to be virtualized (including accounting firms). The extensive usage of mobile computing devices (smartphones, tablets, etc.), which are increasingly being utilized as major methods for accountants to manage their workflows, enhances and expands this phenomenon. As a result, accountants are able to supply and collect real-time information at almost any time and location. However, this suggests that accountants have access to private financial information at ostensibly any time. Given this information, another issue that merits more study and analysis is how to ensure the confidentiality of sensitive data when providing virtual accounting services. All things considered; the virtualization of business necessitates that accountants reconsider how they gauge corporate activity. Similar to this, auditors will need to radically change a number of current processes, including documenting controls, choosing samples, and performing confirmation, vouching, and tracing tests as an extension of traditional EDA.

Transformation (from Generalization to Specialization)

Accounting specialists will outperform generalists due to increasing corporate complexity, knowledge needs, regulatory and legal changes, and client expectations. Forensic accountants and fraud examiners, for instance, are in high demand due to the rising number of fraud cases. Specialization is anticipated to encourage more outsourcing of accounting services as well as increasing collaboration and partnership between accounting companies and other financial professionals. For instance, it is anticipated that big corporations' future outsourcing plans will be dominated by information technology (IT), accounting, finance, and administrative activities. Issues with data security and privacy also exist in the context of outsourcing and collaboration.

Methodology and Research Questions

Design Science Approach

Traditionally, research on accounting information systems has been categorized as natural science research, which is concerned with discovering new truths and explaining occurrences This study adheres to Simon's original definition of design science from 1969. The goal of design science research is to produce artefacts that define how things should be in order to transform current circumstances into ideal ones and advance practice. Understanding how things function is not the goal of this dissertation. Instead, it aims to enhance audit practice by integrating an analytical perspective into the audit process. This dissertation therefore qualifies as design science research.

A model is a description of the connections between several constructions. EDA methods can be thought of as models that represent the

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relationships between the data. A method is a series of instructions or rules used to carry out a task. A mechanism for auditors to incorporate EDA into the audit process is the framework created in this dissertation. An artefact is realized in its context during an instantiation. The rules and steps suggested in the framework are followed by the two case studies presented in this dissertation. They might be thought of as two different instances of the suggested framework.

EDA Application Framework in Auditing

The assessment of engagement risk comes first in an audit cycle. Auditors are primarily concerned with the client's financial status, integrity, and reputation when determining the engagement risk. In this phase, auditors can investigate a client's position in the business world and their financial stability by using data visualization tools on organizational and industry-wide financial data.

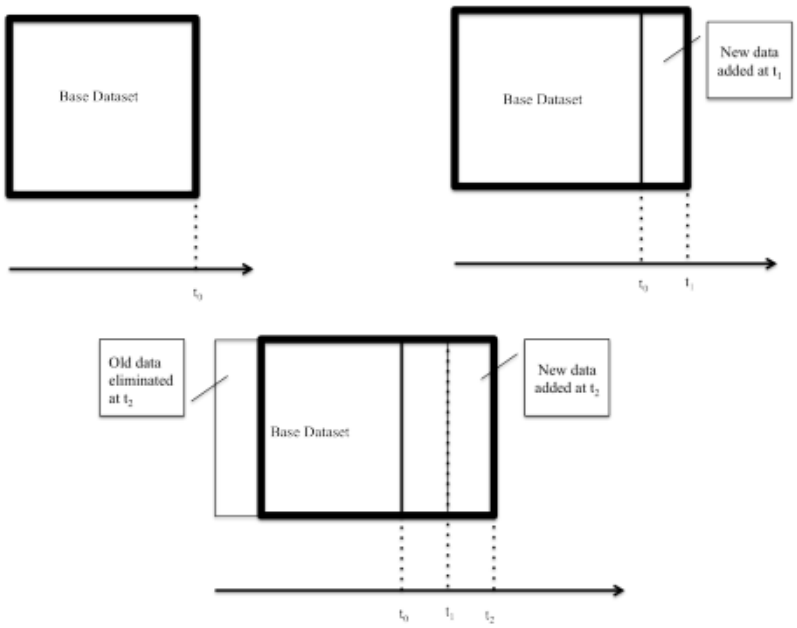

Figure 1: EDA Dataset in a Continuous Auditing System

The EDA process must be automated in order to be included in the continuous auditing system. Not all of the actions in the EDA process can be automated because it is also an interactive process that requires auditors to define salient aspects and select techniques and settings. To accommodate the constant auditing environment related with connected parties, several parts in the EDA process can still be automated.

For instance, it is possible to automatically calculate and display descriptive statistics for numeric fields. The fields that contain a person's identity information, including those for clients and vendors, can automatically do social network analysis. The automatic application of association analysis to item fields, such as purchase items or sold/returned products, is possible. In a conventional audit scenario, the following three steps—identifying significant features, producing hypotheses, and selecting appropriate tests to verify the hypotheses—require human input.

To formalize the judgements of auditors and management, these processes can be automated utilizing expert systems or other artificial intelligence technology.

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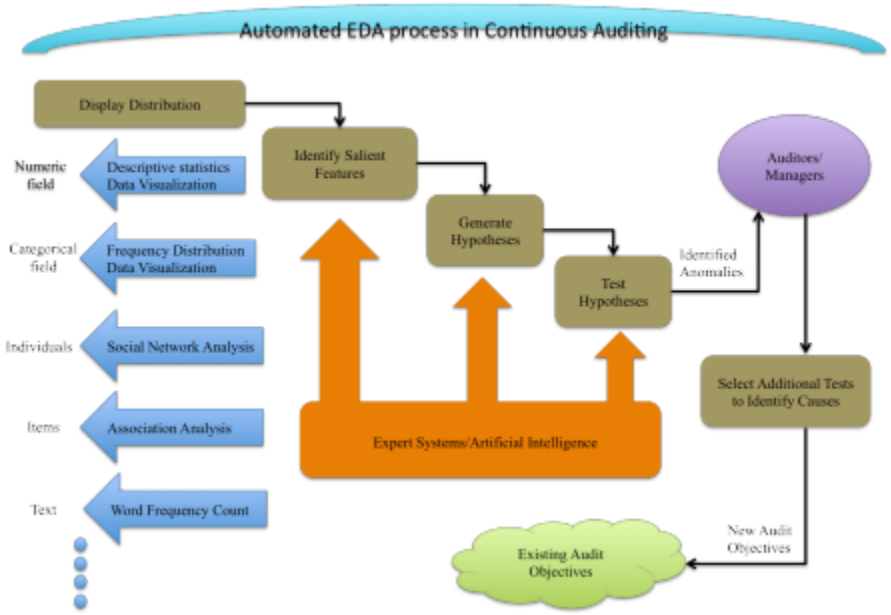

Figure 2: Automated EDA Process in Continuous Audit

Data preparation

The technique of analyzing revenue loss includes the discounts provided by bank representatives. However, there is no field specifically for discount in the raw retention data. Original fees and real fees are two fields that are now related to discounts (fees after negotiation). Before conducting EDA, the difference—which reflects the discount—must be computed. Discount is specifically the result of dividing the difference between the original fees and the actual fees by the original fees. The following is the formula used to determine discounts.

$$Discount = \frac{Originalual\ fee - Actual\ fee}{Original\ fee} \times 100\%$$

Account master data is necessary for several studies (like the credit card quantity check on page 91). So that similar data pieces can be matched, retention data and client master data need to be connected. For instance, each phone conversation to negotiate reductions adds a new item to the retention dataset, even if each client only appears once in the customer master data. This relationship allows for the joining of these many-to-one datasets.

The account sequential number field is used in the joining process because it is included in both datasets and serves as the VBA data's unique identifier.

Applied EDA techniques

The primary methods utilized to explore the data in this case study include conventional EDA methods like descriptive statistics, data transformation, and data visualization tools. Frequency distribution, summary statistics (mean and standard deviation), and category summaries are examples of descriptive statistics employed in this study. The logarithm function is used to transform data. Applied data visualization methods include scatter plots, bar charts, pie charts, and linear charts.

Results and Discussion

Traditional Auditing Techniques

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The maximum discount any bank representative is permitted to provide in accordance with bank policy should be used to establish whether bank representatives are breaking any rules. It must be decided. The bank's policy permits bank agents to provide discounts up to 100% of the annuity is used to keep the customer, hence the standard audit process is used to verify this audit's goal is to determine if any bank representatives offered additional services than discounts of 100%. Internal auditors need only use a filter to run this test. Choose every record that has a discount of more than 100%.

In this example, we'll show you how to apply a straightforward cluster analysis to sharpen your focus and boost customer profitability. Though it may seem alluring and exciting, this will frequently end up being really challenging. Unsupervised clustering analysis is one of the most significant and well-liked ML and multivariate analytic techniques), in Predictive modelling includes discussion of data mining. Therefore, there are four alternative design techniques that we might use for cluster analysis. It can be applied to a wide range of PM&M issues. Here, we'll employ the K-means clustering technique, which organises points in a cluster depending on their distance (mainly Euclidean) from the cluster's centroid. Since cluster analysis is an exploratory technique, we lack a training set to determine whether or not the categorization is accurate. It is crucial to differentiate K-means, an unsupervised learning technique used to solve clustering problems, is between, whereas A supervised learning approach called KNN (k-nearest neighbour) is applied to classification and regression issues.

There is also a response variable in the data (various kinds of PM&M models), but for the time being, we will only use the data for the four years and ignore the response variable's existence. The goal is to determine how the various KPIs will be organised if we initially "desire" four clusters (opposite to hierarchical clustering). A variety of possibilities and assumptions (and repercussions) occur even before we really begin our cluster analysis, which the decision-maker must be aware of in order to make the right choice.

One such supposition is whether the clustering algorithms ought to be based on "high-density" or "center-based" clusters. Here, we'll apply the "center-based" cluster assumption, which once more gives us the option of using the k-center, k-median, or k-means clustering algorithms. Again, the result and, most likely, the implications, will vary depending on the decision.

Here is a formal description. Find a partition $\boldsymbol{C} = \{C1, \ldots, Ck\}$ of A into k clusters, To reduce the sum of squares of distances between the data points and the centers of their clusters, divide A into k clusters with corresponding centres c1,, ck. The goal is to decrease;

$$\Phi_{k-means}\,(C) = \sum_{j=1}^{K} \sum_{aiECj} d^2\,(ai, cj)$$

eISSN 1303-515

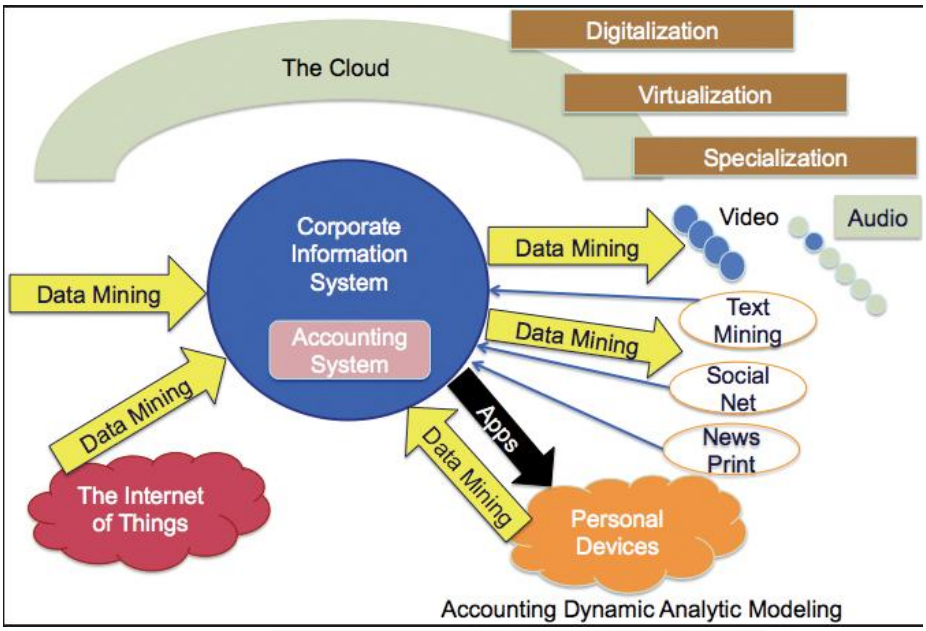

Figure 3: Evolutionary Environment of Accounting

Machine learning's Challenges for Auditors

According to research, the digitization of audit work is causing issues for auditors because a sizable portion of the data they utilise is based on corporations' records. Therefore, to support the external auditors at the end of the financial term, valid and clear account information and correct financial statements are required. Otherwise, incorrect reports would be prepared based on overstated or understated account data, upsetting and negatively impacting stakeholders. The audit firms must gain the experience of cybercrime consultants in order to ensure the integrity of financial and particularly nonfinancial data stored at the client's server because the operation of A.I. embedded algorithms would be based on the record that the client supplies.

Clients also refuse to provide auditors full access to the data because of fundamental ethical and confidential constraints. Therefore, in order to obtain the pertinent and trustworthy information, auditors will need to implement efficient testing controls. Only then would the auditors be allowed to provide the test data for machine learning after the completeness, accuracy, and valuation of the figures contained inside has been authenticated. Similar to how hackers can alter client data by violating security protocols

Observing Tax Laws

The IRS US Tax Regulations are more than 75,000 pages long in total, according to research done by PricewaterhouseCoopers, one of the biggest audit firms in the world. This makes it very challenging for taxpayers to understand such a big amount of sophisticated data, as well as for tax experts, accountants, and auditors. By developing a linguistic system that can organise the reference terms in tax cases and regulations for efficient human reading and comprehension, the company attempted to automate the comprehension of tax passages. The business also used AI to process tax notices automatically by using key terms and creating their reply. Similar to that, the business uses ML algorithms for account classification, tax compliance, and reporting.

By recognising the account names in which a certain transaction falls, ML is also utilised to

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comprehend the trial balance and categorise transactions. The accountants employ this classification for a number of things after that, including tax calculation and account adjustments for income and expense. Similarly, tax reporting and compliance is important for accounting and audit issues. In order to perform and assess the structured and unorganised income tax compliance actions, artificial intelligence is applied. ML capabilities are also employed for other repetitive and structured tasks that were previously carried out manually, such as collecting trial balance data from source systems, making book/tax adjustments, posting the entry of tax, and finishing tax forms.

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