

Artificial Intelligence Research in Financial and Accounting Industry

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Abstract

Purpose: this paper aims to show the need to use artificial intelligence in the accounting and finance industry. The constantly accumulating economic information about the activity of economic agents, the increased complexity and the improvement of information technologies are one of the main prerequisites for the huge impetus in the process of automation of operational reporting and financial analysis of economic indicators. Of course, this process does not go completely smoothly and it is necessary to gain experience and knowledge to achieve the highest degree of efficiency.

Design/methodology/approach This paper has its own theoretical basis, and on its basis analyzes the main practical applications of artificial intelligence in the very specific work of financial advisors, accountants and auditors.

Findings This paper has its own theoretical basis, and on its basis analyzes the main practical applications of artificial intelligence in the very specific work of financial advisors, accountants and auditors. The theoretical understanding of the context of complex analysis in relation to the participants in the process - innovators - who develop algorithms such as the immediate participants who conceptualize these algorithms, comes to analyze the components of the process and ultimately conclude that environmental provocations do not they can exclude the presence of the human mind, and ultimately its ultimate solution.

Originality/Value This paper uses machine learning and artificial intelligence, and analyzes the benefits of their application in the financial and accounting industry.

Keywords: a artificial intelligence, machine learning, large databases ethical treatment of accounting information, architecture of algorithms

Paper type: viewpoint.

JEL: G40, C53, C82

Introduction

The rapid development of intelligent systems will enable people to solve more and more complex tasks.

It is unlikely that as far back as 1494, the well-known Luca Pacioli in his "Third for Accounts and Records", who sought proportions and proportionalities in everything and embodied this philosophy in reflecting the movement of resources and money in space and time. Now this movement is so intense and intense that in order to cope with the huge databases and complex decisions they have to make about their management, it is necessary to seek the help of intelligent machines. Artificial intelligence systems with their extreme accuracy can provide solutions, and in some cases replace human effort.

Of course, the work of an accountant has undergone automation for many years, which actually improves work efficiency and help businesses create added value. Artificial intelligence and the system for its introduction are subordinated only to help people make better decisions in the efficient use and allocation of limited resources, as well as to record deviations from normal accounting practices due to violations of established rules of ethical accounting. Artificial intelligence technologies are accelerating the transformation of the business, with more solutions shaped by machine learning algorithms, responsible use of these powerful tools, properly managed to achieve the desired results.

Research questions can be formulated as follows:

1. Is artificial intelligence a long-term perspective in the accounting business?
 2. How artificial intelligence and human intelligence combine their positive aspects to improve the production capacity and efficiency of the accountant's work.
 3. Are there any negative effects of the use of artificial intelligence and can it be used for abuse
- The theoretical background of the development is the Theory of Technology Dominance, proposed by Arnold, V. And Sutton, S.G. (1998). According to the two professors at the University of Central Florida, who study behavioral technology, knowledge management, innovation in accounting, risk assessment in internal audit, accounting ethics in a corporate context, the use of intelligent systems in accounting can also have a negative effect. This is possible provided that algorithms for the implementation of intelligent systems are developed by those unfamiliar with their implementation, and in this case there is a threat to the quality of decisions that will be made if the system is more informed than the one who apply it.

Theory of Limited Rationality

One of the aspects studied for the role of artificial intelligence is the potential of this technology to change the existing economic theories.

In one of his early studies, Marwala (*Marwala, 2013*)¹ applied artificial intelligence to model the economic and financial instruments of equity derivatives and options. Is it possible for artificial intelligence to change economic theory? For example, Nobel Laureate in Economics Herbert Simon (*H. Simon, 1991*)² noted that when making rational decisions, one does not have

¹ Marwala, T., (2013). *Economic Modeling Using Artificial Intelligence Methods*. Heidelberg: Springer. ISBN 978-1-84996-323-7.

² Simon, H., (1991). "Bounded Rationality and Organizational Learning". *Organization Science* 2 (1): 125–134. doi:10.1287/orsc.2.1.125

the perfect and complete information to make a completely rational decision. In addition, man does not have the perfect brain to process such information in a timely and efficient manner. His decisions are also not entirely systematic and consistent, as they change depending on other factors such as mood swings. Simon calls decision-making in such conditions "rationally limited."

With the advent of artificial intelligence, man gains access to information that has been hidden and therefore not accessible and able to be used consistently. Through the use of artificial intelligence, it is increasingly able to make such decisions timelier and efficiently thanks to Moore's Law, which states that the processing power of machines is constantly increasing (Moore, 2006)³. What does the advent of artificial intelligence mean for the theory of finite rationality? This means that the limits in Simon's theory of finite rationality are actually flexible due to Moore's Law.

Hypothesis for efficient markets

Another economic theory that has been influenced by the advent of artificial intelligence is the Effective Markets a hypothesis, developed by Nobel Laureate Eugene Fama (Fama, 1965)⁴. This hypothesis states that it is often difficult to beat markets because markets are efficient. The problem is because market traders often do not adhere to perfect behavior and the information they have is imperfect and incomplete, and therefore the markets are not efficient. What happens to Effective Markets Theory if market traders are not just people, but a combination of people and artificial intelligence combined into a computer trader? The more efficient computer marketers have become by incorporating more artificial intelligence, the more efficient the markets have become. Therefore, the extent to which markets are efficient depends on the relative share of artificial intelligence traders they occupy in the markets.

Perspective theory

Nobel laureates Daniel Kahneman and Amos Tversky (D. Kahneman, A. Tversky, 1979)⁵ proposed the Theory of Perspective. According to this theory, when people make decisions with a certain probability of the results obtained, they weigh the potential losses against potential gains as a result of making such decisions. The impact of this theory on markets is wide. However, it is ultimately meant that the decision maker is a human being. What happens to this theory if decisions are made not just by a human being, but by a person who uses an artificial intelligent decision-making machine? What will happen if the decision maker is an entirely artificial intelligent machine?

The applicability of Perspective Theory depends on the extent to which the AI machine is used to make such a decision.

Literature review

The application of artificial intelligence in the field of financial services has been the subject of numerous studies by authors from many countries and research centers.

³ Moore, G., (2006). "Chapter 7: Moore's law at 40". In Brock, David. Understanding Moore's Law: Four Decades of Innovation (PDF). Chemical Heritage Foundation. pp. 67–84. ISBN 0-941901-41-6.

⁴ Fama, E., (1965). "The Behavior of Stock Market Prices". Journal of Business 38: 34–105. doi:10.1086/294743

⁵ Kahneman, Daniel; Tversky, Amos (1979). "Prospect Theory: An Analysis of Decision under Risk" (PDF). *Econometrica* 47 (2): 263. Doi: 10.2307/1914185. ISSN 0012-9682

№	Author, Title	Main funding
11.	Arnold, V. and Sutton, S.G., (1998) 'The theory of technology dominance: Understanding the impact of intelligent decision aids on decision makers' judgments', <i>Advances in Accounting Behavioral Research</i> , 1, pp. 175-194.	Dominance technology theory holds that novices can actually make worse decisions when they use a system that is more knowledgeable than the user. Work with experts making decisions to improve efficiency, but rather to make them partners in the process
22.	Anton Korinek,(2019) "Integrating Ethical Values and Economic Value to Steer Progress in Artificial Intelligence", NBER Working Paper No. 26130	The rise of artificial intelligence (AI) is forcing humanity to face new areas in which ethical values and economic value conflict, raising the question of the desired direction of technological progress. According to the authors, the key areas are the effects of artificial intelligence and related forms of automation in the labor market, which can lead to a significant increase in inequality and the need for action to mitigate policy or to supplement human labor.
33.	Mikkelsen,D., Pravdic, A., and Richardson, B. (2019) "Flushing out the money launderers with better customer riskrating models", <i>McKinseyComp</i> .	The authors analyze the models for managing the risk of legalization of criminal income based on an analysis of the main characteristics of customers and the costs they incur to monitor the behavior of those with risk profiles.
44.	S. G. Sutton, Holt, M.,Arnold, V. (2016) . <i>International Journal of Accounting Information Systems</i> "The reports of my death are greatly exaggerated"—Artificial intelligence research in accounting",	This refutes the claim that the application of artificial intelligence techniques is possible in fields other than knowledge-based expert systems, emphasizing the need to pay attention to machine learning applications, as the new reality of the future and the potential of artificial intelligence are related. language processing. In this analysis, however, a word of caution is given. While researchers look at the implications for the future of accountants, the accounting profession and society at large.
55.	Munoko, I., Brown-Liburd, H.L. & Vasarhelyi, M. The Ethical Implications of Using Artificial Intelligence in Auditing. <i>J Bus Ethics</i> (2020) doi:10.1007/s10551-019-04407-1	The authors find that accounting firms use artificial intelligence in their auditing and consulting functions, save time, analyze data faster, and increase accuracy. AI, an emerging technology that aims to mimic people's cognitive skills and judgment, promises competitive advantages. There are 4 companies that use it and plan to continue with this innovation in areas such as risk assessment for audit planning, transaction testing, analysis and preparation of audit working papers, among other applications. Adverse reactions are expected to occur and the ethical implications of using this emerging technology are being explored.
66.	Buchanan, B.G.(2019)." Artificial intelligence in finance", doi.org/10.5281/zenodo.2612537, Alan Turing Institute	Large databases and artificial intelligence are seen in the financial services sector as a technique with great potential. Their introduction in this business is associated with many risks, many techniques of artificial

		intelligence remain untested in scenarios of financial crisis. There are several cases in which the algorithms applied by financial firms seem to operate in a way unpredictable by their developers, leading to errors and crashes.
77.	Lo, Andrew W., Moore's Law vs. Murphy's Law in the Financial System: Who's Winning? (May 2016). BIS Working Paper No. 564. Available at SSRN: https://ssrn.com/abstract=2789737	It calls for the development of stronger technology capable of adapting to human capabilities so that consumers can use these tools safely, effectively and effortlessly. Much remains to be done due to the need for more literacy education and artificial intelligence awareness
88.	Luo, J., Q.Meng, Y. Cai, (2018). "Analysis of the Impact of Artificial Intelligence Application on the Development of Accounting Industry". Open Journal of Business and Management) 8, 850-856	The authors study as an object artificial intelligence in the accounting industry, analyze its impact on its development and have assumptions about existing problems.
99.	Trencheva, M. (2018) "Analysis of the main indicators and regulators of banking in accordance with changes in banking and accounting standards" (dissertation)	The researcher advocates her theory of the growing role of control, applying econometric models to determine the effects of the introduction of the new regulatory framework for banks after the global financial and economic crisis
110.	Trenchev, Iv. M. Trencheva, E. Stavrova, R. Mavrevski, M. Ttaykov.(2018). „Risk analysis in the economics through R Language“ Списание: WSEAS Transactions on Business and Economics,ISSN / E-ISSN: 1109-9526 2224-2899, Volume 15, PP: 179-187	The authors use as a tool a programming language with elements of artificial intelligence, applying an econometric model for risk assessment and management.
111.	PwC. (2018). "Digitalization in finance and accounting and what it means for financial statement audits". Survey on status quo and further digital development. P.52	One of the world's three largest audit firms conducted a survey of 76 large and medium-sized companies in Germany in two consecutive years 2016 and 2017 and analyzed attitudes about the current state of finance and accounting, the digital future of the financial industry, the current state and development the digitalization of audit, as well as the importance of digitalization for strengthening the links between external auditors and clients.
112.	Paskaleva, M. A. Stoykova. (2019). "Relationship between Bulgarian sovereign risk and accounting information", WSEAS Transactions on business and economics", Print ISSN: 1109-9526 E-ISSN: 2224-2899, Volume 16, 2019	The authors examine the relationship between the ability to manage credit risk based on the analysis of accounting information, in order to limit credit risk.
13.	Dzhaparov, Pl. (2019). Application of block chain and artificial intelligence in bank risk management, Economics and Management ISSN: 2367-7600; 1312-594X Volume: XVII, Issue: 1, Year: 2020, pp. 43-57	Blockchain and artificial intelligence are two technologies that have big potential to fundamentally transform banking management.by Big Data processing, customer segmentation, credit scoring, fraud prevention.

114.	Gancho Ganchev & Elena Stavrova & Vladimir Tsenkov & Mariya Paskaleva, 2020. "The "impossible trilemma" and the analysis of its validity by visualization through the use of artificial intelligence software," Economic Thought journal, Bulgarian Academy of Sciences - Economic Research Institute, issue 4, pages 56-75, 76-94.	This research aims to visualize the "impossible trilemma", i.e. the impossibility of simultaneously having a fixed exchange rate, free movement of capital and an independent monetary policy, for every economy through the application of artificial intelligence software. The advantages of visualization techniques are revealed. The explored countries are divided into the following panels: the Eurozone countries, the developed European countries (DEC), the developed non-European countries (DNEC), the BRICS countries (Brazil, Russia, India, China and South Africa), the developing European countries and the Organization of the Petroleum Exporting Countries (OPEC). The results of the research show a great level of confirmation of the trilemma for the developing economies and the developed non-European countries. This implies that there is a compromise between exchange rate stability, monetary independence, and free capital mobility.
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There are many researches in this scientific area as: Trenchev, I., R. Mavrevski, M. Traykov, D. Stoykov (2019), Denchev, S., I. Trenchev, I. Peteva, I. Pavlova (2019), Mittelstadt, B. D., Allo, P., Taddeo, M., Wachter, S., & Floridi, L. (2016), Sutton, S.G., et al.,(2018), Tsenkov, V., Mirchev, K. (2019), **Stavrova, E.**, N. Karanasios, A. Tandetzky, A. Reitano, M. Fazio,(2019) who deserve our attention for ideas similarity and conclusion ones.

Genesis of the application of artificial intelligence in the financial and accounting industry

Although the concept of "artificial intelligence" was discussed as far back as 1956 at a seminar at the University of Dortmund in the United States, Prof. John McCartney, only in the last five years the world has been flooded with a wave of applications of this technology. It successfully replaces human effort without leaving the necessary attention and introduces significant innovations in the accounting industry such as accounting information management.

1. In 2016, Deloitte and Touche were the first to announce the introduction of artificial intelligence techniques in accounting, auditing and taxation.
2. In 2017, world-renowned machine learning and artificial intelligence expert Nigel Duffy formed a global innovative artificial intelligence team in Ernest and Young. [8]
3. KPMG introduces the Artificial Intelligence and Control framework, which offers methods, tools and assessments to assist institutions in assessing the value of artificial intelligence, while achieving algorithmic integrity, accessibility, flexibility and equity.

Algorithms for machine learning in the accounting and financial industry

Artificial intelligence algorithms accumulate data with similar characteristics, process them through mathematical models and form predictions based on the results obtained. In the financial industry, the formation of databases is increasingly used due to the huge amount of data, as well as the ever-increasing capacity of computer hardware, network connectivity, and cloud infrastructure. Leading companies and banks are implementing artificial intelligence technologies, including machine learning, to optimize the structure of their investment portfolios, their production processes, risk, optimization of financial decisions and much more.

The application of artificial intelligence in the accounting and financial industry comes down to solving algorithms. This implies that in this way the economic agents who apply such technology are released from liability. Understanding an algorithm is like a sequence of computational steps that transform inputs into outputs. The goal is to achieve neutrality in maximizing effects or accuracy, which is achieved by software teams.

The analysis of financial documents is one of the main applications of the algorithmic approach. Data is processed with great speed and just as good precision.

Main areas of application:

1. Creditworthiness analysis. Until recently, the work of the Credit Committees in commercial banks was a series of routine operations, logistic regression models from input data such as payment history to predict the probability of default on principal and interest on loans. Of course, this modeling harms individuals and companies with a shorter history or works in unsupervised business environments by banks. As the number of data sources for individuals increases and they are linked to their financial history, financial institutions have the opportunity to apply more modern models for making personalized decisions about their creditworthiness.

2. Robo-advisors. Advisory robots make investment and financial decision making available to people with a lack of readiness. Their investment strategies are derived as an algorithm based on age, income, gender, financial goals, risk tolerance, planned retirement date. Based on this information, they follow traditional investment strategies and asset allocation. In this way, the possibility of conflicts of interest by financial advisers is eliminated, because sometimes their interests are asymmetrically focused.

3. Cyber security and threats. To ensure the security and safety of customers' business assets, financial intermediaries provide highly reliable cyber security protocols. Important case-studies for the use of machine learning in cyber security are: the detection of malware - by detecting and marking unrecognized software that is trying to run as a threat; internal system failures - by monitoring the network traffic in the organization, in the process of which anomalies are registered such as repeated attempts to access unauthorized applications or unusual behavior when working with the keyboard system.

Machine learning models:

1. Regression - information model with numerical output

2. Classification - the category in which the new site will be included is envisaged. Information model usually with binary output, but it is possible that there are models with more than two categories.

Linear regression predicts an output variable using one or more input variables in the form of a line [9], [10].

$$Y = bx + c$$

Supporting vector - a linear vector maximizes the distance between classes and draws a line in the middle. The data is categorized based on its position relative to this line. It is used in more complex functions to more accurately find the widest point between the data.

Decision tree - segments supervision by grouping data by attribute. If we choose the answer variable, the computer program makes partitions through the forecast variables. The number of partitions is formed automatically to prevent insufficient or excessive adjustment of the data to the model.

Random forest - a group of decision trees with the same response variable but fewer different variables.

Clustering - formation of natural groupings between observations in the database.

Agglomerative hierarchical clustering - the most common hierarchical clustering used to group objects into clusters based on their similarity. Each observation begins in its own cluster, pairs of clusters merge as the system is structured.

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The basis of machine learning are algorithms and human responsibility for their structuring. They can be used to form vital decisions for companies and people. Hence the responsibility they bear due to their huge information load due to the possibility of using them in various techniques for managing the full range of financial risks. [14] They cannot be neutral because they create moral consequences, reinforce or neglect ethical principles and allow the destruction of the status, image and limit the dignity of stakeholders. Participate directly in ethical decision making. Hence the high responsibility of the designer of the algorithm for these final decisions if he has structured it so as to exclude a group of people from the consequences of activating this algorithm and implementing a particular solution.

According to Price Water House Cooper (PwC), the most common application of artificial intelligence is currently found in the following operations [11]:

Table. № 1: Application of artificial intelligence in finance and accounting

№	Areas of application	Answer distribution
1.	Automatic reading of invoices and documents for registration in the accounting department	39 %
2.	Automatic payment transfers	29%
3.	Data base monitoring	10%
4.	Coordinated verification of documents	10%
5.	Automatic contracts reading	7%

6.	Business processes tools	5%
7.	Analytical forecasting of the disclosure	0%

From the content of Table. № 1 it can be found that the most popular areas of application of artificial intelligence is the reading of invoices and accounting documents (39%), followed by automatic payment transfers (29%). In third place in the list of priorities is the monitoring of the information database and the coordination of documents - each of them 10%. None of the companies uses artificial intelligence for forecasting, which is considered a major drawback. The findings of the survey also link the level of corporate culture with the level of application of artificial intelligence in the work of companies. In companies where management works to widely introduce digitalized processes and technologies, it is not a problem for the auditor to use artificial intelligence in performing audit procedures through the application of audit algorithms. The audit of accounting information is more efficient and more cost-effective.

The PwC study [11] analyzes the benefits for companies using artificial intelligence:

Table № 2: Factors facilitating the implementation of artificial intelligence in the audit of accounting documents

№	Factors that make the application of artificial intelligence in the audit of accounting documents effective	Answer distribution
1.	Detection of anomalies in the disclosed database	34 %
2.	Establishing instability in the processes	25 %
3.	Status checks or forecasts	19 %
4.	Simulations for evaluating options for estimating the growth of operations	12 %
5.	Develop correlations with the non-financial database, eg sales	1 %
6.	Others	

The ethics of algorithmic syntax

According to Mitt, algorithms carry "handwriting", the specific characteristics that only the developer can invest in them, its biases and are structured in such a way as to give the desired result. Therefore, they are not neural, but:

1. They are obliged to create value.
2. The occurrence of moral consequences is envisaged.
3. Allow restriction of the rights of the interested parties in the process.

Therefore, software developers of algorithms are guided by the principles of right and wrong, therefore good - when benefits to society are expected and bad - when some users will be left with affected interests.

Algorithmic syntax plays an important role in the context of its ethical positioning, as the main characteristics that must be implemented in this process is the comprehensibility and responsibility of the proposed solution. In order to determine the most appropriate criteria for grouping data, it is necessary to have historical rejections, acceptances / inputs, and finally - to identify the package of criteria that must be selected in order to assume that the model is adequate. In this case, artificial intelligence can be used to perform predictive analytical actions.

Regarding the accounting for the movement of resources - it must be adjusted to the level of reporting, thus allowing for the expansion of work on improving the algorithms used so far in the process of reporting and control. [9] [10] The main responsibility for the architecture and syntax of the algorithms lies with the board and management levels at all levels. Decision-making in large databases, at the same time can cause not only positive but also huge losses. Every mistake, even a small one, made in the algorithmic syntax, can bring huge losses mainly due to the law of large numbers.

In the context of all this, access to a database and the availability of new technologies are improving, which is why artificial intelligence with its application is used in specific areas. Companies that make comparisons based on a database with national and international companies improve the state of their resources and company strategies. By being able to forecast, firms gain a competitive advantage, for example, in the sales cycle, as part of international value chains.

Conclusion

Digitalization entered finance and accounting even later than other corporate departments. Another positive trend is that digitalization is managed by the highest corporate level of companies. Development trend such as their reduction in a computer center. the homogeneity of the company architecture and the readiness to standardize and promote the digital process.

New technologies such as artificial intelligence and robotics seem to be delayed mainly due to regulatory requirements and the growing foundation of computer technology, valued for example in mergers and acquisitions. The overall awareness of their connection to new technologies has grown as a function of finance. In other words, the benefits is the need to open up to new technologies has grown. It also stimulates growth, putting pressure on efficiency, and at the same time contributing to the progress of digitalization.

Other References in this area

Trenchev, I., R. Mavrevski, M. Traykov, D. Stoykov (2019) "Mathematical Approaches For Creation Of Complex 3d Models And Their Application In Education", Proceedings of ICERI2019 Conference 11th-13th November 2019, Seville, Spain 4908 – 4914 ISBN: 978-84-09-14755-7.

Denchev, S., I. Trenchev, I. Peteva, I. Pavlova (2019) "Application Of New Technologies For 3d Modeling In An University Information Environment", Proceedings of ICERI2019, Conference 11th-13th November 2019, Seville, Spain, pp. 4932– 4938 ISBN: 978-84-09-14755-7.

Stavrova, E., N. Karanasios, A. Tandetzky, A. Reitano, M. Fazio,(2019). “Development: Crossing the Bridge Pondering Socio-Economic and Techno-Science”, *Economic Alternatives*, 2019, Issue 4, pp. 537-548, DOI: <https://doi.org/10.37075/EA.2019.4.03>

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Tsenkov, V., Mirchev, K. (2019), “*Sustainable post crisis capital market recovery – the case of EURO STOXX 50*”, *Balkans JETSS (2019) 1: 97-106 UDEKOM Balkan*, DOI: <https://doi.org/10.31410/Balkans.JETSS.2019.2.1.97-106>

Sutton, S.G., et al.,(2018). “The reports of my death are greatly exaggerated”—Artificial intelligence research in accounting, *Int J Account Inf Syst* (2016), <http://dx.doi.org/10.1016/j.accinf.2016.07.005>.

Kirsten, M., (2018). “Ethical Implications and Accountability of Algorithms”. *Journal of Business Ethics* (2019) 160:835–850, <https://doi.org/10.1007/s10551-018-3921-3>.

Mittelstadt, B. D., Allo, P., Taddeo, M., Wachter, S., & Floridi, L. (2016). The ethics of algorithms: Mapping the debate. *Big Data & Society*, 3(2), 1–21.