Scientific Journal "Newsletter on the results of scholarly work in sociology, criminology, philosophy and political science" | www.sci-result.de
ISSN (Print) 2699-9382 | ISSN (Online) 2699-9005
Volume 5, Issue 1, 16-27, Published: November 28, 2024
DOI: https://doi.org/10.61439/ACYH4871

The Role of Artificial Intelligence on the Evolution of Accounting

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Abstract

Artifical intelligence nowadays is attracting the focus of both academics and practitioners due to its contrubtion in achieving major changes in business environment. Public accounting as field has benefited a lot from machine learning. Thus, this article aims to highlight the importance and influences of artifical intelligence on accounting. To achieve this aim, this article started with giving a brief overview about artifical intelligence and its evolution over time. This overview helps in showing the power of artifical intelligence and how it attracted investments of billion of dollars due to its leading role in reducing business costs and providing business solutions. Furthermore, the article identifies how artifical intelligence works as this helps accountants to better undertsand machine learning and identify how it can be optimally used in the field of accounting to get the best results. However, to be widely used in the field of accounting, major investments are required and this is one of the obstacles that faces regional small and mid-sized firms that do not have the required resources to effectively implement artifical intelligence. However, the availablity of pre-packaged applications that are offered by big companies such as Google and Amazon can enable small and mid-sized firms to benefit from artifical intelligence. Nonetheless firms will need to train their labor force to benefit from artifical intelligence. Despite the fact that artifical intelligence can help accounting professionals to perform their jobs more efficiently and eliminate reptitive tasks, it is important to note that maching learning cannot eliminate the accountants' role. Artifical intelligence in the accounting field enables accountants to provide their companies with tecnhologies that can save time, increase the efficiency of tasks, reduce costs and help accountants focus more on value-adding activities.

Keywords
machine, learning, accounting, artificial, intelligence, auditing, deep, neural, networks, tax, pcaob, technology, business, fraud, advisory, internal, control

Introduction

Artificial intelligence is one of the main areas that attracts the focus of both academics and practitioners due to its significant impact on business operations as well as decision making process. However, despite being an evolving technology, artificial intelligence is currently affecting not only businesses and their operations, but also affecting the day-to-day decisions

and lives of individuals. Specifically, Google searches, shopping patterns on Amazon, and even movies watched on Netflix as well as several other actions are all monitored and analyzed using artificial intelligence to better understand and target the preferences of each one. Artificial intelligence is also used by Siri and Alexa so that individuals can interact with their devices without having to use a keyboard.

Given the aforementioned uses of artificial intelligence, it resulted in significant changes in business environment. Specifically, artificial intelligence enables business to sift through enormous data sets and identify patterns and provide information that would have taken thousands of labor hours to determine. Furthermore, artificial intelligence leads to disrupting some industries and potentially creating new industries. Thus, managers, governments and individuals have to understand the impacts of machine learning as it results in major changes in business environment that significantly affect all of them. One of the fields that is affected by machine learning is public accounting. Thus, the aim of this article is to help professionals understand artificial intelligence and its possible impact on accounting as well as highlight potential future opportunities.

Methods

This research employed qualitative and qualitative methods based on studies from computer science, accounting, auditing, fraud, and general business. This paper proposes a hypothesis that artificial intelligence will have a profound impact on the field of accounting by automating tasks that were typically handled by an accounting professional in auditing and tax but also creating opportunities for greater productivity in the profession. To validate this hypothesis, this paper uses published materials by both the private-sector as well as governmental entities to evaluate the impact of artificial intelligence in fields outside of accounting. This approach allows a comprehensive review of functions best suited for artificial intelligence. Leveraging analysis of artificial intelligence role in other fields allowed. Tis methodology enabled a harmonization of artificial intelligence attributes that are common across all areas to provide a more nuanced approach to evaluating its impact on the accounting profession. This framework allows the impact of artificial intelligence in areas outside of accounting allowing businesses and policymakers to evaluate the long-term impact of artificial intelligence on society.

Results

The field of accounting is facing a challenging time as various technologies are changing the business environment and the value that they are able to provide the business environment. The Audit function is critical in ensuring the smooth functioning of the capital markets and the economy. Artificial intelligence is having a significant impact on businesses and consequently it will also have a profound impact on the accounting and the capital markets. The profession has taken an active role in enhancing the value provided from the new technologies. There are many challenges including updating standards and procedures as well as ensuring that accounting professionals have the technical knowledge and training to utilize the insight gained from incorporating data analytics into the audit function. The opportunities for accounting to deliver better services and greater level of confidence is unparalleled in the history of the profession.

Discussion

1. Machine Learning

Machine learning is a branch in the field of Computer Science known as Artificial Intelligence. Artificial intelligence is a branch of computer science that develops programs that mimic

human intelligence. Artificial intelligence includes speech processing, image processing, natural language processing, expert systems, and machine learning. Machine learning includes a subfield known as deep learning that uses multiple layers to process the data into information as opposed to what is called "shallow learning", which may only have one layer to process the data as shown in Figure 1.

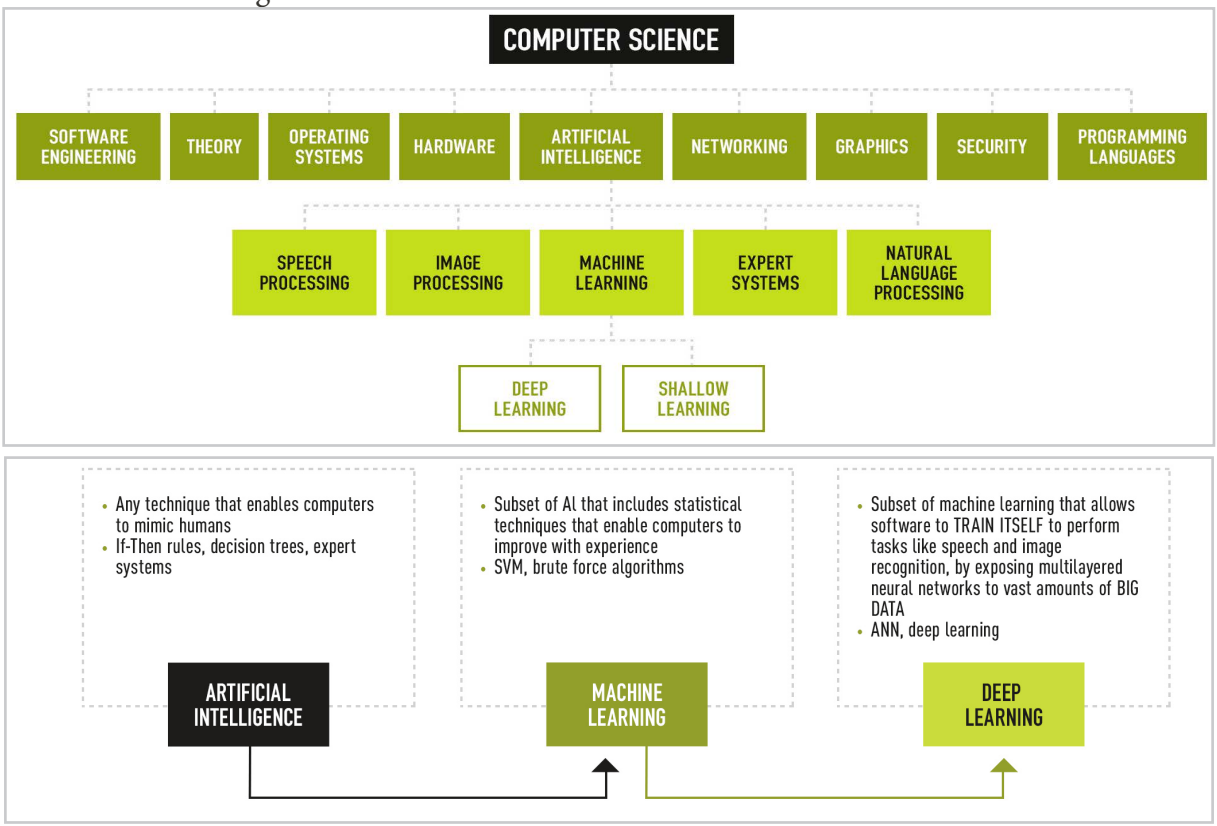

Figure 1. 44th World Continuous Auditing and Reporting Symposium (Appelbaum et al., 2019)

2. History of Artificial Intelligence

Research in artificial intelligence began as early as the 1950's when computers were recently invented and had only limited memory and processing power. In the 1960's and 1970's, expectations about computers were higher than reality and this resulted in a decrease in research funds directed to computers and artificial intelligence. Thus, by 1980's, the concept of machine learning was mostly relegated to science fiction. In the 1990's the concepts for machine learning were being developed and in 1997 IBM's Deep Blue demonstrated the possibilities of machine learning by defeating the world chess champion (Marr, 2016).

Afterwards, machine learning started to gain popularity and get more advanced due to the increased data storage capacity and computer processing power. Furthermore, from 1990's to 2000's, the availability of high-quality data and the development of parallel Graphic Processing Units (GPU) resulted in greater popularity of machine learning. Specifically, since machine learning requires large data sets in order to train the learning algorithms, the large high-quality publicly available data allowed researchers to refine the machine learning algorithms. Furthermore, although the parallel processing units were initially used to meet the requirements of graphic intensive games that were in high demand, the developments in parallel processing were beneficial for enhancing the processing power that is required for machine learning. Accordingly, given the technical development witnessed in recent years, research and development in machine learning increased greatly during the last 15 years. Microsoft, Google, Apple, and Amazon as well as foreign technology companies are investing billions of dollars in advancing machine learning and developing products to help businesses lower costs and improve product development.

3. Working Mechanism of Artificial Intelligence

When computers were first developed, computer programs were created to give those computers instructions to follow in solving a problem. For example, if programmers wanted a computer to add up numbers and give them the average, the programmer would write a program instructing the computer to ask for the numbers to be added, divide the added numbers by the count of the numbers and then display the result on the screen. This referred to as Top-Down Programming and was the most widely method of programming until the 1990's when Object Oriented Programming (OOP) was created. Object Oriented Programing changed the paradigm of programming from isolated computer instructions to treating the programs and the data that it manipulates into a defined object. This paradigm shift resulted in rapid development of graphically based programs that were much easier to maintain because the programs were based on a set of self-contained objects that interacted with each other. OOP worked very well for typical programs such as word processing, spreadsheets and games.

However, both top-down and object-oriented programming did not work very well for tasks that required artificial intelligence because traditional programming required the programmer to give the computer specific instructions as to what to do for both the expected (user clicked the left mouse button) and unexpected (user clicked right mouse button when left was expected) events. Thus, traditional programming worked very well for computational based problems but was very limited in solving complex problems. This, in turn, resulted in developing what is called expert systems that can work well for solving complicated problems and thus it leads to early success in the field of artificial intelligence. An expert system is *"a computer program that uses artificial-intelligence methods to solve problems within a specialized domain that ordinarily requires human expertise"* (Zwass, n.d.). Expert systems emulate a human expert's decision-making by using an inference engine to access a knowledge base and usually has a user interface and a knowledge acquisition system to update the knowledge base (Sharma, n.d.).

However, expert systems have three major drawbacks which are: (i) It requires a great deal of time and effort by experts to develop the knowledge base and the inference engine, (ii) It is limited to solving problems in a very narrow scope, and (iii) It is unable to learn from the data provided. In contrast, in machine learning, it is expected that the algorithm learns from the data provided, thereby it eliminates the limitations inherent in expert systems. Machine learning can either use shallow earning or deep learning. Shallow learning uses one layer to process data while deep learning uses two or more layers. Almost all modern machine learning algorithms use deep learning because it is better suited for solving complex problems. Machine learning attempts to analyze data in a manner similar to how humans learn. For example, if we wanted a young child to learn to identify a cat, we would point at a cat and say to the child "cat". The child would see that a cat is an animal that walks on four legs, has a tail, and is furry. If a child saw a squirrel and pointed at it and said "cat", we would correct the child and say "squirrel". The child would notice that even though the squirrel walked on four legs, had a tail, and was furry, its shape was different from a cat and it walked and made sounds in a manner that is different from a cat.

In machine learning the goal is to write an algorithm that could be trained using test data to look for specific patterns. For example, to have a machine learning algorithm that can analyze animals' pictures and identify those that contain cats, general characteristics of cats should be identified first (four-legged, furry animal with a tail) and provide the computer with a sample that contains pictures of animals. Initially, the algorithm starts with identifying animals that don't have the common characteristics previously highlighted such as snakes (no fur neither legs), birds (no fur neither four-legged) and fish (no fur neither legs). However, there must be algorithm that help the computer program learn that there are other characteristics (such as sounds it makes, claws, and shape of its head and body) to differentiate it from other four legged furry animals with tails as shown in Figure 2.

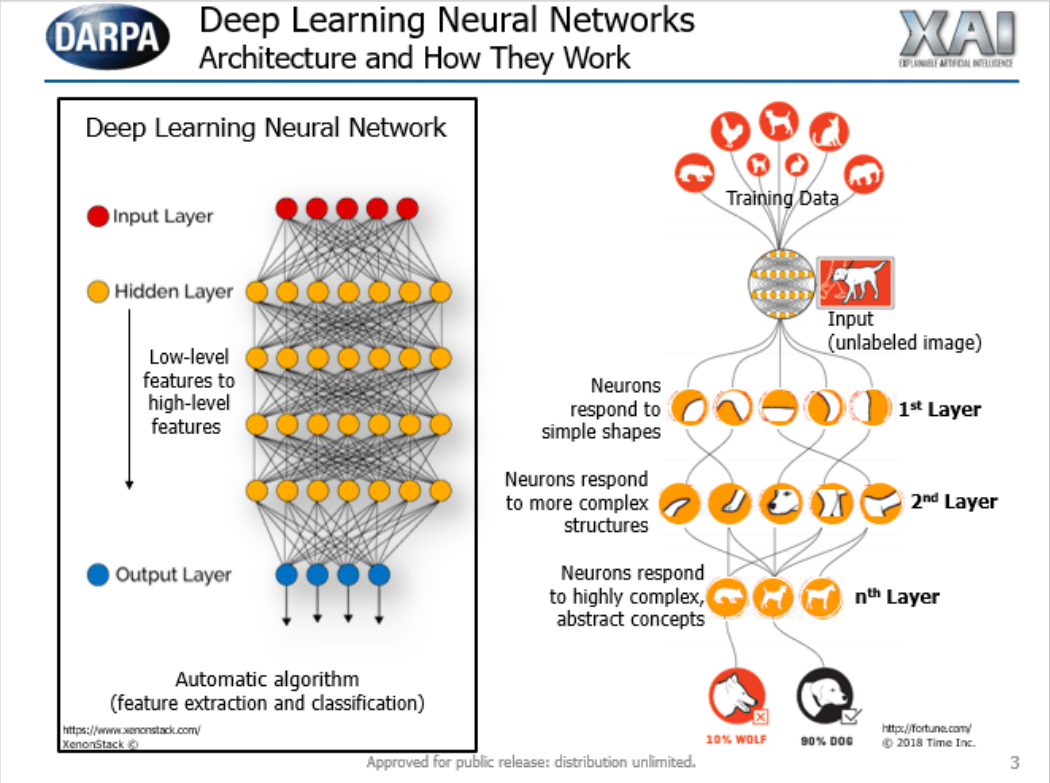

Figure 2. Deep Learning Neural Network

There are many different methodologies used for machine learning, one methodology used to identify something using characteristics is called the K-nearest neighbor (K-NN) algorithm. This algorithm is one of the simplest classification algorithms used in machine learning. The fundamental concept is that the programmer determines the initial value for K, which will be the number of characteristics that the machine learning programming will use (Bronshtein, 2017). This means that, if the programmer used four-legged, furry, tail, and claws as the main characteristics of cats, then this means that the program is going to look at four characteristics to determine if a specific picture contains a cat or not. Increasing the number of characteristics used will allow the program to eliminate animals that are not cats. However, higher number of characteristics could also mean that a cat may get misidentified as not being a cat. For example, if the programmer limits the weight to be under 30 pounds, then house cats would be properly identified, but the big cats would not be identified as cats. Consequently, in machine learning, it is critical to use the optimal algorithm and then train the algorithm using a large set of test data to ensure that the machine learning program is trained properly before using it to solve a problem or identify something based on characteristics.

4. Expected Innovations in Artificial Intelligence

Although machine learning is currently gaining more popularity compared to the previous decade, it is expected that its effect on everyday life and business operations is going to increase dramatically in the near future. Entefy, an artificial intelligence software company, identifies a number of industries that are expected to be affected by machine learning including automotive, manufacturing, consumer goods, and hospitality. In the automotive industry, machine learning can be used to improve human driving skills to improve safety while autonomous vehicles would eliminate accidents caused by carelessness or distractions. Machine learning can be used by manufacturing companies to increase productivity by improving workflow and reducing unnecessary expenses. In consumer goods machine learning can be used to analyze past purchase patterns of customers to determine the development of new products, promotion strategies, and pricing to reduce expenses associated with unsold products. Machine learning

has allowed the hospitality industry to use the purchasing behavior of travelers to tailor the booking process (Entefy, 2018). Entrepreneur Magazine identified a number of innovations resulting from machine learning that included healthcare and embedded retail-management systems. Dr. Corbett in that article highlights that *"Google has developed a machine learning algorithm to help identify cancerous tumors on mammograms. Stanford is using deep learning algorithm to identify skin cancer"* (Agrawal, 2018). Embedded retail management systems allow companies to move inventory to maximize sales and to avoid situations where some stores have excess inventory while others are experiencing lost sales by not having enough inventory.

INDUSTRIES AFFECTED BY MACHINE LEARNING

- Agriculture
- Automotive
- Consumer Goods and Services
- Healthcare and Life Sciences
- Hospitality and Travel
- Insurance
- Manufacturing
- Media and Entertainment

Figure 3. Industries Affected by Machine Learning

Given the widespread use of machine learning in vast amount of industries, it is expected that machine learning will also have a dramatic effect on the accounting profession in the near future. Nowadays, public accounting firms aim to provide their customers with the expertise needed to deploy machine learning algorithms in businesses to speed up and improve business decisions while lowering costs. Price Waterhouse Coopers (PWC) in 2018 announced a joint-venture with a contract analytics software company called eBravia, to use machine learning algorithms for contract analysis (Artificial Lawyer, 2018). Those algorithms are used to review a number of documents related to revenue recognition standards and lease accounting. Deloitte and MapR are collaborating to help retailers enhance customer experience by using machine learning to target product and services based on past buying patterns ("MapR and Deloitte Announce Strategic Alliance to Modernize Analytics and Speed AI Success," 2018). While the major public accounting firms may have the financial resources to invest in custom machine learning applications, regional public accounting firms have the agility to use pre-built machine learning tools to develop expertise through implementations in mid-size companies. Current machine tools that are available from the top technology companies for developing machine learning applications include Google Cloud Machine Learning, Amazon AWS SageMaker, Microsoft Azure Machine Learning, IBM Watson Machine Learning, Oracle Adaptive Intelligence Apps, and Salesforce Einstein. There are smaller companies that are also developing tools for developing machine learning applications including Paperspace (Brookyn company with cloud –based neural network), Snark (Baidu-backed cloud-based machine learning tools), and NimbleBox (Ray, 2019). Smaller public accounting firms can also benefit from the power of machine learning for small companies once pre-packaged applications are available. *"Soon, we'll see prepacked applications that incorporate the distributed processing, machine learning, and analytics of today's overhyped custom-made solutions"* (Oliver, 2015). Current investments in machine learning will in the near future result in commoditization of machine learning applications that will eventually become available to small and mid-size-companies. *"Big companies have to find an AI solution profitable so they will invest in it, and in turn, vendors can continue to develop that solution to the point that it becomes a something that anyone can use. That is how machine learning will become accessible to small businesses"* (Faggella, 2019). Small and Mid-size accounting firms have a potential to capitalize on the eventual availability of machine learning applications usable by small and mid-size businesses. However, the key is data as machine learning algorithms require

large amounts of data in order to properly train them. Small businesses (and many mid-size businesses) either do not have that volume of data or it is not in a format that can be used easily (Faggella, 2019). Small and mid-sized public accounting firms can train the machine learning applications using data from a number of clients in the sector to develop a solution that an individual small business would be unable to develop on their own. In order to be able to capitalize on this opportunity, the requisite skills would need to be developed either by training the current staff or by hiring new staff that have exposure to machine learning and data analytics.

5. Artificial Intelligence and Accounting

Given the technological breakthroughs that the whole world is currently witnessing, it is expected that many of the routine accounting processes will be handled by machine learning algorithms. Accounting processes such as expense reports, accounts payable, and risk assessment, to name just a few, can be easily automated using machine learning. Furthermore, accounting tasks that require processing documents started to disappear with the availability of document scanners, optical character recognition, and software to match source documents. For example, machine learning algorithms can automate the accounts payable process matching an invoice to a purchase order and determine the expense account to charge, reducing the time to process a payment. An employee can release the payments after reviewing the document. This type of automation is referred to as Robotic Process Automation (RPA). *"RPA does not replace humans with actual robots. But there are softwares available in the market which let you configure automation workflows to automate your business operations"* (Kappagantula, 2019). Although RPA was initially used in automating repetitive tasks, the introduction of machine learning enables RPA to automate routine tasks that would normally require human decision-making. *"Robotic process automation (RPA) is the use of software with artificial intelligence (AI) and machine learning capabilities to handle high-volume, repeatable tasks that previously required humans to perform. These tasks can include queries, calculations and maintenance of records and transactions"* (Gillis, 2024). Since the world is changing fast and this causes vast changes in the business environment, it is currently accepted that the accounting jobs like many other jobs will change in the near future, but the key question is how public accounting will change.

Given the fact that many companies currently deploy or will deploy machine learning in their operations to improve accuracy and perform their operations more efficiently, this, in turn, will affect the advisory services provided of public accounting firms. It is estimated that almost 80% of the time spent in advisory services is directed for processing information about the operations of the company (Jesus, 2018). This information processing could by easily handled by machine learning algorithms which can result in directing most of the time billed to the client to value-adding services that focus on analyzing the information produced by machine learning.

However, this does not mean that machine learning can replace accountants, the impact of machine learning will most likely be less pervasive in certain accounting tasks such as tax preparation services that require specialized advice and technical research in the context of complex corporate and individual planning issues. Nonetheless, the tax planning function can still be affected by machine learning. Global companies face large and increasingly complicated tax compliance requirements and allocating revenue and expenses to various taxing jurisdictions requires significant data processing and analysis. Machine learning can help tax professional keep up with relevant tax law changes. Creating algorithms to extract relevant planning information from vast amounts of data is ideal for machine learning. It is hard to do effective tax planning without the relevant and important facts, machine learning can make the fact gathering and analysis function much more efficient and effective.

Finally, taxing authorities are exploring the use of machine learning to increase transparency and audit efficiency. Almost every governmental jurisdiction around the globe raises revenue through taxes. Taxes imposed include income taxes, value-added or VAT taxes, property taxes, payroll taxes and sales taxes just to name a few. The Internal Revenue Service (IRS) has already developed machine learning algorithms to identify activities associated with tax evasion and fraud. Michael Sullivan of Fresh Start Tax and a former IRS agent indicates that *"The public should be aware that the IRS has begun using a new audit method, the" Machine Learning Tax Audit".*

However, it expected to have high error rates when machine algorithms are being trained and this also affected tax planning functions when machine learning was first introduced to it. *"As it turns out, the data from the Machine Learned Audit was incorrect and these taxpayers should not have been selected for audits"* (PRWeb, 2012). The accuracy of machine learning is dependent on two things; large amounts of data and computing power to process the data. The IRS now has both to capitalize on machine learning. The IRS says that it expects that 80 percent of its tax returns will be filed electronically this year. That makes a total of 250 million returns filed, with $2 trillion in revenue. *"But processing those returns uses only a fraction of the agency's computing power. An entire year of tax returns amounts to 15 terabytes, or just 1.5 percent of the IRS storage of 1.2 petabytes (one quadrillion bits of information), based on public data from IRS presentations"* (Satran, 2013). The IRS recently signed a seven-year, $99 million contract with Palantir Technologies to develop machine learning algorithms. *"The project uses machine learning algorithms and artificial intelligence to examine and analyze files tax returns, bank reports, property records and social media posts. It analyzes various patterns of conduct and activities that might indicate noncompliance"* (Stahl, 2018). As tax laws continue to get more complicated and the IRS's processes for identifying a taxpayer for an audit become more sophisticated, machine learning may allow tax accountants to better predict deductions that will be disputed by the IRS and identify the regulations that allow for those deductions.

Another area that is expected to change dramatically in the near future due to the introduction of machine learning is auditing. Specifically, it is expected that the automation of analyzing the clients' financial statements and the related source documents can lead to having smaller audit staffs. However, auditing standards require an auditor to understand the systems and processes related to the preparation of the financial statements. This means that auditors are required to have technical expertise to understand the machine learning algorithms used in a company's financial systems which is not one of the requirements that auditors should have nowadays but it is one of the dramatic changes that is expected to be introduced to the field (Shimamoto, 2018). One of the biggest challenges for auditors in machine learning era is the "black box" problem. *"However, there is a downfall to the use of machine learning: the 'black box effect'. In traditional programming that uses a recipe approach, if a decision-maker or assurance professional wanted to know why a decision was made, software engineers or analysts could peek inside the program and see that threshold X was reached, which triggered the effect. But, with many machine learning algorithms, it is extremely difficult to look inside an algorithm to ascertain why a certain result was returned"* (Clark, 2017). Part of the problem is that the current development of machine learning focuses mainly on performance and ignores the fact that these algorithms may be difficult to explain and understand. Deep learning algorithms can contain hundreds of layers evaluating large number of parameters that would be difficult to understand as shown in Figure 4. *"That process, known as deep learning, allows neural networks to create AI models that are too complicated or tedious to code by hand. These models can be mind-bogglingly complex, with the largest nearing one trillion parameters"* (Bleicher, 2017).

55 companies reported AI as a risk in there 2018 annual reports due to the "black box" problem (Appelbaum et al., 2019). To deal with such a problem, the Public Company Account-

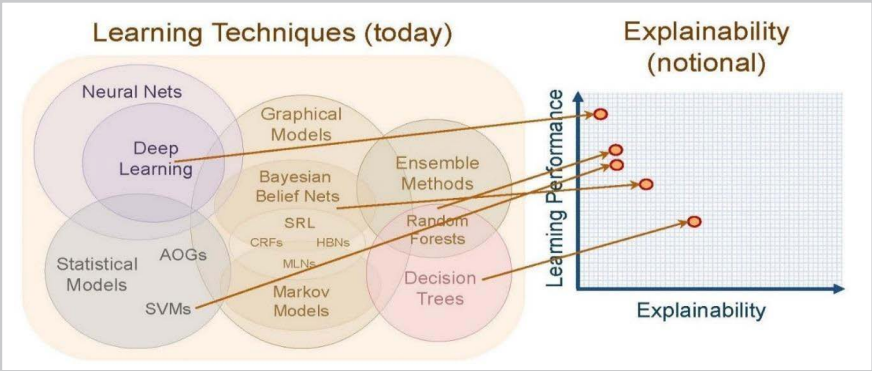

Figure 4. Learning Techniques and Explainability[1]

ancy Oversight Board (PCAOB) has identified machine learning and artificial intelligence as areas of focus for audit inspections. Furthermore, they also monitor the development and use of audit tools that involve machine learning for audit engagements. *"Throughout 2019, we will … consider whether firms are effectively using these tools and applying due care, including professional skepticism, when they do"* (Heller, 2018). Thus, the Defense Advanced Research Projects Agency (DARPA) has identified a new approach to developing machine learning algorithms that would result in more explainable systems as shown in Figure 5 and Figure 6.

Developing machine learning algorithms that are designed to ensure that decisions are explainable is years away, but there is already research in progress to eliminate or reduce the "black box" problem. "A full-fledged fix is still years away but a number of promising plans are emerging. Some researchers test AI systems like scientists test lab rats, tinkering with the inputs to see how they affect behavior in hopes of illuminating the decision-making process. Others attempt to probe the networks' behavior with additional nets or invent new programming languages to better control how these systems learn. The approaches may

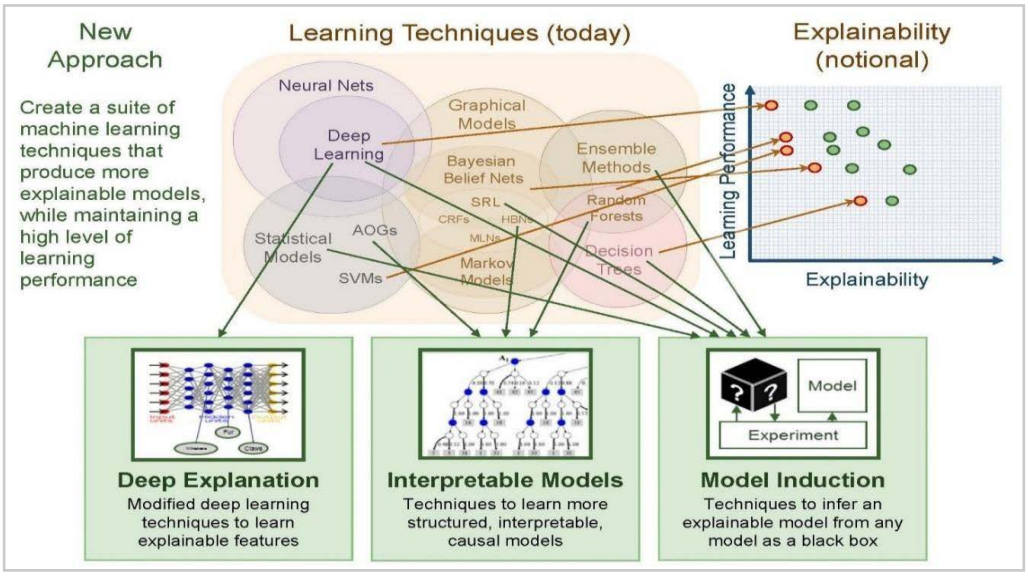

Figure 5. New Approach: Learning technique SS· Approved for public release: distribution unlimitedhttps://www·darpa·mil/attachments/XAIProgramUpdate·pdf

vary but their goal is the same: to ensure that our machines do not evolve too far beyond our ability to understand them" (Bleicher, 2017). At the 44th World Continuous Auditing and Reporting Symposium, Sevilla Spain — March 21 & 22, 2019, six steps were identified in evaluating, testing, and assessing artificial intelligence applications during an audit as shown in Figure 7.

Additionally, the institute of Internal Auditors highlight three lines of defense that can be applied to ensure that artificial intelligence applications are consistent with company policies and procedures as well as governmental laws and regulations as shown in Figure 8.

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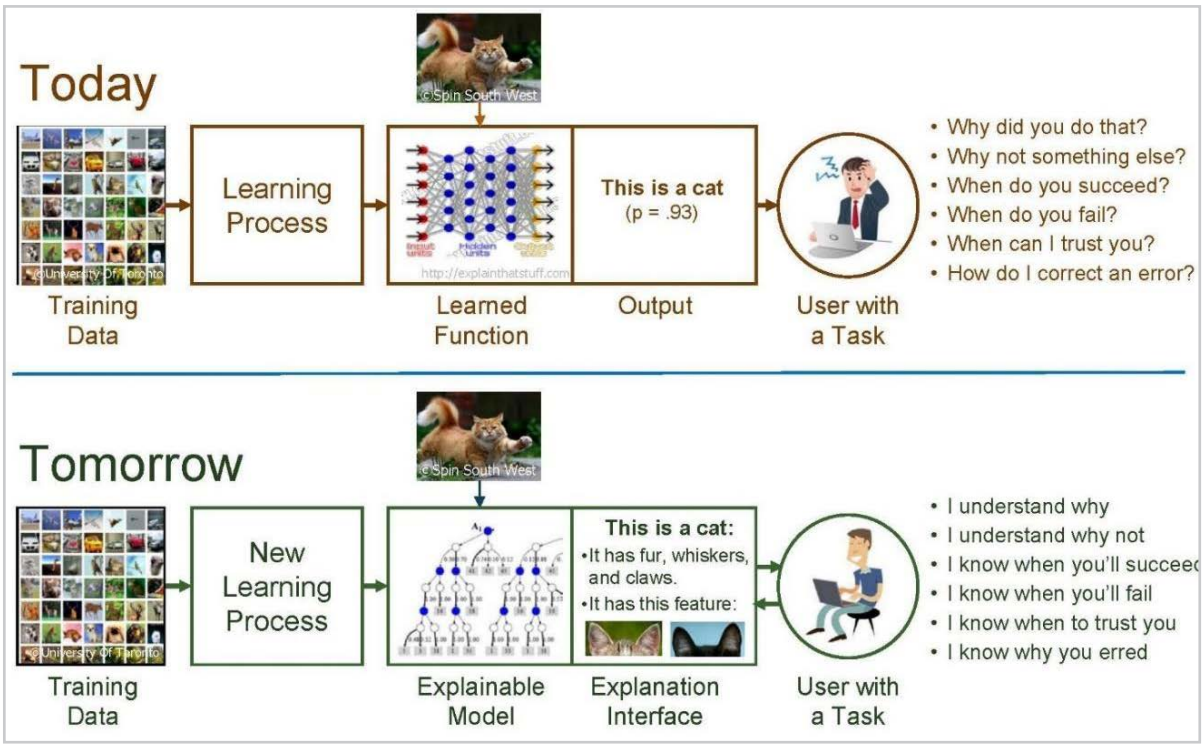

Figure 6. Learning Process Today and in the Future (Approved for public release: distribution unlimited https://www.darpa.mil/attachments/XAIProgramUpdate.pdf)

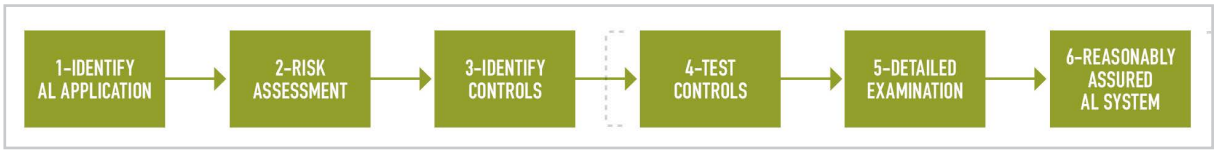

Figure 7. Artificial Intelligence Steps during an Audit (Appelbaum et al., 2019)

The first line of defense is internal controls, the second line includes compliance, security, risk management, and inspections, and the third line of defense is internal audit. Internal audits processes for machine learning algorithms are important for external auditors because it will not only allow for a more reliable risk assessment but it can also reduce the amount of time and effort exerted to understand the machine learning algorithms used by a business.

Auditors will not only need to understand the technologies but also the interaction with internal controls to avoid material misstatements. Potential fraud in a company's financial statements could also become easier to identify by using a machine learning algorithm to identify transactions that have characteristics associated with fraudulent activities.

Machine learning is expected to have a significant impact on businesses as they deploy the technology to improve processes and reduce costs. accounting will need to evolve not only to understand the technology used by companies to better direct its efforts in auditing the financial statements but also to be better positioned to provide the best tax and advisory services at a cost that creates value for their clients. accounting firms have started to invest in machine and data analytics in order to provide their customers with new technologies that improve processes and lower expenses. These investments will expand the range of services provided by public accounting firms creating opportunities for accounting professionals.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

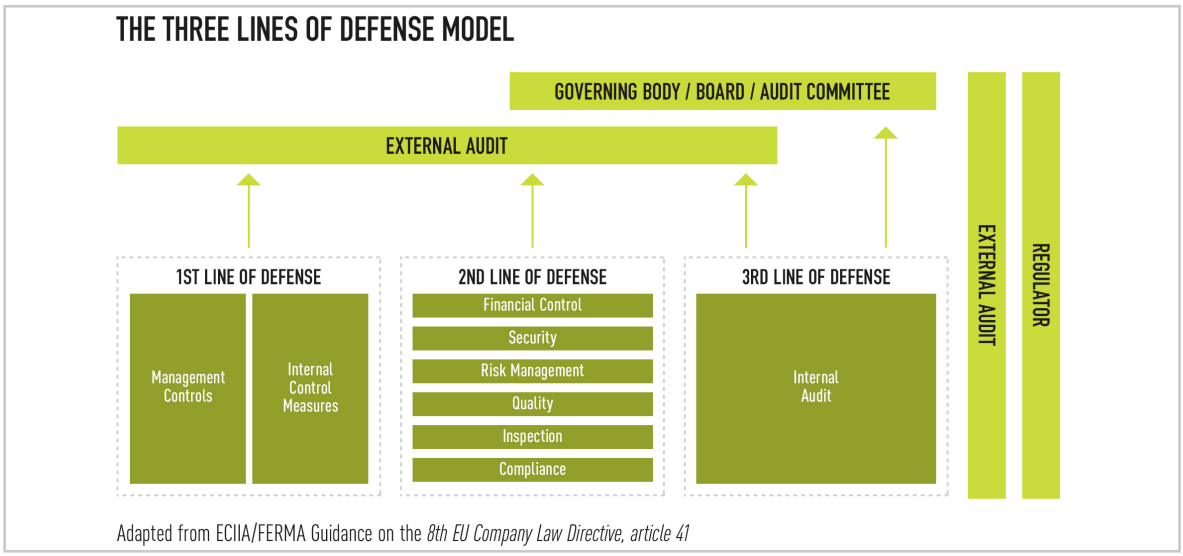

Figure 7. Artificial Intelligence Steps during an Audit (Appelbaum et al., 2019)

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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