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Introduction to Machine Learning

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Abstract: ***The aim of the present study is to understand various aspects of machine learning. The evolution of machine learning began in the 1950s with the 'Turing Test' formulated by Alan Turing, the aim of which was to determine if a computer has real intelligence and in order to pass the test a computer must be able to fool a human into believing it is also human. Machine learning is an application of Artificial Intelligence that enables systems to learn and improve from experience without being explicitly programmed. A systematic research was performed for articles and research papers pertinent to the topic of machine learning with the emphasis on its evolution from the 'Turing Test' to continuing successful applications in medicine, administration, automobiles, banking, personal finance, social networking, etc. The paper explores the applications, types, evolution, challenges, and future prospects of machine learning. In the present times, machine learning is becoming popular and is gaining applications in various fields such as healthcare, finance, retail, etc., for better practices.***

Keywords: Machine learning, artificial intelligence, applications

1. Introduction

When we think about the term 'learning' and what it implies, we usually tend to associate it with first, consciously contemplating and possessing the knowledge of that specific field, i. e., we should be able to clearly present our views on that particular subject. Second, we are able to apply this knowledge in our day-to-day life in different ways viz, maybe solving a certain dilemma, etc. Finally, the crucial process of learning "ends" when we are adept to exhibit our skills and knowledge in the distinct field via reflecting upon previous mistakes, correcting them, and probably even discovering or inventing something new. Thus, it would be correct to say that learning is a process that leads to *change* and *enhancement*, which occurs as a result of *experience* and increases the potential for improved performance and future learning. (Ambrose et al, 2010, p.3). Similarly, in layman terms, when the 'learning' according to the above definition is done by a machine, it is called *machine learning*. In parallel to how we, humans, enhance in different areas, machines also enhance by creating the best solution on the existing experiences and samples during the machine learning process.

The aim of this paper is to present an overview of machine learning and its applications in various fields. In the present times, machine learning is becoming popular and is gaining applications in various fields such as healthcare, finance, retail, etc., for better practices. Recent researchers have demonstrated that AI will become an integral part of all aspects of our lives ranging from managing ourselves, others, organisations, state, as well as sustainable development goals.

2. Method

A systematic research was performed for articles and research papers pertinent to the topic of machine learning with the emphasis on its evolution from the 'Turing Test' to continuing successful applications in medicine, administration, automobiles, banking, personal finance, social networking, etc.

Machine Learning

1) Definition

Conspicuous from the name, machine learning makes a computer much more similar to humans since it gives them *the ability to learn* without being explicitly programmed. That is, machine learning explores the analysis and construction of algorithms that can learn from data and make predictions on this data. By making use of statistical methods, algorithms are trained to make these predictions or classifications, uncovering key insights within data mining projects. Such insights or inferences further drive decision-making within applications and businesses, creating an impact on key growth metrics in these fields. Hence, machine learning techniques make it easier for us to leverage data mining which in turn aids in identifying historic trends and making necessary improvements in future models. Thus, the central principle of machine learning revolves around using statistical learning and optimization methods that let computers analyse datasets and identify patterns. Machine learning is one way to use AI. It was defined in the 1950s by AI pioneer Arthur Samuel as "the field of study that gives computers the ability to learn without explicitly being programmed. " Machine learning is an application of AI that enables systems to learn and improve from experience without being explicitly programmed. It works upon developing computer programs that can access data and further use it to learn for themselves.

2) Evolution

The evolution of machine learning began in the 1950s with the 'Turing Test' formulated by Alan Turing, the aim of which was to determine if a computer has real intelligence and in order to pass the test a computer must be able to fool a human into believing it is also human. Further, Arthur Samuel wrote the first computer learning program which was the game of checkers. The IBM computer improved at the game the more it played, studying which moves made up winning strategies and incorporating those moves into its program. The next step was the designing of the first neural network for computers (the perceptron), which imitated the thought processes of the human brain.

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The 1960s and '70s were marked by the 'Nearest Neighbor' algorithm and the invention of 'Stanford Cart' respectively. 'Nearest Neighbour' algorithm allowed computers to use very basic pattern recognition. It could be used by travelling salesmen to map a route starting at a random city but ensuring they visit all cities during a short tour. 'Standing Cart', invented by students at Stanford University, could navigate obstacles in a room on its own.

In the 1980's we came across the concept of Explanation Based Learning (EBL), introduced by Gerald Dejong, in which a computer analyses training data and creates a general rule it can follow by discarding unimportant data. Explanation-Based Learning (EBL) is a principled method for exploiting available domain knowledge to improve supervised learning. Improvement can be in the speed of learning, the confidence of learning, the accuracy of the learned concept, or a combination of these.

The 1990s included a major shift in machine learning when the focus moved away from a knowledge-based approach to one driven by data. Scientists began creating programs for computers to analyse large amounts of data and draw conclusions from the results.

In 2006, Geoffrey Hinton coined the term "deep learning" for the new algorithms which enable computers to recognize and distinguish objects and text in images and videos. In 2006, Geoffrey Hinton, *et al.* published a paper on deep belief nets (DBN) that demonstrated the possibility of using "deep" neural networks to achieve state-of-the-art results (1.25 percent error rate) in recognizing handwritten digits (Hinton, *et al.*, 2006). This paper marked the first appearance of the words "deep" in the context of machine learning, where "deep" refers to layers of interconnected artificial neurons stacked together. The Stanford AI report defined DL as "a form of machine learning based on layered representations of variables referred to as neural networks. . . can be applied widely to an array of applications that rely on pattern recognition"

In 2010, Microsoft launched Microsoft Kinect for Xbox 360, a controller-free gaming device that Microsoft positioned as an entirely new way to experience entertainment in the living room. It provides a natural user interface (NUI) that allows users to interact intuitively and without any intermediary device, such as a controller, users can interact with the computer via movements and gestures.

2011 witnessed the development of Google Brain and its deep neural network, which began in 2011, by Jeff Dean, Greg Corrado, and Andrew Ng is an Artificial Intelligence system based on open learning. It trained itself to identify the image of a cat based on 10 million images. Google Brain, as the name suggests, is meant to replicate, as closely as possible, the functioning of a normal human brain. And the team behind it has been largely successful in doing the same. Google Brain combines open-ended Machine Learning with Google's computing resources. The Google Brain also contributed to Google Translate.

In 2012, Google's X Lab developed a machine learning algorithm that can autonomously browse YouTube videos to identify the videos that contain cats. These findings were useful in the development of speech and image recognition software, including translation services.

Further in 2014, Facebook developed DeepFace, a software algorithm that can recognize or verify individuals on photos to the same level as humans can. Face recognition in unconstrained images is at the forefront of the algorithmic perception revolution.

In 2015, Amazon launched its own machine learning platform. AWS helps you at every stage of your ML adoption journey with the most comprehensive set of artificial intelligence (AI) and ML services, infrastructure, and implementation resources (Amazon, 2015)

Microsoft created the Distributed Machine Learning Toolkit (2015), which facilitates the efficient distribution of machine learning problems across multiple computers. The toolkit, available now on GitHub, is designed for distributed machine learning — using multiple computers in parallel to solve a complex problem. It contains a parameter server-based programming framework, which makes machine learning tasks on big data highly scalable, efficient, and flexible. It also contains two distributed machine learning algorithms, which can be used to train the fastest and largest topic model and the largest word-embedding model in the world (*Thomas Jr, 2015).*

A Google artificial intelligence program defeated a Chinese grandmaster at the ancient board game Go on Tuesday, a major feather in the cap for the firm's AI ambitions as it looks to woo Beijing to gain re-entry into the country (Cadell, 2017).

3. Machine Learning Methods

Suppose you are to build a chair, now, depending upon the time limit, prerequisites, etc., one's approach in building it might be different however, the result would definitely be a chair. Similarly, for machine learning, depending upon the kind of data available and the research question at hand, scientists choose to train an algorithm using a specific learning model. Most machine learning models are defined by the presence or absence of human influence on raw data. Machine learning algorithms can either be supervised or unsupervised although some authors also classify other algorithms as reinforcement, because such techniques learn data and identify patterns for the purposes of reacting to an environment. (Alloghani et al., 2020).

a) Supervised Learning:
Supervised learning is defined by its use of labelled datasets to train algorithms to classify data or predict outcomes accurately. As input data is fed into the model, it adjusts its weights (which are the parameters within a neural network, for example, if/then conditions, etc.) until the model has been fitted appropriately. It allows the algorithm to see how accurate its performance is by comparing the results with those of the training set. It is important to note that by a labelled dataset, we mean that each example in the training dataset already has a correct answer which is made available to the computer. This allows the model to compare answers

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and make improvements to its algorithm in order to become more and more efficient. Example: Consider a labelled dataset of dog images that would tell the model which photos are of golden retrievers, labradors, etc. Now, when the model is shown a new image, it compares this image to the training examples and tries to predict the correct label.

b) Unsupervised Learning:
In unsupervised learning, the raw data used to train is unlabeled and the algorithm is required to identify patterns and relationships within the data without any human intervention. This method studies how systems attempt to autonomously find structure in the data by extracting useful features and analysing them to create the said structure. This ability to discover similarities and differences in information makes it the ideal solution for exploratory data analysis, cross-selling strategies, customer segmentation, image, and pattern recognition.

c) Semi-supervised Learning:
Semi-supervised learning is inclusive of both structured and unstructured datasets which allow machine learning algorithms to learn to label unlabeled data. A smaller labelled data set is used to navigate classification and feature extraction from a larger, unlabeled data set.

d) Reinforcement Learning:
This method is based on a reward/punishments system and feedback which help the model find the optimal path to a specific goal or improve performance on a specific task via trial and error. It's an iterative process, the more rounds of feedback, the better the model's strategy becomes. This technique is especially useful for training robots, which make a series of decisions in tasks, for example steering an autonomous vehicle or managing inventory in a warehouse.

4. Applications

- Data Security: Data security vulnerabilities can be easily identified using machine learning models before they turn into breaches. As a result of its attribute to predict future high-risk activities, machine learning also helps us mitigate risks.
- Finance: Machine learning algorithms are used by banks, trading brokerages, and fintech firms to automate trading and provide financial advisory services to investors. Erica, a chatbot that is being used by the Bank of America to automate customer support is another example.
- Healthcare: Analysing massive healthcare data sets is another advantage of machine learning. This analysis further aids in accelerating the discovery of treatments and cures, improving patient outcomes, and automating routine processes to prevent human errors.
- Fraud Detection: Machine learning has made it easier for us to analyse large numbers of transactions which helps in uncovering fraudulent activity in the financial and banking sectors.
- Retail: Based on buyers' past choices, as well as historical, geographical, and demographic data, machine learning algorithms are used to develop AI recommendation engines that offer relevant product suggestions.
- Speech Recognition: It is a capability that uses natural language processing (NLP) to process human speech into a written format. Eg: Siri.
- Computer Vision: Computers and systems are enabled by AI technology to derive meaningful information from digital images, videos, and other visual inputs, and based on those inputs it can take action. This is used in radiology imaging in healthcare, self-driving cars within the automotive industry, etc.

5. Challenges

By now it is understood that machine learning is majorly driven by the amount and kind of raw data provided to a model. Evidently, we can say that *machine learning certainly cannot attain human-level intelligence* due to the machine's 'intelligence' being dictated by the volume of data one trains it with. *The training of machine learning models is difficult.* The majority of data scientists admit that training AI with data is more difficult than expected since the required time and resources are most definitely not a paltry sum. Due to proneness to data issues, such as data quality, data labelling, etc., an extraordinarily high threshold has been created for ML success. Machine learning often might be biassed, and since the models are known for operating in a black box, that is one has no visibility into how the machine learns and makes decisions, there is no way for us to know the cause of a bias in the output. Thus, the only other option, which is also not a guarantee, is that the model is retrained with additional data.

6. Future Prospects

Every major sector, including business, government, finance, agriculture, transportation, cybersecurity, marketing, etc., has now incorporated machine learning in some way or the other. This continued digitization of almost every sector of society and industry implies that an accrescent volume of data will continue to be generated. Machine learning equips us with the ability to gain insights from these extensive datasets and henceforth, address an enormous array of issues such as identifying and treating diseases more effectively, fighting cybercriminals, helping organisations function efficiently to boost their growth metric, etc.

It is evident from self-driving cars, automated assistants, smart cities, etc., that smart machines are feasible. Thus, it would be appropriate to say that the machine learning revolution will stay with us for a long period of time.

7. Conclusion

Machine learning arms us with insights from vast datasets and helps organisations operate more efficiently and scale their growth. It forms the foundation for AI systems that automate processes and solve data-based problems autonomously. The possibility to replace or augment certain human capabilities is a result of machine learning. Hence, in conclusion, it can be said that the main aim of machine learning is to create models that can train themselves to improve, perceive complex patterns, find solutions to new

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problems by using previous data and identify historic trends to inform future models without explicit programming or human intervention.

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