FUTURE AND EMERGING TECHNOLOGIES IN AI&ML

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Review

Artificial Intelligence and Machine Learning in Modern Technology: A Comprehensive Review

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ABSTRACT

An explosion in data has resulted from the widespread use of digital technologies, which in turn has enabled machines to gain knowledge through experience and gradually enhance their performance. As a result, AI and ML have emerged as crucial technologies propelling innovation across numerous domains. Concepts, definitions, types, applications, and the link between ML and AI are all covered in this paper's thorough examination. Topics like as language processing, scheduling, robotics, and anomaly detection are expanded upon in this work, along with supervised, unsupervised, and reinforcement learning. Researchers, practitioners, and students in the area will find this study important since it adds to the body of knowledge by offering a complete overview of AI and ML. Research on the moral consequences of AI and ML in different contexts is warranted, according to this paper.

Keywords

Artificial intelligence (AI); Machine learning (ML); Traditional programming; Supervised learning; Unsupervised learning; Reinforcement learning.

INTRODUCTION

Everything from our professional life to our social media accounts, health records, and information pertaining to cybersecurity is kept online. Everything nowadays is connected to some kind of data source; we really are living in the data era (Sarker, 2021). Structured, semi-structured, and unstructured data may exist. According to Badillo, Banfai, Birzele, Davydov, Hutchinson, Kam□ Thong, Siebourg□ Polster, Steiert, and Zhang (2020), a dataset consists of several samples, or points, where each sample represents an item that we want to study. There has been speculation about computers learning abstract ideas from data and applying them to unobserved situations since at least the 1950s. Recent lightning-fast technological advancements have led to an explosion in data collecting, which in turn has skyrocketed the need for artificial intelligence (AI) during the last decade. The capacity to use hardware acceleration and developments in machine learning methods have been the primary drivers of this rise (Verbraeken, Wolting, Katzy, Kloppenburg, Verbelen, & Rellermeyer, 2020). There is always space for advancement in research since technology is always changing, which in turn leads to better technology. According to Amandeep, Dhiman, Mansi, and Ramneet (2020), artificial intelligence has great potential for a wide range of technological advancements in several industries. Some of the many possible tasks that artificial intelligence (AI) can do include language processing, scheduling, robotics, automated learning, and reasoning (Goar, 2022).

These days, machine learning (ML) is everywhere, and no one is using it intentionally. In machine learning, researchers examine the statistical models and techniques used by computers to do certain jobs automatically, rather than relying on human programming (Mahesh, 2020). One main advantage of machine learning (ML) is that algorithms may learn to automate their duties provided they have a good grasp of data. This is why learning from data is the main objective of ML. Machine learning (ML) methods may solve a variety of problems, such as anomaly detection, classification, grouping, and many more.

An in-depth analysis of artificial intelligence (AI), machine learning (ML) (including its many forms), and their interplay is presented in this study.There are four parts to this study: Section one covers the introduction, while Section two covers the literature review. Section three delves into the following topics: what is AI?, what is ML? and the varieties of ML?, and the link between AI and Section three provides an in-depth analysis of ML, while Section four discusses the results and suggests avenues for further study.

Literature Review

While many research have addressed AI and machine learning, this section focuses on a selection of the literature that has been examined. For example, Mahesh (2018) discusses the idea of machine learning and associated algorithms. Within machine learning, this article classifies several approaches such as neural networks, instance-based learning, reinforcement learning, multi-task learning, unsupervised learning, semi-supervised learning, and so on. Among the algorithms discussed in this piece are decision trees, naïve bayes, principal component analysis, K-means (unsupervised learning), generative models, self-training, support vector machine (semi-supervised learning), boosting, bagging (ensemble learning), supervised neural networks, unsupervised neural networks, reinforced neural networks, and k-nearest neighbor (instance-based learning). Wei et al. (2019) investigate the use of machine learning in materials science. Several well-established areas of materials science have recently used machine learning algorithms for property analysis; these include drug design, inverse design, structure-oriented design, element-oriented design, degradation detection, nanomaterial analysis, molecular property prediction, and quantum chemistry. The article delves into the basic operational steps of applying machine learning to these fields, as well as the recent applications, and the required advancements, for widespread application. The article shows how machine learning is widely used in quantum chemistry, novel material discovery, and property prediction due to its high prediction power and very cheap processing cost.

As far as machine learning is concerned, Maulud and Abdulazeez provide a comprehensive review of linear regression (2020). The report compared and contrasted the efficacy of polynomial and basic linear regression by studying relevant literature. However, the authors found that when the variables have a polynomial relationship, a multiple linear regression model is used. When there is a linear relationship between two or more independent variables, a simple linear regression model is used. Lastly, when there is no polynomial relationship, a polynomial regression model is used."Machine learning and AI in marketing: Connecting computing power to human insights" is the title of another paper that Ma and Sun (2020) scrutinize. Highlighting the current status of AI-driven marketing, this paper goes into great detail. By facilitating media-rich and interactive content, customization, real-time automation, and an emphasis on the customer journey, the writers discovered that AI and ML greatly benefit marketing via a number of processes, such as marketing mix, consumer engagement, searching, recommendation, and attribution. Additionally, this study summarizes previous work that has used machine learning techniques for marketing optimization, including support vector machines, deep learning, ensemble methods, causal forests, network embedding, active and reinforcement learning, and network embedding.

The practical applications of AI were examined by Amandeep et al. (2020). The research centered on AI as a whole and its several subfields and applications, including robotics, NLP, facial recognition, expert systems, neural networks, and special recognition. Additionally, the report pinpoints the present and future impacts of AI. The research found that AI has a lot of potential for many different kinds of technological advancements in many different sectors. With their 2020 publication, Badillo et al. introduce machine learning. Not only does the article delve into the two main branches of machine learning—supervised learning and unsupervised learning—the article also defines data points, features, feature spaces, and similarity measures. Supervised learning uses labeled data to "predict," while unsupervised learning uses unlabeled data to explore. In contrast to supervised learning's reputation for regression and classification problems, unsupervised learning is well-known for dimensionality reduction and clustering, as this article shows. Numerous methods were discovered for every issue in this research. In the latter section of the article, the commonly used metrics for evaluating model performance are detailed. Precision, accuracy, area under the curve, mean squared error (for classification issues), recall false positive rate, and accuracy are all measurements that fall into this category.

Goar (2022) explores the effects and revolution of AI by providing a thorough review of recent developments in the subject and their uses in many domains, such as healthcare and medicine, the environment, education, the economy, and agriculture. Artificial intelligence (AI) may be used in the following domains, as shown in the study: In healthcare and medicine, it improves decision-making and connects human cognition with digital data; in the field of education, it simplifies the work of lecturers and aids students in pursuing their interests at the university level; in the economy, it changes the outdated view of the agricultural landscape; and in environmental science, it provides ways to convert qualitative knowledge, like enological relationships, into a quantitative form that computers can understand. Machine learning and its methods, including Decision Tree, Naïve Bayes, K-Nearest Neighbor, Random Forest, and Support Vector Machine, are covered in Jain and Kumar's (2022) discussion. This article presents three types of machine learning: supervised learning, unsupervised learning, and reinforcement learning. Algorithms suitable for classification and regression issues were enumerated by the writers. There were five algorithms discussed for classification problems: Naïve Bayes, Decision Tree, Support Vector Machines, Random Forest, and K-Nearest Neighbors. On the other hand, four techniques were described for regression problems: linear regression, neural network regression, lasso regression, and ridge regression. According to the report, the scientists also verified that clustering issues are best tackled using unsupervised learning approaches, even if reinforcement learning includes Q- and R-learning. Furthermore, the essay shows how the model's performance is impacted by the data quality.

An examination of assaults using machine learning is carried out by Patil and Zuber (2023). A first look at the root causes of privacy breaches in machine learning systems and an outline of typical security tactics against the issue are both included in the study. Scientists' increasing concerns regarding the impact of mechanism knowledge on privacy, transparency, and equity have led to significant advancements in security mechanisms, as shown by the survey findings of this research. Sravani, Chowdary, and Ramu (2023) discuss the ways in which the agricultural sector might benefit from AI, ML, and the IoT. Since the adoption of AI solutions will dictate the future of AI in farming, the essay emphasizes the critical nature of AI and ML's use in this sector. In addition to automating agricultural systems, the authors of this research highlighted that AI in agriculture goes be-

yond that to achieve precision cultivation, which in turn increases crop yield, improves crop quality, and reduces resource consumption. Utilizing historical agricultural data, machine learning may help farmers understand crops, their DNA, and any illnesses more thoroughly. Because of this, they will be able to foresee potential threats to their crops and make quicker judgments.

To begin with, what is AI? Machines with artificial intelligence can mimic human thought processes (Ma & Sun, 2020).When computers or robotic systems that are connected to computers can learn, make choices, and solve problems in ways that are similar to how humans do it, we say that they have artificial intelligence (AI) (Patel, Raut, Dhok, Sagwadiya, More, Mahale, & Student, 2022).A computer with artificial intelligence (AI) can learn and think like a human, giving it intelligence and the capacity to multitask efficiently (Goar, 2022).To summarize, artificial intelligence (AI) is made up of two parts: artificiality, meaning it is man-made, and intelligence, meaning it can reason. The whole point of artificial intelligence is to program a computer to mimic human intelligence in terms of problem-solving and decision-making.Data quantities, algorithms, and computing and storage capabilities are all on the rise, which is leading to a growth in the prevalence of AI (Goar, 2022). Neural networks, expert systems, NLP, and other forms of artificial intelligence (AI) have progressed to the point that they can compete with humans. Among the many societal advantages of AI automation include lower rates of human error, shorter workweeks, and more output per worker (Amandeep et al., 2020).

In artificial intelligence, ML is a subset. In contrast to AI, ML has a narrower scope and is more targeted. Not all of the strategies and tools used in AI fall within the purview of machine learning. The ultimate goal of AI is to imbue robots with human-like abilities. Machine learning (ML) is an AI technique that use algorithms to analyze information, derive conclusions, and finally apply those forecasts and judgments to the actual environment. The connection between AI and ML is shown in Figure 1.

Figure3.1 shows that AI is a superset of ML, while ML is now a subset of AI, and that denotes that the scope of AI is far wider than that of ML.

What is Machine Learning (ML)?

The following are a few of the many accepted definitions of "machine learning":It is claimed that a computer program gains knowledge via experience ("E") in connection with a set of tasks ("T") and a metric for performance ("P").Machine learning (ML) refers to the field of computer science that studies how computers may learn to do certain jobs automatically, without human intervention (Mahesh, 2020).The term "machine learning" (ML) refers to an approach to algorithmic programming that uses past data to generate new algorithms automatically. As it processes more and more data, the algorithm learns to adapt its parameters to the input's specific properties.In a nutshell, machine learning (ML) is an AI subfield that enables computers to autonomously learn from data and previous experiences, allowing them to uncover patterns and provide predictions with little human involvement.Models in machine learning are trained on data using algorithms, which allows the model to identify patterns and make predictions. The old-fashioned way of programming included solving problems by handwriting code. So, it's safe to state that ML's techniques set it apart from more conventional approaches to programming. The contrasts between ML and conventional programming are shown in Figure 3.2.

Figure 2 shows that in traditional programming, step-by-step process (formula) in which a given problem will be solved when given an output is manually written by the programmer, while in ML, the input data and the resulting outcome are all there is to give to ML algorithms; the algorithm will be the one to figure out the relationship (pattern) between the input and output data, and this recognized pattern is what will be used for future prediction of any input data. Although their primary drawback is that ML techniques sometimes lack interpretability, as seen by their opaque model structures and ambiguous variable relationships, ML techniques nevertheless hold a lot of promise to handle significant problems (Ma & Sun, 2020).

Workflow of Machine Learning

Figure 3 depicts the step-by-step process ML takes in training algorithms that are used for future purposes and they include:

Data Acquisition: This is the process of gathering and storing data for machine learning from a range of sources. The process comprises collecting, analyzing, and applying critical data to ensure accurate measurements, real-time observation, and informed decision-making.

Data Preprocessing: Machine learning (ML) data preprocessing is the act of preparing and transforming unprocessed data into a format that can be used to train ML models. It is a crucial stage in an AI or ML pipeline since it affects the models' accuracy and performance directly.

Train-Test Split: When you divide your data into a testing set and a training set, this is known as a train-test split. The testing set is used to test your model after it has been trained using the training set. This enables you to test the accuracy of your models on the testing set that is hidden after training them on the training set. While there are a few variations on how to execute a train test split, splitting your data into two sets is the most popular method. 80% for training and 20% for testing, for instance. This guarantees that both sets accurately reflect the complete dataset and provides you with a useful means of gauging the precision of your models.Lastly, after the model has been tested and has satisfied accuracy, its trained model can be downloaded to be used for production.

Machine Learning Types

Figure 4 shows that ML is broadly categorized into three categories (supervised, unsupervised, and reinforcement learning), where supervised and unsupervised ML also have their own sub-categories, and the examples of algorithms under each category are stated.

Supervised ML

This is the most popular and widely used ML techniques. In supervised machine learning, a function that converts input data into the intended output is sought after. The output can then be predicted by applying this function to fresh input data (Verbraeken et al., 2020).

Supervised machine learning algorithms are ones that require outside support.The two main categories of supervised machine learning are "classification," which uses a dataset to learn how to assign a class, and "regression," which models the connection between several features and a continuous target variable.

Unsupervised ML

Unsupervised learning techniques use training data made up of input objects without output values in order to group the unsorted data and create a function that describes the structure of the data (Verbraeken et al., 2020). The most popular use of unsupervised learning is the grouping of data according to shared characteristics and latent patterns. It is also applied to dimensionality reduction difficulties.With unsupervised machine learning, the model can find patterns and information on its own that it had not previously seen. Numerous real-world uses exist for, including client segmentation, data mining, and referral networks (Jain, & Kumar, 2022).

Reinforcement Learning

An agent that must act in a given environment depending on its observations is trained via reinforcement learning. Feedback is based on a cost or reward function that assesses the system's condition (Verbraeken et al., 2020).

Since reinforcement learning picks up on feedback on its own, tagged data is not necessary. Playing games, facial recognition, text detection, and other applications are areas where reinforcement learning is put to use (Jain, & Kumar, 2022).

Conclusion

The development of AI and ML is having a profound impact on many aspects of human life. This study demonstrates how AI and ML may be used to automate human operations, improve productivity, and guarantee accurate predictions. Some of the many areas that AI and ML have found use in include scheduling, anomaly detection, language processing, and robotics. In the ever-changing world of technology, AI and ML will play an essential role in molding the trajectory of innovation. Therefore, our study suggests using AI and ML in a variety of contexts, each with its own set of advantages and disadvantages. As a valuable resource for researchers, practitioners, and students in the field of artificial intelligence and machine learning, this study adds to the existing body of knowledge by offering a comprehensive review of AI and ML. It highlights various types of ML work, such as supervised, unsupervised, and reinforcement learning.

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