ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN MODERN TECHNOLOGY: A COMPREHENSIVE REVIEW

BY

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Abstract
The utilization of digital technologies has led to an exponential growth in data generation, making it possible for machines to learn from experience and improve performance over time, leading to the emergence of artificial intelligence (AI) and machine learning (ML) as key technologies driving innovation in various fields. This paper provides a comprehensive review of AI and ML, covering concepts, definitions, types, applications, and relationship between AI and ML. Moreover, this paper extends its coverage to supervised, unsupervised, and reinforcement learning and their applications in areas like language processing, robotics, scheduling, and anomaly detection. Overall, this study contributes to the body of knowledge by providing a detailed review of AI and ML, making it a valuable resource for researchers, practitioners, and students in the field. This study suggests that further study should investigate the ethical implications of AI and ML in various application areas.
***Keywords*:** Artificial Intelligence (AI),Machine Learning (ML), Traditional programming, Supervised learning, Unsupervised learning, Reinforcement learning.

Introduction

Our lives are digitally recorded, whether they be business, social media, IoT, health, or cybersecurity data. We live in the age of data, where everything is linked to a data source (Sarker, 2021). Data can be structured, semi-structured or unstructured. A dataset is made up of several points, or samples, each of which corresponds to an entity that we wish to examine (Badillo, Banfai, Birzele, Davydov, Hutchinson, Kam-Thong, Siebourg-Polster, Steiert, & Zhang, 2020). Since at least the 1950s, there has been talk about computers being able to acquire abstract concepts from data and apply them to circumstances that have not yet been observed. The demand for artificial intelligence, or A.I., has increased dramatically over the past ten years due to the unprecedented growth in data collection brought about by the recent rapid development of new technologies. This growth has been driven by advancements in machine learning techniques as well as the ability to take advantage of hardware acceleration (Verbraeken, Wolting, Katzy, Kloppenburg, Verbelen, & Rellermeyer, 2020). Technology is constantly evolving, which leads to improvements throughout time and gives researchers room to grow even more. A.I. offers a promising future for diverse technical innovations across multiple fields (Amandeep, Dhiman, Mansi, & Ramneet, 2020). A.I. may perform a variety of activities, such as language processing, robotics, scheduling, automated learning, and reasoning (Goar, 2022).

Whether they realize it or not, everyone uses machine learning (ML) these days. ML is the scientific study of the statistical models and algorithms that computer systems employ to carry out certain tasks without needing to be explicitly programmed (Mahesh, 2020). The fundamental benefit of machine learning (ML) is that, once an algorithm understands how to use data, it can do its tasks automatically. For this reason, the goal of ML is to learn from data. A wide range of tasks, including anomaly detection, classification, grouping, and more, can be accomplished with ML techniques.
In this research work, what A.I. is, what ML is and its types, and the relationship between A.I. and ML will be discussed in detail.This research is divided into four sections: the introduction is covered in section one, the literature review is covered in section two, what AI. is, what ML is and its types, the relationship between A.I. and

ML is covered in detail in section three, and the conclusion and recommendations for further research are covered in section four.

Literature Review

Several studies have been conducted to discuss the concepts of machine learning and artificial intelligence; however, some of the literature reviewed is highlighted in this section. For instance, the notion of machine learning and related algorithms is covered by Mahesh (2018). This article categorizes machine learning into: neural networks, instance-based learning, multi-task learning, reinforcement learning, unsupervised learning, semi-supervised learning, and neural networks. 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) are some of the algorithms covered in this article.Machine learning in materials science is explored by Wei, Chu, Sun, Xu, Deng, Chen, Wei, and Lei, (2019). The article discusses the fundamental operational steps involved in using machine learning to analyze material properties, the recent applications of machine learning algorithms to a number of established materials science fields (including drug design, inverse design, structure-oriented design, element-oriented design, degradation detection, nanomaterial analysis, molecular property prediction, and quantum chemistry), and the necessary advancements for broad application. The paper demonstrates how machine learning, with its strong prediction capabilities and reasonably low processing cost, is frequently applied in the investigation of quantum chemistry, the identification of new materials, and the prediction of properties.

A thorough overview of linear regression in machine learning is presented by Maulud and Abdulazeez (2020). Through a study of pertinent literature, the paper contrasted the effectiveness of polynomial and basic linear regression. Nonetheless, the authors discovered that a polynomial regression model is frequently employed when the variables have a polynomial relationship; a multiple linear regression model examines a linear relationship between two or more independent variables; and a simple linear regression model is appropriate for data containing a linear relationship between two variables.Another study titled "Machine learning and AI in marketing: Connecting computing power to human insights" is examined by Ma and Sun (2020). This study delves far into highlighting the state of AI-driven marketing. The authors found that through a variety of operations, including marketing mix, customer engagement, searching, recommendation, and attribution, AI and machine learning significantly contribute to marketing by enabling interactive and media-rich content, personalization, real-time automation, and a focus on the customer journey. This paper also reviews machine learning methods, such as support vector machines, deep learning, ensemble methods, causal forests, network embedding, and active and reinforcement learning, that have been employed for marketing optimization in earlier research.

Amandeep et al. (2020) reviewed artificial intelligence in practice. The study focused on the broad idea of artificial intelligence (AI) and its various applications, such as robotics, natural language processing, face recognition, expert systems, neural networks, and special recognition. The study also identifies the effects of AI in the current and future worlds. According to the study, AI has great promise for a variety of technical innovations across a wide range of industries. Machine learning is introduced by Badillo et al. (2020). Apart from delving into the two primary sub-disciplines of machine learning—supervised learning, which uses labeled data and aims to “predict,” and unsupervised learning, which uses unlabeled data and aims to explore the article clarifies the concepts of data points, features, feature spaces, and similarity measures. This article also demonstrates that, whereas unsupervised learning is renowned for clustering and dimensionality reduction, supervised learning is known for regression and classification challenges. In this study, many algorithms were identified for each problem. The paper concludes by identifying measures that are frequently used to quantify the performance of models. These metrics include accuracy, precision, recall false positive rate, area under curve, mean squared error (for regression problems), and accuracy (for classification problems).

By giving a comprehensive overview of current advancements in the field of artificial intelligence and its applications in a variety of fields, including healthcare and medicine, the environment, education, the economy, and agriculture, Goar (2022) investigates the impact and transformation of artificial intelligence. According to the study, artificial intelligence (AI) has the following uses in the aforementioned fields: It enhances decision-making and bridges the gap between human cognition and digital data in healthcare and medicine; it offers ways to translate qualitative knowledge—such as enological relationships—into a quantitative form that computers can understand in the environment; it makes it easier for lecturers to carry out their duties in the field of education and helps students in higher education pursue their interests effectively and efficiently; it improves the state of the economy and modifies the outdated perception of the agricultural landscape.The concepts of machine learning and machine learning algorithms, such as Decision Tree, Naïve Bayes, K-Nearest Neighbor, Random Forest, and Support Vector Machine, are discussed by Jain and Kumar (2022). Three categories of machine learning are presented in this article: reinforcement learning, unsupervised learning, and supervised learning. The authors listed categories of algorithms that are appropriate for classification and regression problems. For classification problems, five algorithms (Naïve Bayes, Decision Tree, Support Vector Machines, Random Forest, and K-Nearest Neighbors) were mentioned, and for regression problems, four algorithms (linear regression, neural network regression, lasso regression, and ridge regression) were listed. Furthermore, the scientists confirmed that while reinforcement learning encompasses Q- and R-learning, unsupervised learning techniques are appropriate for clustering problems, according to the article. More so, the article demonstrates how the quality of the data in use affects model performance.

Patil and Zuber (2023) conduct a survey on machine learning attacks. The survey includes an overview of common defense strategies against the threat as well as a first examination of the underlying causes of privacy leaks in machine learning systems. This study's survey results demonstrate how scientists' growing worries about how mechanism knowledge affects safety, secrecy, and fairness have resulted in major breakthroughs in security mechanisms. Applications of artificial intelligence, machine learning, and the Internet of Things in agriculture are presented by Sravani, Chowdary, and Ramu, (2023). The article points out that the usage of AI and ML in agriculture is crucial since the uptake of AI solutions will determine how far AI can go in farming in the future. The authors of this study noted that artificial intelligence (AI) in agriculture extends beyond automating farming systems to precise cultivation for increased crop production and improved crop quality with reduced resource consumption. Farmers can utilize machine learning to gain a deeper understanding of crops, their genes, and potential diseases by adopting historical agricultural data. This will help them predict crop vulnerabilities and make decisions more quickly.

What is Artificial Intelligence (AI)?

AI is the ability for machines to use human intelligence (Ma & Sun, 2020).Artificial Intelligence (AI) is the capacity of a computer or computer-enabled robotic system to process data and provide results that are comparable to human cognition in learning, making decisions, and problem-solving (Patel, Raut, Dhok, Sagwadiya, More, Mahale, & Student, 2022).Artificial Intelligence (AI) is the ability of a machine to think and learn, which gives it intelligence and the speed to complete several jobs quickly (Goar, 2022).In summary,AI is composed of two components: artificiality, which denotes human-made, and intelligence, which represents the ability to reason. All AI is about is building a machine that will be able to think and act like humans when solving problems and making decisions.AI is becoming more common due to increased data volumes, improved algorithms, and advancements in compute and storage (Goar, 2022). As artificial intelligence (AI) has advanced to include neural networks, expert systems, natural language processing, and other capabilities, it can now challenge humans. Artificial intelligence (AI) automation has several benefits for society, including reduced human mistake rates, reduced time commitment, and enhanced efficiency and production (Amandeep et al., 2020).
One subset of AI is ML. Compared to AI, ML is more focused and has a smaller reach. Machine learning does not encompass all of the tactics and technology that make up artificial intelligence. Giving machines capacities often associated with humans is the aim of artificial intelligence. ML is a method of AI that makes use of algorithms to

evaluate data, draw conclusions from that analysis, and then use that conclusion to forecast and make judgments about the real world. Figure 1 depicts the relationship between AI and ML.

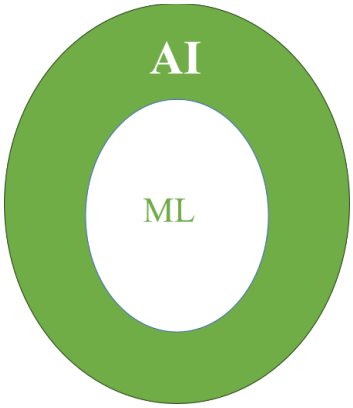

Figure 1: Relationship between AI and ML

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)?

There are different definitions available for machine learning; among them are these defined below:It is asserted that a computer program learns from experience ("E") in relation to a class of tasks ("T") and a performance measure ("P").The scientific study of algorithms and statistical models used by computer systems to carry out certain tasks without explicit programming is known as machine learning (ML) (Mahesh, 2020).Machine learning (ML) is an algorithmic paradigm that learns from experience and doesn't require human programmers to create new algorithms. The algorithm learns by digesting an increasing amount of data and then adjusting its own parameters in response to the characteristics of the input.In summary, ML is a branch of artificial intelligence that gives computers the capacity to automatically learn from data and past experiences in order to recognize patterns and make predictions with the least amount of human intervention.Through the use of algorithms, models are trained on data in machine learning, enabling the model to recognize patterns and make predictions. Writing code by hand to solve a given problem is the traditional programming method. With this, we can say that ML is totally different from traditional modes of programming due to their methods. Figure3.2 shows the differences between traditional programming and ML.

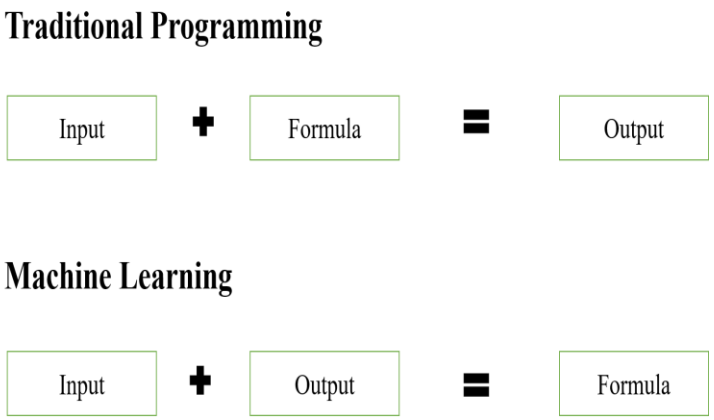

Figure 2: Difference between Traditional Programming and ML.

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

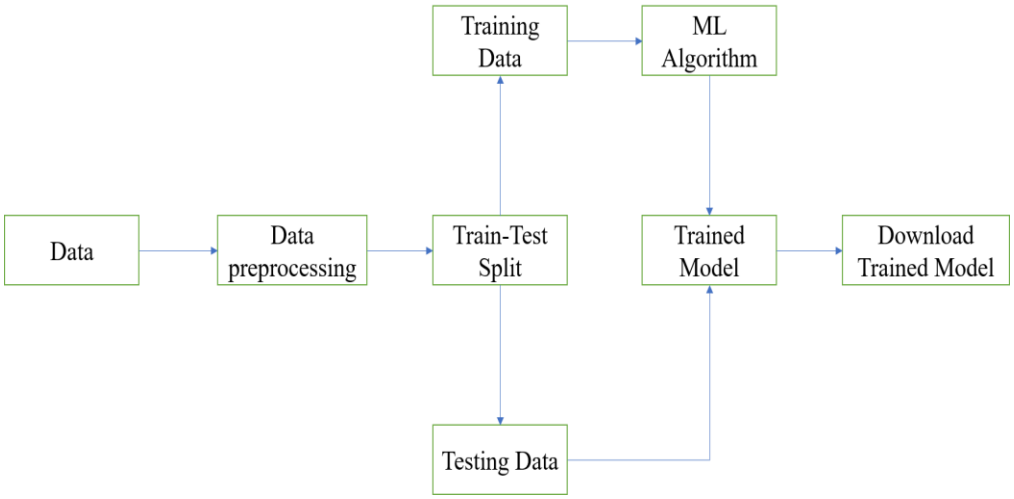

Figure 3: ML Workflow

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

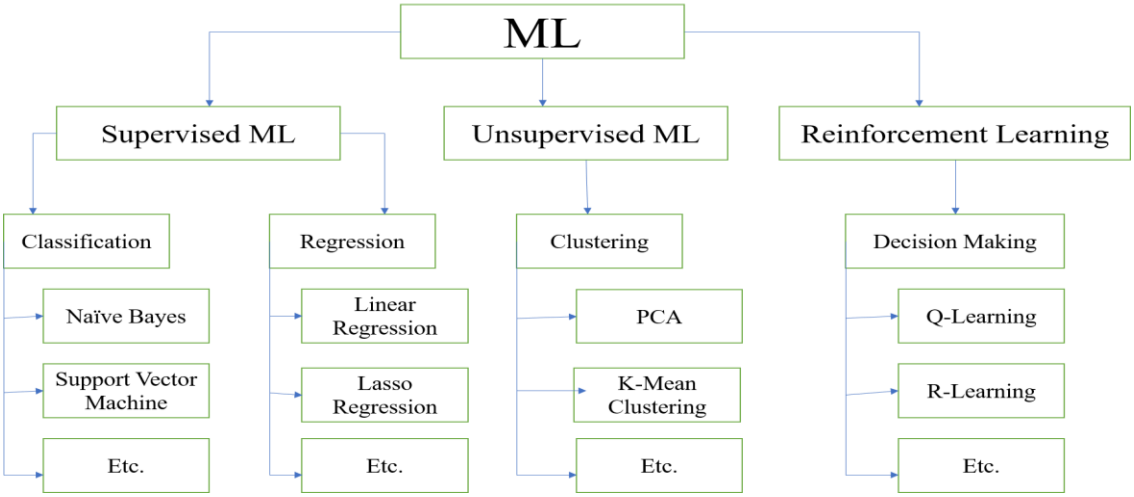

Figure 4: Types of ML

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

Artificial Intelligence (AI) and Machine Learning (ML) are transforming the way humans live and carry out their activities. This research showcases the relevance of AI and ML in the automation of human tasks, efficiency enhancement, and ensuring accurate predictions. AI and ML applications touch various fields, including language processing, robotics, scheduling, and anomaly detection. As technology continues to evolve, AI and ML will continuously contribute to shaping the future of innovation. Hence this research recommends the applications of AI and ML in diverse domains: challenges and limitations. This study contributes to the body of knowledge by providing a detailed review of AI and ML, highlighting ML work and types, including supervised, unsupervised and reinforcement learning, making it a valuable resource for researchers, practitioners, and students in the field of machine learning and artificial intelligence.

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