Machine Learning in Healthcare Technology: Insights, Challenges, Roles and Applications

R. Naga Sathvik[1], T.S Prem Rajiv Kumar[2], CH. V. N. Rugvidh[3], Vavilla Rupesh[4], Chinnem Rama Mohan*[5], N. Subramanyan[6], S. Kiran*[7] and A. Ashok Kumar*[8]

[1, 2, 3, 4]UG Scholars, Department of Computer Science and Engineering, Narayana Engineering College, Nellore, 524004, Andhra Pradesh, India

[5]Associate Professor, Department of Computer Science and Engineering, Narayana Engineering College, Nellore, 524004, Andhra Pradesh, India

[6]Research Scholar, Department of Computer Science, Sri S.R.N.M College, Affiliated to Madurai Kamaraj University, Tamil Nadu-626 203, India

[7]Department of CSE, YSR Engineering College of YVU, Proddatur, 516360, Andhra Pradesh, India

[8]Department of Physics, YSR Engineering College of YVU, Proddatur, 516360, Andhra Pradesh, India

ABSTRACT

In today's ever-changing world, Machine Learning (ML) has become significantly important. It is reshaping what we thought was not going to be possible. Data plays a crucial role in this era. Thus, data is essential in various advanced technologies, like IoT devices, web services, deep learning models, and the expansion of Artificial Intelligence. This paper aims to explore Machine Learning by starting with an overview and then getting into its nature and overall mission. It discusses various factors such as transparency issues, scalability issues, and security issues that come with Machine Learning, also suggesting various techniques to overcome these concerns effectively. Furthermore, this article also highlights real-world examples which describe the impact of Machine Learning across various domains. It also describes the various kinds of learning in ML and the importance of data in ML—the Impact of Machine Learning in Industries: Enhancing Decision-Making Techniques. Along these, this includes applications, advantages, and disadvantages of ML. In conclusion, this article aims to deliver a detailed overview of Machine Learning in today's context and its developments.

KEY WORDS: MACHINE LEARNING, ARTIFICIAL INTELLIGENCE, NLP, COMPUTER VISION, ALGORITHMS, DEEP LEARNING, NEURAL NETWORKS, SCALABILITY, TRANSPARENCY, SECURITY.

INTRODUCTION

Machine learning (ML) is a branch of artificial intelligence that focuses on developing the various algorithms that help computer systems improve their performance. ML is capable of making the machines make use of information and then recognize the patterns. Further, it will be able to take the decisions by itself. ML also includes developing a different number of algorithms through the learning process. The history of machine learning started in the middle of the 20th century when the concept of "artificial intelligence" started. Alan Turing and John von Neumann have established the foundation for decision-making. Between the 1950s and 1960s, researchers developed the first ML algorithm, including the perceptron, which also helped the study of neural networks. However, the process was stopped in the 1970s due to less access to data. This period has seen the comeback of interest in the 1990s with more advanced algorithms, and researchers have access to large datasets. Since then, machine learning has kept growing, advancing in deep learning, reinforcement learning, and other technologies (Baştanlar & Özuysal, 2014; Badillo et al., 2020).

Machine Learning algorithms are in different forms; they can be in prediction tasks and deep neural networks, which can control extensive data, including images and text. As ML is a quickly developing technology, it will come up with many of the latest improvements in the field of AI and other technologies; it will reshape the way we interact with

Article Information:*Corresponding Author: ramamohanchinnem@gmail.com rkirans125@gmail.com & drashok.yvuce@gmail.com
Received 15/07/2023 Accepted after revision 30/09/2023
Published: Sep 2023 Pp- 178- 189

Available at: https://bbrc.in/ DOI: http://dx.doi.org/10.21786/bbrc/16.3.8

machines and overcome many limitations. It is capable of detecting information and making predictions on its own (Kubat & Kubat, 2017; Senders et al., 2018).

Machine Learning is a field that is evolving very rapidly. Future developments in machine learning certainly include more automation and integration with IOT, the creation of NLP models for text and speech analysis, etc. This is a brief overview of Machine Learning.

The objectives of this work are – To explain the mission and vision of machine learning as a discipline.To provide insights into the complexities and difficulties within the field. To explore professionals' diverse roles and challenges in machine learning.To examine issues related to transparency, scalability, and security in machine learning and offer solutions for addressing these concerns. To showcase the wide-ranging applications of machine learning across different industries and domains. To discuss potential future developments and advancements in machine learning.

Components of Machine Learning

- **a. Subset of Artificial Intelligence:** Machine learning is one of the fields of intelligence that creates models that can perform tasks independently without any human instructions. AI has many subfields, and ML is one such field.
- **b. Algorithms and Models:** ML involves creating and using various algorithms and models. These algorithms are designed to learn from data and then make predictions based on that learning. The ML algorithm is the "brain" behind all the processes/tasks.
- **c. Learning from data:** The idea of ML is that the system can learn from data. Here, we do not give any of the user's instructions; ML systems use data to make patterns and relationships. This learning process allows them to think and make predictions about new data.
- **d. Performance Improvement:** Here, the systems are designed in such a way as to improve their performance. This improvement helps itself in different ways, like making more accurate predictions and better recognition of processes.
- **e.Without Clear programming:** In Machine Learning, unlike general software, where developers write the code to perform the task, ML systems do not depend on particular rules or instructions. Instead, they improve themselves based on the data and feedback they receive (Dreossi et al., 2019).

Importance of Data in ML

The importance of data in Machine learning (ML) is very crucial. Data is essential for ML as it plays a crucial role in all aspects of the Machine Learning pipeline. Here, we can clearly understand the importance of data in ML (Jain et al., 2020).

- **a. Training the Models:** ML models highly depend on data to learn patterns and then make predictions based on the data. During the training process, the data is given as input, and their results are taken to retrain them repeatedly to make the model efficient. The model will learn based on the input data. The quality of the model can be improved when trained by giving larger datasets as input. So, the model will be able to produce the accurate results.
- **b. Generalization:** ML models are designed to generalize by the number of times they are trained. So, training the model as often as possible will help provide more accurate predictions. The model also learns from various historical data to make the right decisions about the future. If we provide sufficient data during training, the model can provide generalized data, which is appreciated.
- **c. Generating various Features:** The data is crucial in ML mode to generate various features. So, selecting the correct data and performing training more often will produce quality results. Data scientists are often involved in selecting the most relevant data, carefully selecting and modifying it for better results. Thus, this process is very crucial in making the model highly reliable.
- **d. Evaluation of Model:** To verify the quality of the model, it is essential to have the test and training data. This data is used to measure model performance, which includes factors like accuracy, F1 score, etc. So, with reliable test data, it is easier to determine how well the model performs and whether it is ready for real-world deployment.
- **e. Bias & Fairness:** Data quality is essential to find out the issues of abuse and justice in Machine Learning. More data will produce false predictions, which will have a positive impact. So, ensuring that the training data is bias-free is mandatory, which is an essential consideration in ML.
- **f. Continuous Learning:** In most situations, models have to quickly learn and adapt to the latest data, which improves their performance and quality in generating better results.Thus, the Data is a fundamental part of Machine Learning as Machine learning would only be successful now with providing better input/training data.

Advanced Technologies in ML:

- **a. Deep Learning:** Deep learning is a subbranch of ML that will focus on the topics of Deep Neural Networks. These are made to learn from the data and then represent the data automatically. These use various ML algorithms to train the neural networks. Deep neural networks help us in getting various features from the data directly. The best situation where Deep learning is widely used is in image and speech recognition.
- **b. Natural Language Processing:** NLP is also an Artificial Intelligence and ML subbranch. The main focus of NLP is to create interaction between computer and human language. This also includes understanding the input text and regenerating text and speech in human language. NLP depends upon ML algorithms; these primarily work on supervised techniques and Deep learning. ML models, including Recurrent Neural Networks (RNN) and Convolutional Neural Networks (CNN), are very much used to process and understand the language. These are trained on a large amount of input data to improve their performance.
- **c. Computer Vision:** Computer Vision is one of the

other sub-fields of AI and ML that mainly focus on making the machine describe and understand visual information from a more extensive set of input data of images and videos. Computer vision also uses ML algorithms, like deep learning techniques such as Convolutional Neural Networks (CNN), as these models are trained on labeled images, which helps the model to learn various image features and patterns. So, the learned data can be further utilized for various tasks such as image and object detection.

Thus, the latest Machine learning technologies have several applications, including image processing, text-to-speech, and automating tasks. The main link between Deep learning, NLP, and computer vision with ML is that they all use ML algorithms to perform various tasks on Data. Thus, all together, they help each other in creating the world into a more advanced place (Hassanien et al., 2021).

Learning's in Machine Learning: In Machine Learning, the models are designed with the ability to adapt to the data. So, it is essential to learn from data in various ways and choose the best learning method for each situation. Thus, it further helps build complex algorithms, generating accurate results. The learnings in ML are classified into three main categories. They are Supervised Learning, Unsupervised Learning, and Reinforcement learning. We will now clearly understand them and their sub-classifications (Naeini & Prindle, 2018).

Types of Learnings-

- a. Supervised Learning: Supervised Learning is one of the most widely used ML learning methods. The algorithm learns from input data, which is linked to output, so the model will have simultaneous access to both input and output, thus making it simple to learn for the machine. This Learning uses several algorithms, including linear and logistic regression decision trees. Supervised Learning is classified into two types based on their tasks. They are Classification and Regression.

1. **Classification:** The main aim is to classify the data into predefined classes or labels. It is suitable for image recognition, disease diagnosis, and many more.
2. **Regression:** Regression predicts continuous values, such as stocks, gold prices, currency exchange rates, etc. This is achieved by learning the relation between the input data and the numeric values.

Thus, both classification and regression models of supervised Learning are built based on the input data. These have a significant role in achieving discrete and continuous-based results.

- **b. Unsupervised Learning:** Unsupervised Learning differs from supervised Learning because we will train the model using unlabeled data here. The main aim is to find patterns and relationships within the input data. This Learning includes various algorithms like clustering and anomaly Detection. This is widely used in data analysis, feature engineering, and understanding data structure.
- **c. Reinforcement Learning:** Reinforcement Learning is the other most important Learning in ML. Here, the agent is trained in such a way as to make sequential decisions by interacting with the environment. An agent is like a decision-taker who decides based on the environment. Reinforcement learning algorithms include Q-learning and DQN. This learning technique is used in applications like robotics, automated vehicles, and online games. This Learning is essential in AI, too.

Thus, there are various types of learning in ML. These learnings are done based on the type of model that is being developed. These learnings are attached to various algorithms Machine learning uses, like Supervised Learning, Unsupervised Learning, NLP, anomaly detection, and deep learning algorithms.

Now, we will look at a few of the most important algorithms used in machine learning.

Types of Machine learning Algorithms

- **a. Supervised Learning Algorithms:** In this algorithm, they learn from labeled data. The best algorithm under supervised Learning is Linear regression. These are developed by taking the human brain as a referential model.
- **b. Unsupervised Learning Algorithms:** These algorithms learn from unlabeled data. This always aims to find hidden/old patterns and the latest requirements. In unsupervised learning, Principal Component Analysis (PCA) helps us to reduce.
- **c. Reinforcement Learning Algorithms:** Reinforcement Learning Algorithms focus on training the agents. These algorithms are mainly used in AI agents, which is crucial during decision-making. These works are based on the principle of trial and error.
- **d. Anomaly Detection Algorithms:** These algorithms find very rare or uncommon information. The Isolation Forest algorithm freezes the anomalies by separating data into smaller subsets.
- **e. Time Series Forecasting Algorithms:** These algorithms are designed specially; these are capable of estimating future values based on the past. Autoregressive Integrated Moving Average (ARIMA) is effective for forecasting trends.
- **f. Dimensionality Reduction Algorithms:** These algorithms reduce the number of features in a dataset, making it more manageable. Singular Value Decomposition (SVD) is helpful for matrix factorization, and Isomap will enhance geodesic distances to uncover underlying structures in data.
- **g. Ensemble Learning Algorithms:** Ensemble learning combines various numbers of models to improve the predictive performance. Boosting manages the weights of data points, which is unnecessary; it also focuses on complex examples when the stacking combines the diverse models to create a more robust predictor.
- **h. Deep Learning Architectures:** Deep learning controls the deep neural networks for complex tasks. Convolutional Neural Networks (CNNs) help us analyze the image and can also be recognized using convolution layers. Whereas Recurrent Neural Networks (RNNs)

can catch sequential information, making them most suitable for tasks like text generation.

Thus, these are various algorithms used by Machine Learning. Models select the required algorithm according to task requirements. Selecting the suitable algorithm ensures us with the most efficient result. The whole ML concept runs with these algorithms (Sarker, 2021).

Machine Learning – Frameworks and Libraries: Machine Learning has a large number of tools as well as libraries that help us in developing the models. These built-in tools and libraries will reduce task time and difficulty. Here are a few of the most widely used tools and libraries of ML (Nguyen et al., 2019).

a. TensorFlow:
- TensorFlow is one of the most popular frameworks of ML, which Google developed. The main task is to produce high-level and low-level APIs.
- This is considered very flexible for deep neural networks and to deploy the created models in various environments.

b. PyTorch:
- This open-source framework was developed by Facebook's AI Research Lab (FAIR). Researchers widely use this for their research works.
- It is known for its flexibility and ease of use ways. This framework truly helps us in reducing the complexity of tasks.

c. Keras:
- Keras is another open-source API. It shows high-end functionalities.
- It is specially designed to connect with TensorFlow and also with other backends.
- It is simple to use and most suitable for beginners.

d. Caffe:
- The Berkeley Vision and Learning Center (BVLC) developed this deep learning framework. It is known for its efficiency in training deep neural networks very quickly.
- However, the only limitation is that it is less flexible than other frameworks, but it is a potent tool.

e. Chainer:
- Chainer is also a deep learning-based framework. This specialty is that it uses dynamic computation, which is similar to PyTorch.
- It is more widely used in countries like Japan, and the best part of this comes with its flexibility and helps users to perform the necessary tasks very fast.

f. NumPy:
- It is one of the basic libraries of ML; NumPy is a shorthand representation of Numerical Python.
- It is used to perform many mathematical operations, like arrays, matrices, etc., in a much easier and faster manner.
- This library is used in various fields like universities, research centers, etc.

g. Pandas:
- Pandas are other ML libraries mainly used for data wrangling and analysis.
- With the help of pandas, it becomes easier to transform the data and prepare quality datasets.

h. Scikit-Learn (sklearn):
- It is a famous Python-based library for ML. It provides various algorithms for various tasks, including classification and data evaluation.
- It is a lot easier to use and straightforward to work on for the users, making it the most suitable library for data classification.

i. Matplotlib and Seaborn:
- These are the Python-based libraries that are useful for data visualization. Using these tools, we can create various kinds of charts and plots.
- The task becomes more accessible and straightforward when we use Matplotlib and Seaborn. Because they are trained well, they produce very accurate results.

Thus, these are some of the most widely used frameworks and libraries in machine learning. So, using these libraries and tools reduces the difficulty in doing tasks and completes the tasks much faster and easier. The rest of the paper is organized as follows: Section 2 contains the mission and vision of machine learning. Section 3 contains challenges within machine learning. Section 4 deals with various roles within the field of machine learning. Section 5 describes various transparency, scalability, and security issues in machine learning and the suggested methods for tackling those issues. Section 6 consists of applications of machine learning across various fields. Section 7 consists of merits and demerits of machine learning. Section 8 concludes with possible future advancements in machine learning.

Mission And Vision Of Machine Learning: Mission: Machine Learning (ML) aims to create algorithm models that allow computers to learn from data, and then ML makes predictions or decisions without the need for explicit programming. Its applications include improving data analysis, automation, and decision-making in various tasks. This whole iteration process involves continuous training called fine-tuning. Thus, it reduces most of the errors and will train the ML systems to adapt to the environment and make more accurate predictions. Vision: Machine learning is a technology that is making rapid changes. Also, on the other hand, it aims to develop AI, various algorithms, and models that allow the computer to learn and make decisions independently. The vision of machine learning is to create intelligent systems that can perform tasks other than what is being performed at present. Its vision includes:

- **a. Automating Tasks:** Machine learning can automatically perform tasks using algorithms. However, making them more efficient and dependable is essential to use them in the long run. Let us consider the automatic vehicles; though they are proposed, they still need to be allowed to be used in a complete run as this requires much more training and

testing.

- **b. Adapt and Improving:** ML has to adapt to the latest information because generating older results might make the user feel misguided and lose trust in the model. So, the model has to be trained and improved according to the latest data to be dependable and trusted by users.
- **c. Enhancing the Decision-Making:** It can make predictions and decisions. Improving the model to the latest trends will also make it more robust. Thus, we can use it more accurately for advanced tasks like Disease diagnosis.
- **d. Natural Language Processing:** ML is intensely used in NLP. It can understand human text and speech, an essential requirement for most chatbots, voice assistants, etc. So, enhancing it to newer levels, like making it more interactive and easier to use, will make it more suitable for all age groups.
- **e. Innovation and Research:** Machine learning can analyze more extensive datasets. So, it reduces the burden of scientists and helps them focus on the original innovation instead of analyzing data.
- **f. Environmental and Sustainability Applications:** It is also capable of fetching out the environmental challenges and helping in finding better solutions. It can analyze a large number of problems that are contributing to environmental damage. So, we can fix those problems to protect the environment and sustainability.
- **g. Ethical Thinking:** ML has emerged as an essential technology. We can now make use of it make use of as a trustable model. A model must be unbiased and transparent to say it is better. So, later, we can combine ML with AI to get better results.
- **h. Personalization:** Machine Learning can learn from the data and interactions, making it more powerful. So, using this, it will sense the user interactions on various interests and make a list of preferences, and from then on, it will recommend the user based on his interests. However, the model should also focus on the things that should not stop the user from accessing all the content.Thus, these are the Missions and visions of Machine Learning. These must be carried out to create a world with advanced user experiences, accurate decision-making, and solve complex problems in different fields (Moye, 2019).

Challenges Of Machine Learning

Though ML has rapidly developed, this field has a few challenges (Holzinger et al., 2018). These challenges must be overcome to make ML stand out as a better technology. Here are some of the critical challenges in the ML:

- **a. Data Quality and Quantity:** High-quality data is crucial for better results. In most advanced topics, we might need more accurate and high-quality data, which results in less accurate results. Data preprocessing is vital because it reduces disturbance, noise, and inaccurate data. Thus, ensuring more quality outcomes.
- **b. Overfitting and Underfitting:** This problem is faced when we get excess data or less data than we require for the model. Overfitting is when the model is trained well with the data but fails to produce new or prediction-based data. Underfitting occurs when the model is straightforward but still shows poor/less performance.
- **c. Model Selection:** Even after having many models, it is essential to select the right and most suitable model according to our task requirements. When we choose a suitable model, it might lead to positive results.
- **d. Bias and Fairness:** Training the model with unbiased datasets is essential to ensure the model is safe. Otherwise, giving ambiguous data might result in unfairness or discrimination, resulting in privacy and unsafe issues for the user.
- **e. Continuous Learning:** Another essential challenge occurs while training the model because the data continuously develops and changes happen. So, ensuring the model is trained continuously to get better results is essential.
- **f. Scalability:** As said above, the machine learning models have to quickly adapt to extensive set data and real-time applications, which is difficult as it needs continuous learning.
- **g. Evaluation Metrics:** Selecting the most suitable evaluation metrics is essential. When we choose the right-suited metrics for the task, it leads to interpretation.
- **h. Security:** Providing security to the users is crucial for any application or model. If the model is not designed using solid algorithms, it might be vulnerable to attacks. So, maintaining security is a crucial challenge.
- **i. Hyperparameter Tuning:** ML always requires hyperparameters, which must be set correctly. However, finding the correct hyperparameters takes time and effort. This turns out to be a big challenge.
- **j. Concept Drift:** It is a phenomenon where the statistical properties of the target variables in machine learning keep changing. So, to keep all of them up to date is a challenging thing. However, the main problem occurs when we do detection, adaptability, mitigation, and labeling.
- **k. Cost and Resource Management:** Managing the cost is complicated in ML projects because it requires lots of cloud storage for data storage. So, managing the cost and available resources is very important to reduce the cost.
- **l. Collaborative Learning:** Collaborative learning in ML refers to protecting the privacy of the developed model. It lets the multiple parties to share the data without letting others know this. It ensures the model's efficiency and also makes the model lot secure.
- **m. Cultural and Organizational Adoption:** This refers to ML and AI's various challenges and processes. It requires lots of support from leaders to get it done. Thus, Cultural and Organizational adoption is mandatory for the smooth going of the tasks.
- **n. Reproducibility and Documentation:** This is another essential aspect of ML for ensuring the transparency and accountability of the model. So, maintaining the kind of data used in the language is vital for further usage. Thus, documentation is essential.Thus, these are the various challenges that occur in Machine Learning. So, managing all the above requirements is very important to overcome these challenges.

Roles Of Machine Learning

Machine Learning (ML) is a subbranch of artificial intelligence that has gained much importance recently. Its ability to enable systems to learn and adapt to various environments without any explicit programming has made it develop a wide range of applications. Since it does not require explicit programming, it can provide many features and capabilities, making it very popular. Now, we will look at the various roles that Machine Learning plays in our modern world (Waqas et al., 2022).

- **a. Data Analysis and Insights:** Machine Learning plays a crucial role in data analysis. It is capable of processing larger datasets and finding patterns and valuable information that might not be possible to do using traditional data analysis methods. ML algorithms can identify correlations, anomalies, etc., essential for decision-making in various fields like finance, healthcare, and marketing.
- **b. Predictive Modelling:** One of the primary goals of Machine Learning is to make correct predictions. ML algorithms are capable of making the right predictions based on historical data. For example, in the financial sector, these models can predict stocks. ML can predict diseases in healthcare, and in e-commerce, it can predict customer needs based on reviews.
- **c. Natural Language Processing (NLP):** Machine Learning algorithms are key for Natural Language Processing (NLP), a field that focuses on making computers understand and generate human languages. NLP is incorporated into chatbots, virtual assistants, and language translation services to make the interaction between humans and computers much more accessible.
- **d. Image and Speech Recognition:** Machine Learning has reshaped image and speech recognition technology. ML models can now describe objects from the given input data, allowing applications like facial recognition and medical image analysis. In speech recognition, ML enables voice-activated assistants and various transcription services.
- **e. Recommendation Systems:** Machine Learning boosts recommendation systems, which have become extremely common in online platforms. These systems can analyze user behavior and preferences to create personalized recommendations, improving user experiences in e-commerce, online streaming services, and social media platforms.
- **f. Healthcare:** In healthcare, Machine Learning helps in disease diagnosis, drug discoveries, and treatment. ML models are also used to analyze medical images to detect disease in early stages, identify suitable drugs for patients, and help doctors make more accurate decisions.
- **g. Autonomous Systems:** Machine Learning is an integral part of developing autonomous systems. Self-driving cars, drones, and robots use ML algorithms, which further help in navigation and make real-time decisions based on training and sensor data. This technology has also got the potential in transportation and logistics.
- **h. Anomaly Detection:** Machine Learning is widely used for anomaly detection. ML models can identify unusual patterns in domains, including network security and cyber threats. Manufacturing (predicting equipment failures), and finance (to detect fraud transactions).
- **i. Environment Conservation:** Machine Learning helps in the conservation of the environment. It can grab data from sensors and satellites, which further helps track and protect endangered species, observe climate changes, and predict natural disasters, contributing to our planet's conservation.
- **j. Personalization:** Machine Learning plays a crucial role in personalization. Online platforms use ML algorithms to deliver content, products, and services to each user based on preferences, which enhances user satisfaction.
- **k. Quality Control in Manufacturing:** Machine Learning plays an essential role in quality control during manufacturing processes. It can identify various problems in real-time by analyzing the sensor data. Thus, it produces the lines, ensuring that only high-quality products are released.
- **l. Dynamic Pricing in E-commerce:** Machine Learning is capable of dynamic pricing strategies in e-commerce. It continuously analyses market conditions, competitor prices, and customer behavior to adjust prices in real time, increasing profit.
- **m. Sentiment Analysis in social media:** Machine Learning is also designed for sentiment analysis on social media and other platforms. It can automatically analyze and categorize public opinions and emotions expressed in posts and comments, providing valuable data for businesses.

Machine learning (ML) has become a part of our world, which impacts various fields and industries. Its knowledge in data analysis, predictive analytics, natural language processing (NLP), image and speech recognition, recommendation systems, healthcare, autonomous systems, anomaly detection, environmental protection, personalization, manufacturing quality control, impact analysis, and social media and many more have changed the way we work in different areas. Machine learning can make valuable information from large data sets, make accurate predictions, and enable human-machine interactions, making it a trustworthy and dependable technology.

Issues In Machine Learning: Machine learning is a powerful tool, but it does face some issues. These issues are classified into three types. They are Transparency issues, Security issues, and scalability issues. Overcoming these issues will further help us to resolve issues and make ML lot dependable.

Transparency Issues in Machine Learning: Transparency Issues are one of the issues in ML (Pynadath et al., 2018). These deal with the awareness of the people who use Machine learning. It refers to how much Machine Learning is open to people for use or practical implementation. Some of the transparency issues are given below.

- **a. Black Box Models:** The name is Black Box, which means that the box or the room we are working in is dark because of its black color. So, we will be unable to see what is inside and how it works. Similarly, ML is being improved by

researchers and scientists to reduce ambiguity and increase understandability.

- **b. Interpretability and Explainability:** Interpretability means the ability to understand, and Explainability means the ability to explain a concept. In Machine Learning, it may be very difficult to explain and understand some algorithms which are very complex. Models like Deep Neural Networks are a few of those cases. Their decision-making is complex to demonstrate.
- **c. Fair and Bias:** Machine Learning makes decisions based on the data it receives and the training data set. The outcomes are biased, based on the data set and data we provide, which might affect the Fairness towards some aspects of situations which is not preferred for a model.
- **d. Data Compliance Regulations:** General Data Protection Regulation (GDPR) issued some rules to avoid and decrease the discriminatory and unfair results of a model that is acquired from a data set or another data model. Its main objective is to increase Fairness and the outcomes of a data model.
- **e. Privacy and Data Protection:** Any user or developer, including the data models, works on the data that has to be protected. Machine Learning must prioritize protecting data from unwanted data access and unwanted attacks on databases.

Security Issues in Machine Learning: Any real-world application must be provided with basic security (Xue et al., 2020). Security is the central aspect of working in the world. Security means being safe and well protected from any unpleasant and unwanted access or theft of the data or resources. Implementation of security and privacy is crucial and also a tricky job. Some of the security issues are given below.

- **a. Adversarial Attacks:** It is a process in which the data that is inputted into the data training model is modified in such a way that the outputs may raise conflicts or they may also increase vulnerabilities of the model.
- **b. Data Poisoning:** It is the same as an Adversarial Attack. However, instead of inputting misleading data, the data model is compromised by poisoning the data set during or before training.
- **c. Model Stealing:** In this process, the crucial information of the data training model is attacked by its essential components due to its weaknesses and vulnerabilities. It is achieved either by attacking the weak points or by reverse engineering.
- **d. Reverse Engineering:** Reverse Engineering is a process in which the essence of a full-fledged model is obtained by analyzing from its outer components but not from its inner logic. The information is obtained with knowledge of its infrastructure.
- **e. Robust Models:** The built Machine Learning Models must be robust and unexposed to stand firm against attacks like Adversarial Attacks, Data Poisoning, etc.
- **f. Privacy-Preserved Machine Learning:** Machine Learning Models must also respect the privacy of the users and developers. There are emerging ideas and implementations like multi-party computations and collaborative working environments. Here, the model should only expose raw data and crucial information with precautionary measures.

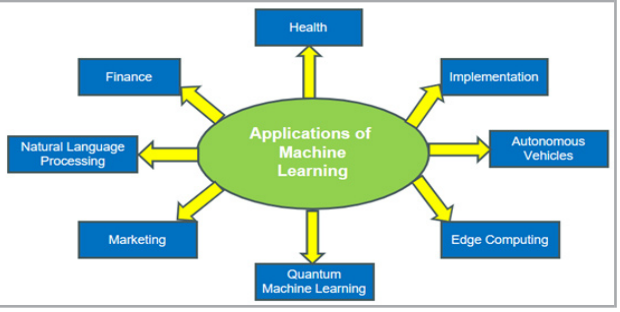
Scalability Issues in Machine Learning: Scalability is the ability of the model to increase and decrease its capability of serving multiple requests at a time (Mohammed et al., 2018). Whenever there is an increase in demand, the model should be able to scale itself by increasing its capacity. And it should be able to decrease the capacity when there is no/less demand. Increasing the capacity when needed will help the model serve multiple requests in high demand. It improves the trust and reliability of users on the model. Moreover, decreasing the capacity when there is no demand helps the model to maintain the resources efficiently and decrease the unnecessary load on the system. Machine Learning depends on training with larger data sets and producing predictions using complex situations and algorithms.

- **a. Magnitude of Data:** Since the data being used for Machine Learning is very large, it keeps growing daily. So, it would be difficult when there is an unexpected rise in the data used to train the model.
- **b. Resources for Computation:** When dealing with larger and more complex models, we come across concepts like Deep Learning that require physical hardware resources such as Graphical Processing Unit (GPU) and Tensor Processing Unit (TPU). So, when there is an increase in the amount of data being used, the hardware must be capable of handling such extensive data and prove necessary resources.
- **c. Real-Time Processing:** Machine Learning models are explicitly made to train on data sets and then produce predictions by performing complex calculations and analysis. So, in case of any increase in the size of the data set, then the calculations should be repeated to gain accurate results. If the size of the data set is increased at a high rate, then it might take more time to produce results.
- **d. Model Deployment:** When multiple devices and users require the data model to get deployed, there is much work and care to do. Increasing the number of use cases will require the deployment of multiple models. If the model is too large and complex to handle, it might become more accessible to finish the job accurately.
- **e. Efficiency of Algorithm:** When there are multiple places to deploy the model, the algorithm implemented in the model should be solid and efficient to handle large requests, users, and data.

Thus, these are vital issues of Machine Learning. Overcoming these problems will make the model much more efficient than now.

Applications Of Machine Learning: Machine Learning is a subject of artificial intelligence (AI) that allows computers to look at data and improve their performance on duties without being explicitly programmed. Over the years, the demand for ML has increased in various industries. This article gives us ML applications in healthcare, finance, advertising and marketing, autonomous vehicles, and natural language processing as shown in figure 1 (Sarker, 2021; Dhall et al., 2020).

Figure 1: Applications of ML



a. Healthcare: Machine Learning has rebuilt the whole healthcare system with the help of enhancing evaluation, remedy, and affected individual care. Some essential packages include:

- **Diagnosis:** ML algorithms can look at scientific records, images, and genetic data to assist in the early analysis of illnesses, which includes most cancers, diabetes, and coronary heart situations.
- **Medicine Discovery:** ML has fastened drug discovery by predicting the requirements of drug candidates, improving molecular interactions, and figuring out novel drug goals.
- **Predictive Analytics:** Healthcare companies use ML to expect affected characteristic outcomes, optimize sanatorium operations, and decrease readmission charges.
- Personalized Care: ML enhances plans to character sufferers, considering their genetics, medical records, and their lifestyle.

b. Finance: In the financial industry, device studying is included for diverse duties, including:

- **Trading:** ML models analyze market statistics to predict buying and selling stocks; it is being trained with more data to expand performance and profits.
- **Management:** Banks and economic establishments use ML for credit score rating hazard assessment, fraud detection, and portfolio manipulation.
- **Service:** Chatbots and digital assistants are a few of the most widely used services of ML. It enhances customer service by addressing inquiries and facilitating transactions.
- **Analysis:** ML is used to make news and social media analysis. Thus, it accesses sentiment, emotions, and many other positive results.
- **Marketing:** ML has also made its mark in advertising strategies. Thus, it also supports various businesses.
- **Customer Segmentation:** ML fashions organization clients primarily based on behavior and alternatives, permitting targeted advertising campaigns.
- **Recommendation Systems:** E-trade systems use ML to suggest products to customers, boosting income.
- **Ad Targeting:** ML algorithms optimize ad placements, growing clicks on on-via charges, and ad effectiveness.
- **Churn Prediction:** Companies count on purchasers to churn the usage of ML, allowing them to take proactive retention measures.
- **Autonomous Vehicles:** Machine learning plays a crucial role in automatic vehicles for their functioning.
- **Detection:** ML agents understand the people, vehicles, and road surroundings for safe navigation.
- **Planning a route:** Algorithms in ML are meant to be for planning correct routes based on real-time online visiting websites.
- **Maintenance:** ML is useful for early prediction of car renovation needs, reducing problems, and improving safety.

c. Natural Language Processing (NLP): NLP, a subset of ML, has made intense progress in understanding and producing human language. NLP is a subfield of ML that makes a specialist in the interplay between computers and human language. It has several programs beyond what becomes noted in advance. Its applications are:

- **Language Generation:** NLP fashions like GPT-three can generate human-like textual content; this is applied in content advent, chatbots, and even innovative writing.
- **Language Translation:** Services like Google Translate use NLP to offer actual-time translations among languages.
- **Chatbots and Virtual Assistants:** NLP-powered chatbots and digital assistants understand and respond to natural language queries.
- **Sentiment Analysis:** Companies analyze social media and patron opinions to gauge public sentiment.
- **Speech Recognition:** NLP permits voice assistants like Siri and Alexa to understand and respond to spoken language, enhancing character stories in numerous devices and programs.
- **Text Summarization:** ML fashions can summarize lengthy texts or articles, making it more straightforward for customers to digest statistics rapidly, which is treasured in records aggregation and studies.

d. Challenges and Ethical Considerations: Despite its considerable ability, system studying additionally gives worrying conditions and moral troubles. These encompass bias in algorithms, records privacy worries, and the capacity for assignment displacement.

e. Future Trends and Opportunities: The destiny of gadget studying holds promise, with possibilities for growth in areas like reinforcement learning, quantum computing, and explainable AI. Continued research and development are crucial to help with complex conditions and maximize the benefits of ML.

These are a few of the many applications of machine learning. In all the above fields, ML influences tasks directly or indirectly because the users depend on these agents as they complete the work very fast and efficiently.

Advantages & Disadvantages of Machine Learning: Advantages:Machine Learning is an actual trump card when it

comes to Automating tasks with the help of AI; here are a few more advantages of machine learning (Khanzode & Sarode, 2020).

Advantages based on Machine Learning:

- **a. Real-Time Processing:** Let us consider a data set and you want to do some peculiar tasks from that data set. With machine learning, you can do that in real time; it works like magic, giving rapid responses and improvised suggestions in real-time, which will help boost productivity.
- **b. Personalization:** Imagine you have access to an image-based dataset for machine training, a text-based dataset, and a mathematical dataset. The good news is you can tailor your model to your liking. However, the choice of dataset for training and personalization should align with the user's specific interests and needs.
- **c. Scalability:** Suppose you have a large data set; it is possible to train it in machine learning. It is one of the most significant advantages of machine learning. Training a machine with a large data set will benefit because it can perform in any environment.
- **d. Data-based Decision-making:** Consider a machine that is well-trained with data regarding English grammar. When a situation is provided, it can make the right decision or changes based on the data it is trained on; if the data is of good quality, the chances of producing a good result are higher.
- **e. Uphill Improvement:** A machine learning model with more data will generally improve continuous improvement; it will only improve with more training of good data.
- **f. Predictions:** When an ML is based on one bunch of predictable data sets and mathematics, then that machine has attained the capability to predict. For example, if a machine is trained on a bunch of weather data, we can predict the future weather (mostly). Hence, this is one of the most essential advantages of machine learning.
- **g. Recognizing Patterns:** Let us consider a chess game as an example; the first step you take when the match starts are either the movement of the pawn or a knight. There are over 3000 openings, like Sicilian defense, French defense, Scandinavian defense, Italian game, Queen's gambit, King's gambit, etc. These are patterns that commonly occur with the starting move from both opponents in chess, and this trained machine can recognize what pattern it is, and based upon that, it can predict results or make moves if this machine itself is playing.
- **h. Cost Reduction:** A model that is a well-trained machine is significantly better in the manufacturing process than a human; a human can work a fixed amount of hours and need more money to maintain if a machine is trained to do human tasks such as packing boxes, the machine would be more cost-efficient and work 24/7 compared to a human.
- **i. Risk Analysis:** Analyzing the risk once or if we get into the problem is only possible. Let us consider that we want to analyze the risk of investing in a specific company; if an ML model is trained on the data of investments, it can analyze all sorts of risks involved. In this way, we can apply it to the medical scene, transport scene, etc.
- **j. Language translation:** We can train a machine when we have enough data; we can train a machine that responds in real-time and translates our language to another language; it is also capable of generating text-to-speech results, which helps hundreds of users to do their tasks.

Advantages of ML Based on particular domains:

- **a. Natural Language Processing:** An NLP is a domain where a model is required to understand the language of the person communicating with the machine. For example, a well-developed ML model in NLP can rearrange all the mail from the customer as good and bad reviews so that the organization can efficiently work on the bad ones and provide good feedback and solutions to the customer.
- **b. Autonomous Vehicles:** A machine would make mistakes like humans do. We can observe over 1000 accidents a day; most of these accidents happen due to human error. What if there is a model that is trained on all the traffic rules and patterns and predictions and the dos and don'ts? Thus, the term autonomous vehicles came into focus; we have already seen cars like Tesla, BMW, and Mercedes, which have inbuilt assisted autonomous steering where, on highways, the car can drive itself under the guidance of a human driver.
- **c. Health care:** ML is also trained with medical facts that are proven with evidence. It is beneficial to help the patients. If any personal bias is involved, it can lead to totally biased treatment instead of evidence-based treatments. This might become a severe backlash if the patient's health is affected negatively. So, there are several benefits to having an ML model in health care, like giving a free analysis of a patient's condition, and if the condition is terrible, referring to a doctor visit would be beneficial. If it is a common cold, the machine can suggest treatment options, etc.
- **d. Quality analysis:** When a large number of products are given to a machine with a trained data set, it could figure out the defective pieces; this will be especially useful in pharma manufacturing, where even the slightest mistake could have horrible consequences.
- **e. Agriculture:** This is a domain where weather prediction, soil analysis, and plant condition have to be measured to give accurate instructions to the farmer to take the necessary steps to get a good yield. Even this task can be done using ML algorithms.

Disadvantages: Disadvantages based on Machine Learning:

- **a. Dependent on the dataset:** When a machine is trained on a good-quality data set, it naturally tends to be on the good side, and the same thing is true in the opposite scenario; if a machine is trained on bad-quality data or biased data, it will not be helpful. In terms of analogy, training a machine can be a double-edged sword (Khanzode & Sarode, 2020).
- **b. Storage Safety:** We all know that if a company trains a large-scale ML agent, an enormous data set lies somewhere in a data center. One day, if those data centers are attacked and bad actors gain access to the data set, it will lead to severe consequences. Personal data might be used for the wrong purposes, which causes a loss of user privacy.
- **c. Expensive:** Some ML models with large data sets require

a large amount of computational power, which can only be provided by a few organizations, hence reducing the power of machine learning too little.

- **d. Overfitting:** This is a case where an ML model is trained and tested in its environment. It is fast and responsive, but if a new condition or scenario is given out of its data set as a question, we can see some struggle in its answering capabilities.
- **e. Ethical Concerns:** If the ML model is trained with only hateful content or made for biased purposes and is implemented in robots or hardware, it turns out to be very dangerous. Giving our video captures from recordings or footage to a machine learning model is ethical. So, it can learn ethical constraints in developing a machine learning model.
- **f. Complexity of a Model:** When working with large amounts of data, keeping track of what kind of task is being implemented is essential. It will be complicated if new employees take on the journey of developing an already existing model since keeping track of almost all functions is very difficult, increasing the model's complexity.

Disadvantage Of ML Based on particular domains:

- **a. Legal Domain:** Let us consider a document regarding the case given to the model to verify and generate unbiased judgment; if the model is not trained with enough data required for accurate results, it will surely fail. So, providing and training the model in the best possible way is essential.
- **b. Drug Manufacturing:** The daily routine is going on, and the machines work as usual. Suddenly, a sensor fails or faults, allowing the faulty drug to go by the quality check. If a patient consumes this faulty drug, their health is at risk; these mistakes are hazardous in drug manufacturing.
- **c. Health care:** when a model is trained under only a particular demographic, then that model might produce a wrong judgment, leading to a potential misdiagnosis, which can confuse healthcare workers and even risk the patient's health.
- **d. Autonomous Transport:** we know autonomous transportation is much safer than a human being, but with all the good things, there are some potential harmful elements. If the model is not well updated with the routes and geography, it will probably make a mistake that might risk the lives of passengers.
- **e. Content Moderation:** we are well aware of the recommendations Tab where we will get our daily recommendations; what if an ML model is only trained with single users' data based on a short period of content consumption? It will lead to a content loop where the consumer will tend to get the same repetitive content. Hence, the consumer will not be able to see the available diverse content.

Thus, these are the various advantages and disadvantages of Machine learning. As ML is a fast-growing language, most cons would be identified and corrected. However, with ML's advantages, users trust this advanced technology.

Future Scope Of Machine Learning:

The future of Machine learning will be much more advanced than that of now because it has a smaller number of limitations and is also very effective on most of the tasks (Ghosh & Dasgupta, 2022).

- **a. Safe Healthcare:** Machine learning can profoundly contribute to healthcare areas where manual tasks cannot be performed. Then we will be using these ML and AI-based agents which are going to replace the tasks of humans (doctors in this case)
- **b. Fraud Prevention:** All financial institutions are heading towards ML to let their tasks be done with enhanced security. It develops the trust of users in those organizations. It restricts malpractices from being happening.
- **c. Natural Language Processing (NLP):** This a subfield of artificial intelligence where a machine can generate human-based outputs. To achieve this, models must be trained on large amounts of data. Machine learning will play a significant role in enabling applications such as sentiment analysis models, chatbots, language translation models, etc.
- **d. Job Empowerment:** ML has rapidly grown in various parts of the globe. Thus, it has also produced various job opportunities for the people. So, the ML can produce jobs and complete tasks efficiently. In the future, it is going to get much better when it is enhanced with AI.
- **e. Recognizing Patterns:** Recognizing the patterns is very important for the model. Let us consider a chess game. The first step you take when the match starts is either the movement of the pawn or a knight; there are several different openings in itself. These patterns commonly occur with the starting move from both opponents in chess. These trained machines can recognize what pattern it is and, based on that, can predict results or do moves if this machine is playing.
- **f. Automobile field:** ML is reshaping the concept of driving. As it is being trained in such a way that the car is becoming automated. However, this technology is being implemented now; these must be improved and tested in various environments.

Thus, these are some of the best examples that showcase the importance of ML in the present day and also what field it will focus on in the future.

CONCLUSION

Machine learning has slowly grown more extensive and more significant. Its ability to analyze massive datasets and patterns has reshaped many fields like healthcare, transportation, and various industries. ML has found many new things during this process, like various challenges to adapting to new environments. The most significant success behind ML is its quality and relevance in data analysis. With reliable data, it is easier to produce accurate results predictions. So, in machine learning, the data has a crucial role. Along with the data, its algorithms are designed so that they are secure and robust. The results are always unbiased because they have trained models with real-time data, bringing us better

results. The model is also trained so that it continuously evolves according to the latest conditions and updates.

This machine will play a key role everywhere in the future due to its high performance and very few limitations. Thus, making it more trained and powerful will make it an outstanding technology to depend on for better output generation. Finally, machine learning is not just a technology but a transformative force. Its ability to make decisions according to the environment without bias makes it more dependable for users for various tasks. Joining the ML with advanced technologies like AI will make it more robust and secure.

Funding: This research did not receive any specific grant from funding agencies in the public.

Conflict of Interests: The authors declare no conflict of interest.

Data Availability Statement: Data can be available on request.

REFERENCES

Baştanlar, Y. and Özuysal, M. (2014). Introduction to machine learning. miRNomics: MicroRNA biology and computational analysis, pp.105-128. https://doi.org/10.1007/978-1-62703-748-8_7

Badillo, S., Banfai, B., Birzele, F., Davydov, I.I., Hutchinson, L., Kam-Thong, T., Siebourg-Polster, J., Steiert, B. and Zhang, J.D. (2020). An introduction to machine learning. Clinical pharmacology & therapeutics, 107(4), pp.871-885. https://doi.org/10.1002/cpt.1796

Dhall, D., Kaur, R. and Juneja, M. (2020). Machine learning: a review of the algorithms and its applications. Proceedings of ICRIC 2019: Recent Innovations in Computing, pp.47-63. https://doi.org/10.1007/978-3-030-29407-6_5

Dreossi, T., Donzé, A. and Seshia, S.A. (2019). Compositional falsification of cyber-physical systems with machine learning components. Journal of Automated Reasoning, 63, pp.1031-1053. https://doi.org/10.1007/s10817-018-09509-5

Ghosh, S. and Dasgupta, R. (2022). The Future of Machine Learning. In Machine Learning in Biological Sciences: Updates and Future Prospects (pp. 333-336). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-16-8881-2_37

Hassanien, A.E., Chang, K.C. and Mincong, T. eds. (2021). Advanced Machine Learning Technologies and Applications: Proceedings of AMLTA 2021 (Vol. 1339). Springer Nature.

Holzinger, A., Kieseberg, P., Weippl, E. and Tjoa, A.M. (2018). Current advances, trends and challenges of machine learning and knowledge extraction: from machine learning to explainable AI. In Machine Learning and Knowledge Extraction: Second IFIP TC 5, TC 8/WG 8.4, 8.9, TC 12/WG 12.9 International Cross-Domain Conference, CD-MAKE 2018, Hamburg, Germany, August 27–30, 2018, Proceedings 2 (pp. 1-8). Springer International Publishing. https://doi.org/10.1007/978-3-319-99740-7_1

Jain, A., Patel, H., Nagalapatti, L., Gupta, N., Mehta, S., Guttula, S., Mujumdar, S., Afzal, S., Sharma Mittal, R. and Munigala, V. (2020). Overview and importance of data quality for machine learning tasks. In Proceedings of the 26th ACM SIGKDD international conference on knowledge discovery & data mining (pp. 3561-3562). https://doi.org/10.1145/3394486.3406477

Khanzode, K.C.A. and Sarode, R.D. (2020). Advantages and disadvantages of artificial intelligence and machine learning: A literature review. International Journal of Library & Information Science (IJLIS), 9(1), p.3.

Kubat, M. and Kubat, J.A. (2017). An introduction to machine learning (Vol. 2, pp. 321-329). Cham, Switzerland: Springer International Publishing. https://link.springer.com/book/10.1007/978-3-319-63913-0

Mohammed, R.A., Wong, K.W., Shiratuddin, M.F. and Wang, X. (2018). Scalable machine learning techniques for highly imbalanced credit card fraud detection: a comparative study. In PRICAI 2018: Trends in Artificial Intelligence: 15th Pacific Rim International Conference on Artificial Intelligence, Nanjing, China, August 28–31, 2018, Proceedings, Part II 15 (pp. 237-246). Springer International Publishing. https://doi.org/10.1007/978-3-319-97310-4_27

Moye, J.N. (2019). Creating Shared Mission, Vision, and Values. In A Machine Learning, Artificial Intelligence Approach to Institutional Effectiveness in Higher Education (pp. 15-29). Emerald Publishing Limited. https://doi.org/10.1108/978-1-78973-899-520191002

Naeini, E.Z. and Prindle, K. (2018). Machine learning and learning from machines. The Leading Edge, 37(12), pp.886-893. https://doi.org/10.1190/tle37120886.1

Nguyen, G., Dlugolinsky, S., Bobák, M., Tran, V., López García, Á., Heredia, I., Malík, P. and Hluchý, L. (2019). Machine learning and deep learning frameworks and libraries for large-scale data mining: a survey. Artificial Intelligence Review, 52, pp.77-124. https://doi.org/10.1007/s10462-018-09679-z

Pynadath, D.V., Barnes, M.J., Wang, N. and Chen, J.Y. (2018). Transparency communication for machine learning in human-automation interaction. Human and Machine Learning: Visible, Explainable, Trustworthy and Transparent, pp.75-90. https://doi.org/10.1007/978-3-319-90403-0_5

Sarker, I.H. (2021). Machine learning: Algorithms, real-world applications and research directions. SN computer science, 2(3), p.160. https://doi.org/10.1007/s42979-021-00592-x

Senders, J.T., Zaki, M.M., Karhade, A.V., Chang, B., Gormley, W.B., Broekman, M.L., Smith, T.R. and Arnaout, O. (2018). An introduction and overview of machine learning in neurosurgical care. Acta neurochirurgica, 160, pp.29-38. https://doi.org/10.1007/s00701-017-3385-8

Waqas, M., Tu, S., Halim, Z., Rehman, S.U., Abbas, G. and Abbas, Z.H. (2022). The role of artificial intelligence and machine learning in wireless networks security: Principle, practice and challenges. Artificial Intelligence Review, 55(7), pp.5215-5261. https://doi.org/10.1007/s10462-022-10143-2

Xue, M., Yuan, C., Wu, H., Zhang, Y. and Liu, W. (2020). Machine learning security: Threats, countermeasures, and evaluations. IEEE Access, 8, pp.74720-74742. DOI: 10.1109/ACCESS.2020.2987435