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Machine Learning Techniques: Applications and Challenges

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Abstract - Machine learning is a cutting edge technology based on the idea of how a system can learn from already existing data and work with minimal human supervision. Machine learning differs from existing computer systems in that it does not know the logic in advance and it discovers the logic based on the data and then applies the learned login on new data. Thus machine learning has a huge scope in various fields such as healthcare, finance, education, e-commerce, railways, entertainment, telecommunication etc. Machine learning algorithms can be effectively used for disease prediction, disease detection, providing personalized healthcare, etc. This paper introduces the systematic review of machine learning techniques, applications and their challenges.

***Key Words*:** optics, photonics, light, lasers, stencils, journals

1. Introduction

Machine learning is a branch of artificial intelligence (AI) that trains computers to think like humans by learning from past data and already existing data. It uses minimal human intervention to analyze data and identify trends and predict the outcome of new data by looking at patterns or logic of historical data. Machine learning has a wide impact on society, including production lines, healthcare, education, transportation, e-commerce, telecommunications, and food [1]. Machine learning has left its impact in every field over time, due to which it has been quite popular and in the coming time you will find machine learning being used in every field such as agriculture, health care, finance, entertainment etc. The main goal of machine learning is to give computers the ability to collect data, understand it, and make decisions based on past and current results. For prediction and analysis tasks on historical data, machine learning is classified into three types including supervised, unsupervised, and semi-supervised learning [2].

ML models are applied to data due to their ability to solve a variety of problems, ranging from problems that can be solved through traditional statistical and scientific techniques to complex problems that require extensive analysis. In this regard, ML allows problems to be solved faster and better than traditional techniques. Therefore, ML-based techniques are used to predict the results of new data, make predictions and classifications, or help people in the decision-making process. Any problem can be solved by following the machine learning process. In supervised learning, the result is available for each data. If the result is a continuous number, then the problem is regression and if the result is categorical, then the problem is classification. No result is available for unsupervised problems while in semi-supervised learning the result for some data is available.

The protuberant objective of this research work is to exhibit a survey and state-of-the-art information related to the Machine Learning technologies and highlight the applications of the Machine Learning technologies into the various domains and challenges related to the machine learning. The remainder of the research paper is organized as follows. Related research in machine learning domain is illustrated in Section 2. Sections 3 briefly describes applications of machine learning. The challenges in the field of machine learning are given in section 4. Finally, the conclusion and future work is given in Section 5.

2. Related Work

ML has many branches, and each branch can deal with different learning tasks. However, ML learning has different framework types. The ML approach provides a solution such as random forest (RF). The ensemble of the decision tree is the random forest [3]. The study [4] examines various approaches that might be utilized to enhance and refine the quality of the chosen heuristics as well as the general quality of machine learning and deep learning models in order to boost the compiler's efficiency. The authors [5] investigated current techniques in machine learning, focusing on validation in the real world, and dealing with data set variability. A survey on machine learning approaches and its techniques have been summarized in [6]. The review paper [7] provides a comprehensive overview of the existing ethical frameworks that guide ML in healthcare and evaluates their adequacy in ad-dressing ethical challenges.

3. Applications of Machine Learning

The importance of machine learning is playing a very important role in every sector and there is no sector which is untouched by it. Be it agriculture sector, health care, finance, education, industry, defence, computer vision, cyber security or any other. In this section, some of the major applications of machine learning are comparatively explained so that the usefulness and impact of machine learning in these areas can be studied.

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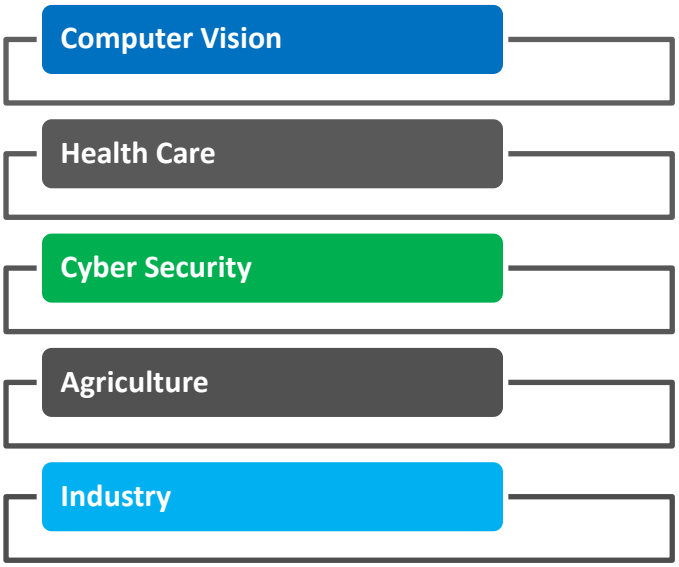

Fig- 1: Applications of Machine Learning

a. Computer Vision

The goal of machine learning and computer vision is to give computers the ability to collect data, understand it, and make decisions based on past and current results [8]. Computer vision is important for the Internet of Things, Industrial Internet of Things, and human cognitive interfaces. Computer vision and machine learning techniques are used to identify and track complex human actions in multimedia streams. There are many applications of machine learning in computer vision. For example, biological sciences include segmentation, feature extraction, pattern matching, visual model optimization, form representation, surface reconstruction, and modeling. Computer vision evaluates data from images detecting cars and pedestrians using machine learning, uses images to analyze remote sensing data for geographic information systems, automatically diagnoses defects in railroad ties, identifies different varieties of mango fruits based on shape characteristics, and extracts graphical and textual information from document images [9].

b. Health care

The combination of machine learning (ML) and healthcare technologies is nothing short of revolutionary as we are now witnessing an era where computational algorithms can analyze complex medical data and diagnose diseases based on that data, providing transformative applications ranging from improved diagnostic accuracy to automated monitoring of a patient's vital organs. In doing so, these technologies serve to enhance the quality of medical care as well as increase the efficiency of healthcare systems, making the job of a physician much easier [10].

The potential of ML models for healthcare applications is also benefiting from advancements in co-existing technologies such as cloud/edge computing, mobile communications, and big data technology [11]. With these technologies, ML is able to generate highly accurate predictive results and can facilitate human-centric intelligent solutions [12]. With other benefits such as enabling remote healthcare services for rural and low-income areas, these technologies can play a vital role in reviving the healthcare industry.

c. Cyber Security

ML techniques are playing a vital role in many cybersecurity applications for early detection and prediction of various attacks such as spam classification, fraud detection, malware detection, phishing, darkweb or deepweb sites, and intrusion detection. ML techniques can overcome the shortage of required personnel with expertise in these specific cybercrime detection techniques. Moreover, robust approaches are needed to detect and respond to new generation (automated and evolutionary) cyberattacks. Machine learning is one of the potential solutions to act quickly against such attacks because machine learning can learn from experiences and respond to new attacks in time [13].

ML-based techniques perform better than traditional signature-based systems because even a slight change in the attack pattern can easily bypass signature-based IDS. Because ML-based systems learn from traffic behavior, they can easily detect attack types and prepare themselves for new attacks. Moreover, the CPU load ranges from low to medium in ML-based systems as they do not analyze all the signatures in the database. ML-based systems also perform better in terms of accuracy and speed when capturing and uncovering complex properties of attack behavior.

d. Agriculture

With the ongoing data tsunami impacting data-driven businesses, the fusion of smart farming and precision agriculture emerges as a beacon of innovation. ML algorithms, analyzing historical and real-time environmental data, soil conditioning, predicts suitable crop for maximum yields, detect diseases, and optimize irrigation in smart farming, facilitating informed decision-making [14].

Precision agriculture benefits from autonomous vehicles and drones, driven by ML, ensuring precision in planting, harvesting, and crop monitoring. Resource efficiency increases as ML optimizes energy consumption, manages fertilizer application, and promotes climate resilient practices.

e. Industry

With the advent of the fourth industrial revolution, commonly known as Industry 4.0 (I4.0), the employment of CPS has become widely spread as a source of automation and information sharing. Leveraging the capacities of integration provided by the CPS, the concept of smart manufacturing has emerged, representing a fully integrated approach to the manufacturing processes. This integration has been made feasible through the application of key enabling technologies, such as AI, cloud computing, big data, advanced analytics, and IoT [15].

4. Challenges in Machine Learning

The capabilities of ML algorithms to process and analyze large, complex datasets offer new dimensions that are revolutionizing the world. Nevertheless, the machine learning domain has a range of ethical considerations and challenges that are increasingly gaining attention within computer science communities. Data privacy emerges as one of the most urgent ethical considerations. Healthcare databases often contain sensitive information, ranging from patient demographics to their medical histories [16]. The depth and breadth of data used in training machine learning models are extensive, amplifying the risks associated with any potential data breach or misuse.

Beyond the critical issue of data privacy is the ethical challenge of algorithmic fairness and bias. Early implementations have shown that machine learning algorithms, if trained on biased or unrepresentative data, can lead to discriminatory or unequal healthcare outcomes. In the worst cases, these algorithms might exacerbate existing healthcare disparities by misclassifying certain demographic groups or failing to accurately predict medical outcomes [17]. As machine learning algorithms become more capable of decoding and interpreting this data, questions about consent, privacy, and potential misuse become increasingly pressing [18]. Data quality is a recurring issue, with noisy, incomplete, and inaccurate data undermining the accuracy of classification and overall results. Achieving high-quality data is essential for the success of ML models, necessitating a meticulous approach to data preparation.

Another major challenge in the field of machine learning is Overfitting occurs when a model captures noise and inaccuracies from a large dataset, adversely affecting its performance. This can be mitigated by employing linear and parametric algorithms, increasing training data, or reducing model complexity. Conversely, underfitting arises from a model being too simple for the data, resulting in incomplete and inaccurate predictions. Methods to address underfitting include increasing model complexity, using better features, and adjusting constraints.

5. Conclusion

Machine learning is an embryonic mechanism of computer science today, whose usefulness is increasing day by day in every field related to it and no field has been able to keep itself away from its applications. As their popularity increases, their applications have been also applied in many domains. This paper represents the overview of the machine learning as well as their application in various domains where it can be implemented to enhance their capability. As their usage is broaden, there are many challenges also associated with it. We have given a systematic overview of the machine learning techniques as well as their applications and associated challenges with it.

REFERENCES

1. S. Sah, ‘‘Machine learning: A review of learning types,’’ Jul. 2020, doi: 10.20944/preprints202007.0230.v1.
2. L. Cheng and T. Yu, ‘‘A new generation of AI: A review and perspective on machine learning technologies applied to smart energy and electric power systems,’’ Int. J. Energy Res., vol. 43, no. 6, pp. 1928–1973, 2019, doi: 10.1002/er.4333.
3. V. Arora, R. S. Leekha, K. Lee, and A. Kataria, ‘‘Facilitating user authorization from imbalanced data logs of credit cards using artificial intelligence,’’ Mobile Inf. Syst., vol. 2020, pp. 1–13, Oct. 2020, doi:10.1155/2020/8885269.
4. V. Duarte, S. Zuniga-Jara and S. Contreras, "Machine Learning and Marketing: A Systematic Literature Review," in IEEE Access, vol. 10, pp. 93273-93288, 2022, doi: 10.1109/ACCESS.2022.3202896.
5. L. B. Pandey, M. Sharma, R. Tiwari, R. S. Panda and P. Roy, "A Survey of Optimized Compiler Using Advanced Machine learning and Deep Learning Techniques," 2024 IEEE 6th International Conference on Cybernetics, Cognition and Machine Learning Applications (ICCCMLA), Hamburg, Germany, 2024, pp. 256-259.
6. T. R. N and R. Gupta, "A Survey on Machine Learning Approaches and Its Techniques:," 2020 IEEE International Students' Conference on Electrical,Electronics and Computer Science (SCEECS), Bhopal, India, 2020, pp. 1-6, doi: 10.1109/SCEECS48394.2020.190.
7. H. Javed, H. A. Muqeet, T. Javed, A. U. Rehman and R. Sadiq, "Ethical Frameworks for Machine Learning in Sensitive Healthcare Applications," in IEEE Access, vol. 12, pp. 16233-16254, 2024, doi: 10.1109/ACCESS.2023.3340884.
8. S. V. Mahadevkar et al., "A Review on Machine Learning Styles in Computer Vision—Techniques and Future Directions," in IEEE Access, vol. 10, pp. 107293-107329, 2022, doi: 10.1109/ACCESS.2022.3209825.
9. H. H. Martens, ‘‘Two notes on machine ’learning,’’’ Inf. Control, vol. 2, no. 4, pp. 364–379, 1959, doi: 10.1016/S0019-9958(59)80014-0.
10. L. Hadjidemetriou, L. Zacharia, E. Kyriakides, B. Azzopardi, S. Azzopardi, R. Mikalauskiene, S. Al-Agtash, M. Al-Hashem, A. Tsolakis, D. Ioannidis, and D. Tzovaras, ‘‘Design factors for developing a university campus microgrid,’’ in Proc. IEEE Int. Energy Conf. (ENERGYCON), Jun. 2018, pp. 1–6.
11. S. Latif, M. Asim, M. Usman, J. Qadir, and R. Rana, “Automating motion correction in multishot MRI using generative adversarial networks,” in Proc. 32nd Conf. Neural Inf. Process. Syst., 2018.
12. X.-W. Chen and X. Lin, “Big data deep learning: Challenges and perspectives,” IEEE Access, vol. 2, pp. 514–525, 2014.
13. K. Shaukat, S. Luo, V. Varadharajan, I. A. Hameed and M. Xu, "A Survey on Machine Learning

Techniques for Cyber Security in the Last Decade," in IEEE Access, vol. 8, pp. 222310-222354, 2020, doi: 10.1109/ACCESS.2020.3041951.

14. G. Mohyuddin, M. A. Khan, A. Haseeb, S. Mahpara, M. Waseem and A. M. Saleh, "Evaluation of Machine Learning Approaches for Precision Farming in Smart Agriculture System: A Comprehensive Review," in IEEE Access, vol. 12, pp. 60155-60184, 2024, doi: 10.1109/ACCESS.2024.3390581.
15. K. Zhou, T. Liu, and L. Zhou, “Industry 4.0: Towards future industrial opportunities and challenges,” in Proc. IEEE 12th Int. Conf. Fuzzy Syst. Knowl. Discov., 2015, pp. 2147–2152.
16. V. Machamint, K. Oureilidis, V. Venizelou, V. Efthymiou, and G. E. Georghiou, ‘‘Optimal energy storage sizing of a microgrid under different pricing schemes,’’ in Proc. IEEE 12th Int. Conf. Compat., Power Electron. Power Eng.
17. N. S. Savic, V. A. Katic, N. A. Katic, B. Dumnic, D. Milicevic, and Z. Corba, ‘‘Techno-economic and environmental analysis of a microgrid concept in the university campus,’’ in Proc. Int. Symp. Ind. Electron. (INDEL), Nov. 2018, pp. 1–6, doi: 10.1109/INDEL.2018.8637613.
18. V. Bertolotti, R. Procopio, A. Rosini, S. Bracco, F. Delfino, C. B. Soh, S. Cao, and F. Wei, ‘‘Energy management system for Pulau ubin islanded microgrid test-bed in Singapore,’’ in Proc. IEEE Int. Conf. Environ. Electr. Eng., IEEE Ind. Commercial Power Syst. Eur. (EEEIC/I&CPS Europe), Singapore, Jun. 2020, pp. 1–6.