CGC International Journal of Contemporary Technology and Research
ISSN: 2582-0486 (online) Vol.-5, Issue-2; DOI: 10.46860/cgcijctr.2024.01.10.344

Applications of Machine Learning in Diverse Sector: A Study

Gagandeep Kaur[1], Santosh Kumar[2*]
[1]Department of CSE, Chandigarh Group of Colleges, Landran Mohali Punjab
[2]Department of Mechanical Engineering, Chandigarh Group of Colleges, Landran Mohali Punjab
Email: santoshdgc@gmail.com

Abstract: Machine learning (ML) has a ray of hope in various sectors such as smart cities, cyber security, e-commerce, manufacturing, healthcare, agriculture etc. Various types of ML techniques (supervised, un-supervised, semi supervised, and reinforcement learning) exist in this field. Hence, the purpose of this manuscript is to give an overview of distinct ML techniques. Then the role/applications of ML techniques in real world applications are discussed. Finally, the challenges and research directions are presented. Thus, this paper will become useful for industry, academia professional and decision makers in distinct real world applications.

Indexed Terms- Machine Learning Techniques, Challenges, Research Directions, Applications.

I. INTRODUCTION

In the present era of industry 4.0 (also termed as a 4th industrial revolution) we live an electronic world where the whole things being related to a data source and digitally recorded [1]. The digital world has access to a multitude of data including Smart city data, COVID-19, Cyber Security (CS), and Healthcare data, Social media, Business Data etc. The perceptive of Artificial intelligence (AI) predominantly ML is crucial to intelligently access these data and create the allied automated and smart applications [2]. "Building an array of intelligent applications in the related fields can be done by means of the insights that can be extracted from these data, but it is critical to recognize how ML algorithms are applied in diverse sectors to obtain the kind of outcomes that would end result in actual commercial gains"[3].

Technology like Machine Learning (ML) can assist us to discover opportunities in data and convert them into real world business prospects. The field of machine learning has grown too large to be completely specialized due to ongoing developments. ML, which a form of AI is firstly coined by Arthur Samuel in 1959 [4]. Figure 1 depicts that ML is a subset of AI [5].

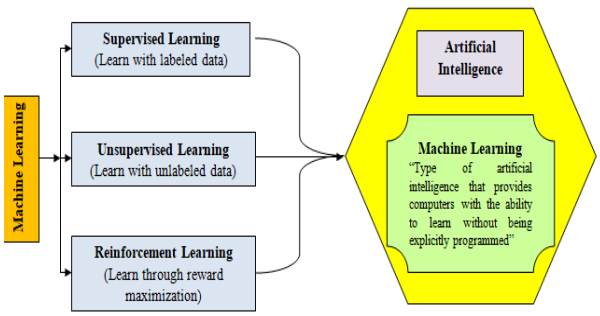

Figure 1: Machine learning as subset of AI [3]

ML allows that software programme can forecast outcomes more precisely. Thus, in order to predict new output values, ML algorithms or approaches use chronological data as input. Thus, the primary role of this manuscript is to illustrate the essentials of various ML approaches and how they can be applied to diverse real-world application areas [6].

II. TYPES OF ML

The study of machine learning covers a broad range of problems and is influenced by research in other fields, such as artificial intelligence. The focus of the field is on learning, or developing skills or information through real-world use. A machine may automatically learn from the data, perform better based on past experiences, and make predictions using machine learning [7]. There are several algorithms used in Machine learning that can process enormous amounts of data. ML is primarily categorized into four types depending on the techniques and learning areas, as shown in Figure 2.

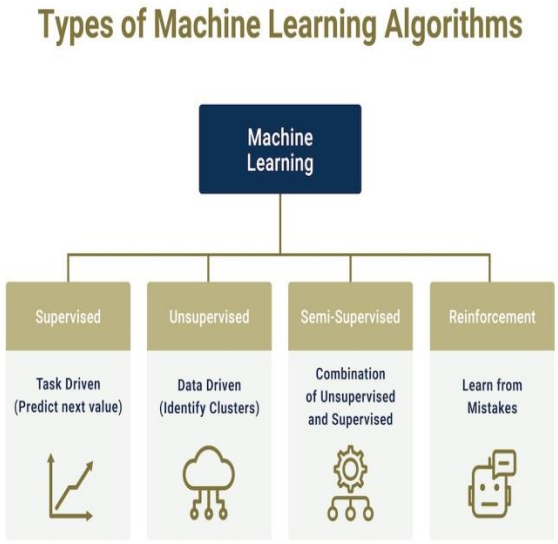

Figure 2: Types of ML Algorithms [3, 8]

These algorithms are fed data to train and then, based on that training; they create the model and carry out the desired task [3], [8]. These ML techniques support solution of numerous issues, including Regression, Classification, Forecasting, Associations, Clustering, and others. A comprehensive explanation of the many types of Machine

© All Rights Reserved to CGCIJCTR

Learning (ML) and the associated algorithms [8] is as follows:

A. Supervised ML

Because supervised machine learning is based on "Supervision," we train the machines with "labelled" datasets, and they then forecast the output based on the training [9], [10], [11].

B.Unsupervised ML

This learning is distinct from the supervised learning method because as its name implies supervision is not required. This means that the present system is trained on an unlabeled dataset & makes output predictions without any human supervision [12]. The key goal of this learning is to classify unsorted dataset based on similarities and dissimilarities. The hidden patterns in the input data set are to be found by the machines [13]. In order to better understand this concept, let's take an instance Consider a basket of fruit photos that we input into the machine learning model. The machine's job is to identify patterns and classifications in the photos, which are completely unknown to the model. When the machine is tested with the test dataset, it will now learn its patterns and distinctions, such as colour differences and form differences, and anticipate the output [14]. Unsupervised learning can be further divided into the following 02 categories:

- Association
- Clustering [15], [16], [17].

C. Semi-Supervised ML

B/w the supervised & unsupervised ML, there is a form of method known as semi-supervised learning [18], [19]. It uses a combination of labelled and unlabeled datasets during the training phase and stands in the between of "supervised learning and unsupervised learning techniques"[20], [21].

With an example, we may visualise these algorithms. When a student is engaged in supervised learning, both at home and in school, an instructor is watching over them. Additionally, unsupervised learning is when a pupil analyses a subject on their own without assistance from the teacher. The student must revise independently after evaluating the same subject while receiving advice from a college instructor [22].

D. Reinforcement Machine Learning

With reinforcement learning, an AI agent (a software component) automatically explores its surroundings by striking and trailing, acting, learning from experiences, and increasing performance. Reinforcement learning operates on a feedback-based method. The objective of this ML agent is to maximise the rewards since the agent is rewarded for every good activity and penalised for every bad action. In contrast to supervised learning, reinforcement learning relies only on the experiences of the agents [23].

The method of reinforcement learning is comparable to that of a human being; for instance, a kid learns different things through encounters in his daily life. Playing a game where the environment is the game, an agent's actions at each step establish states, and the agent's objective is to score highly is an example of reinforcement learning. Agent gets feedback in the form of sanctions and benefits. Because of its working it is used in a array of disciplines, such as multi-agent systems, game theory, operation research, and information theory [24].

• Positive Reinforcement Learning: It refers to raising the likelihood that the desired behaviour will occur once more. It strengthens the agent's behaviour and has a favourable effect on it [25].

• Negative Reinforcement Learning: The reverse of positive reinforcement learning is negative reinforcement learning [26]. However, the comparison of distinct ML techniques is shown in Table 1.

Table 1: Comparison of distinct ML techniques [26]

ML techniques	Data set	Purpose
Supervised learning	Labeled	To forcast the label of the testing test, to know the inter relation b/w output and input.
Un-Supervised learning	Un-labeled	To identify data patterns & data sample grouping etc.
Semi supervised learning	Both	To know the label of the testing set.
Reinforced learning	NA	To find out the best course of action through interacting with the environment

III. APPLICATIONS OF MACHINE LEARNING

Machine learning technology is becoming more popular because it developing very quickly and can learn from past and make wise decisions. Without realising it, we use machine learning every day in various applications like Google Maps & Assistant, Alexa, etc. [27]. Most common application areas for machine learning technology [28] are shown in Figure 3 and discussed.

Healthcare: In a number of medical fields, including infection prediction, medical information extraction, spotting patterns in data, etc., machine learning can assist in solving diagnostic and prognostic issues. As per World WHO report, a recently identified coronavirus is the source of the infectious disease coronavirus disease (COVID-19). In the fight against COVID-19, learning strategies have recently gained popularity [29], [22]. The learning approaches are applied to the COVID-19 pandemic to categorize patients at severe risk. Additionally, it can be employed to predict the COVID-19 outbreak, investigate the origins of the virus, and diagnose and cure illnesses [30], [31], [32].

© All Rights Reserved to CGCIJCTR

Figure 3: applications of ML in diverse sectors [28]

Cyber security (CS): CS is the most important area of today's world used for shielding hardware, data from digital threats etc. In order to enhance sense malware in encrypted communications, spot internal threats, anticipate where bad areas are online, ML has offered as a critical cyber security tool [33], [34], [35], [36].

Smart Cities: Another key element of "Industry 4.0 is the IoT", which transforms common items into smart items by enabling them to send data & automate processes without requiring human participation. IoT is consequently viewed as the great unexplored territory that has the potential to develop practically every aspect of our life, like smart government, and business etc. [37], [38], [39].

Transportation: The development of a nation's transportation infrastructure has become essential to that nation's economic growth. However, a number of cities throughout the world are seeing an excessive increase in traffic, which is leading to severe problems like CO2 pollution, accidents, and crises, as well as a reduction in the quality of life in modern civilization [40], [41], [42].

E-commerce: Product suggestion is one of the most well-known and often utilized applications of ML in use today. It is the glaring features of virtually any e-commerce website. Due to the fact that companies may employ ML technology to analyze their clients' past purchases and offer tailored manufactured goods suggestions for their potential purchases based on their preferences and interests [3], [43], [44].

Prediction Analysis: Machine learning finds significant use in the intelligent decision-making that result from predictive analytics (data driven). However, the core of this analytics is the identification and use of correlations b/w explanatory factors and predicted variables from past occurrences in order to forecast the unknowable result [45].

Speech, Face and Pattern Recognition: The common use of ML in the actual world is image recognition, which can recognize an object (as a digital image). Examples: determining whether an x-ray is malignant or not, and tag suggestions on social media sites is speech recognition, which often employs sound and language models [46].

Behavior Analytics Applications: A system's capacity to study about its atmosphere at any time and adapt behavior consequently is termed as context awareness [47], [3].

Agriculture: For all human endeavors to survive, agriculture is necessary. The supply chains for sustainable agriculture rely heavily on knowledge and are built on information, skills, technologies, etc.[48].

Thermal Power Plant: Smart power generation has become essential owing to rising concerns about environmental protection, and climate change [49]. In addition, premature failure of boiler tubes in coal based thermal plant is a major problem [50]. However, various researchers [51], [52], [53], [54] minimized failure in thermal plant by deposited different thermal spray coatings on boiler parts to combat oxidation, corrosion and erosion problem. Recently, distinct ML techniques has been used for combustion optimization and to determine premature failures in thermal power plant in order to improve the efficiency of plant [55].

Natural Language Processing (NLP): This enables the use of ML techniques in situations where it is necessary for computers to read texts, hear voice, interpret it, assess sentiment, and so forth. Examples of NLP-related tasks include virtual personal assistants, chatbots, document descriptions, linguistic etc. [56], [57].

IV. CHALLENGES AND RESEARCH DIRECTIONS

The efficiency a ML-based resolution depends on the kind and quality of the data as well as the effectiveness of the learning algorithms. Even while modern cyberspace facilitates the production of enormous amounts of data at a very high frequency, gathering data in crucial sectors like cyber-security, IoT, healthcare, and agriculture—all of which are covered in Sect. "Applications of ML"—is not clear-cut [39]. Therefore, it is essential for future research to collect relevant data for the administration of the goal ML-based applications, such as smart city apps. As a result, a more complete examination of data gathering methods is necessary when working with actual-world data. Moreover, the past data may also enclose a significant amount of ambiguous figures, and meaningless data etc. [58]. Therefore, it is required to modify or improve current pre-processing techniques or suggest new data preparation procedures in order to make use of learning algorithms in the relevant application field efficiently [3], [59].

Therefore, a ML-based solution's and any related applications' long-term success is based upon on both the learning algorithms and data. If, the training data are inappropriate for learning then ML models may lose their

© All Rights Reserved to CGCIJCTR

utility or perform less correctly. It is essential to manage the data and different learning algorithms effectively for a ML-based solution and ultimately producing intelligent apps [3].

V. CONCLUSION

Machine learning has developed into a powerful tool with numerous uses. Based upon the current study following conclusions are made: This manuscript will be useful for decision-makers in a range of real-world scenarios and application such as academic and business professionals. The usefulness of machine learning in manufacturing applications shows how ML can be included into every stage of the product lifecycle, from conception to disposal in a manufacturing context. ML has become an effective tool in health care sector. Recently ML has been employed in the battle against COVID-19 for forecasting, drug development, medical diagnostics, and contact tracing.

REFERENCES

[1] Vaidya, S., Ambad, P., & Bhosle, S. (2018). Industry 4.0–a glimpse. *Procedia manufacturing*, *20*, 233-238.

[2] Ahmed, S., Hossain, M. F., Kaiser, M. S., Noor, M. B. T., Mahmud, M., & Chakraborty, C. (2021). Artificial intelligence and machine learning for ensuring security in smart cities. In *Data-Driven Mining, Learning and Analytics for Secured Smart Cities: Trends and Advances* (pp. 23-47). Cham: Springer International Publishing.

[3] Sarker, I. H. (2021). Machine learning: Algorithms, real-world applications and research directions. *SN computer science*, *2*(3), 160.

[4] Chen, L., Yao, X., Xu, P., Moon, S. K., & Bi, G. (2021). Rapid surface defect identification for additive manufacturing with in-situ point cloud processing and machine learning. *Virtual and Physical Prototyping*, *16*(1), 50-67.

[5] Tapeh, A. T. G., & Naser, M. Z. (2022). Artificial Intelligence, Machine Learning, and Deep Learning in Structural Engineering: A Scientometrics Review of Trends and Best Practices. *Archives of Computational Methods in Engineering*, 1-45.

[6] Awad, M., & Khanna, R. (2015). *Efficient learning machines: theories, concepts, and applications for engineers and system designers* (p. 268). Springer nature.

[7] Carleo, G., Cirac, I., Cranmer, K., Daudet, L., Schuld, M., Tishby, N., ... & Zdeborová, L. (2019). Machine learning and the physical sciences. *Reviews of Modern Physics*, *91*(4), 045002.

[8] Tyagi, A. K., & Chahal, P. (2022). Artificial intelligence and machine learning algorithms. In *Research Anthology on Machine Learning Techniques, Methods, and Applications* (pp. 421-446). IGI Global.

[9] Ouadah, A., Zemmouchi-Ghomari, L., & Salhi, N. (2022). Selecting an appropriate supervised machine learning algorithm for predictive maintenance. *The International Journal of Advanced Manufacturing Technology*, *119*(7-8), 4277-4301.

[10] Singh, A., Thakur, N., & Sharma, A. (2016, March). A review of supervised machine learning algorithms. In *2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom)* (pp. 1310-1315). Ieee.

[11] Ray, S. (2019, February). A quick review of machine learning algorithms. In *2019 International conference on machine learning, big data, cloud and parallel computing (COMITCon)* (pp. 35-39). IEEE.

[12] Hahne, F., Huber, W., Gentleman, R., Falcon, S., Gentleman, R., & Carey, V. J. (2008). Unsupervised machine learning. *Bioconductor case studies*, 137-157.

[13] Ahmed, E., Saint, A., Shabayek, A. E. R., Cherenkova, K., Das, R., Gusev, G., ... & Ottersten, B. (2018). A survey on deep learning advances on different 3D data representations. *arXiv preprint arXiv:1808.01462*.

[14] Alzubi, J., Nayyar, A., & Kumar, A. (2018, November). Machine learning from theory to algorithms: an overview. In *Journal of physics: conference series* (Vol. 1142, p. 012012). IOP Publishing.

[15] Van Engelen, J. E., & Hoos, H. H. (2020). A survey on semi-supervised learning. *Machine learning*, *109*(2), 373-440.

[16] Zhu, X., & Goldberg, A. B. (2022). *Introduction to Semi-Supervised Learning*. Springer Nature.

[17] Pise, N. N., & Kulkarni, P. (2008, December). A survey of semi-supervised learning methods. In *2008 International conference on computational intelligence and security* (Vol. 2, pp. 30-34). IEEE.

[18] Choi, H., Kim, M., Lee, G., & Kim, W. (2019). Unsupervised learning approach for network intrusion detection system using autoencoders. *The Journal of Supercomputing*, *75*, 5597-5621.

[19] Ho, I. M. K., Cheong, K. Y., & Weldon, A. (2021). Predicting student satisfaction of emergency remote learning in higher education during COVID-19 using machine learning techniques. *Plos one*, *16*(4), e0249423.

[20] Kaelbling, L. P., Littman, M. L., & Moore, A. W. (1996). Reinforcement learning: A survey. *Journal of artificial intelligence research*, *4*, 237-285.

[21] Christiano, P. F., Leike, J., Brown, T., Martic, M., Legg, S., & Amodei, D. (2017). Deep reinforcement learning from human preferences. *Advances in neural information processing systems*, *30*.

[22] Fayaz, S. A., Jahangeer Sidiq, S., Zaman, M., & Butt, M. A. (2022). Machine Learning: An Introduction to Reinforcement Learning. *Machine Learning and Data Science: Fundamentals and Applications*, 1-22.

[23] Shekhar, H., Seal, S., Kedia, S., & Guha, A. (2020). Survey on applications of machine learning in the field of computer vision. In *Emerging Technology in Modelling and Graphics: Proceedings of IEM Graph 2018* (pp. 667-678). Springer Singapore.

[24] Lv, H., & Tang, H. (2011, October). Machine learning methods and their application research. In *2011 2nd international symposium on intelligence information processing and trusted computing* (pp. 108-110). IEEE.

[25] Mohammad-Rahimi, H., Nadimi, M., Ghalyanchi-Langeroudi, A., Taheri, M., & Ghafouri-Fard, S. (2021). Application of machine learning in diagnosis of COVID-19 through X-ray and CT images: a scoping review. *Frontiers in cardiovascular medicine*, *8*, 638011.

[26] Syeda, H. B., Syed, M., Sexton, K. W., Syed, S., Begum, S., Syed, F., ... & Yu Jr, F. (2021). Role of machine learning techniques to tackle the COVID-19 crisis: systematic review. *JMIR medical informatics*, *9*(1), e23811.

[27] Singh, M., & Kumar, S. (2021). IMPACT OF NOVEL COVID-19 ON VARIOUS SECTORS: A STUDY. *Journal on Future Engineering & Technology*, *16*(4).

[28] Singh, H., Kumar, S., & Kumar, R. (2021). A study on novel CoronaVirus Disease (COVID-19). *Asian Journal of Engineering and Applied Technology*, *10*(1), 29-37.

[29] Montasari, R., Carroll, F., Macdonald, S., Jahankhani, H., Hosseinian-Far, A., & Daneshkhah, A. (2021). Application of artificial intelligence and machine learning in producing actionable cyber threat intelligence. *Digital Forensic Investigation of Internet of Things (IoT) Devices*, 47-64.

[30] Sharma, M., Jindal, H., Kumar, S., & Kumar, R. (2021). Overview of Data Security, Classification and Control

© All Rights Reserved to CGCIJCTR

Measure: A Study. *i-Manager's Journal on Information Technology*, *11*(1), 17.
[31] AlDairi, A. (2017). Cyber security attacks on smart cities and associated mobile technologies. *Procedia Computer Science*, *109*, 1086-1091.
[32] Jindal, H., Kaur, A., Kumar, S., Gautam, N., & Kumar, R. (2020). IoT Based Smart Agriculture: A Study. *i-Manager's Journal on Information Technology*, *10*(1), 31.
[33] Jindal, H., Kumar, D., Ishika, S. K., & Kumar, R. (2021). Role of Artificial Intelligence in Distinct Sector: A Study. *Asian Journal of Computer Science and Technology*, *10*(1), 18-28.
[34] Ahmad, R., & Alsmadi, I. (2021). Machine learning approaches to IoT security: A systematic literature review. *Internet of Things*, *14*, 100365.
[35] Verma, A., Harsha, V., & Subramanian, G. H. (2021). Evolution of urban transportation policies in India: A review and analysis. *Transportation in Developing Economies*, *7*, 1-15.
[36] Kumar, S., & Kumar, M. (2022). Tribological and mechanical performance of coatings on piston to avoid failure—a review. *Journal of Failure Analysis and Prevention*, *22*(4), 1346-1369.
[37] Boukerche, A., & Wang, J. (2020). Machine learning-based traffic prediction models for intelligent transportation systems. *Computer Networks*, *181*, 107530.
[38] Tuli, B., Gautam, N., & Kumar, S. (2022). Overview of Electronic Commerce (E-Commerce). *i-Manager's Journal on Information Technology*, *11*(2), 29.
[39] Schafer, J. B., Konstan, J. A., & Riedl, J. (2001). E-commerce recommendation applications. *Data mining and knowledge discovery*, *5*, 115-153.
[40] Chowdhury, S., Joel-Edgar, S., Dey, P. K., Bhattacharya, S., & Kharlamov, A. (2022). Embedding transparency in artificial intelligence machine learning models: managerial implications on predicting and explaining employee turnover. *The International Journal of Human Resource Management*, 1-32.
[41] Chan, H. P., Samala, R. K., Hadjiiski, L. M.,& Zhou, C. (2020). Deep learning in medical image analysis. *Deep Learning in Medical Image Analysis: Challenges and Applications*, 3-21.
[42] Zhang, D., Adipat, B., & Mowafi, Y. (2009). User-centered context-aware mobile applications—The next generation of personal mobile computing. *Communications of the Association for Information Systems*, *24*(1), 3.
[43] Liakos, K. G., Busato, P., Moshou, D., Pearson, S., & Bochtis, D. (2018). Machine learning in agriculture: A review. *Sensors*, *18*(8), 2674.
[44] Sun, L., & You, F. (2021). Machine learning and data-driven techniques for the control of smart power generation systems: An uncertainty handling perspective. *Engineering*, *7*(9), 1239-1247.
[45] Kumar, S., Kumar, M., & Handa, A. (2018). Combating hot corrosion of boiler tubes–A study. *Engineering failure analysis*, *94*, 379-395.
[46] Kumar, S. (2022). Influence of processing conditions on the mechanical, tribological and fatigue performance of cold spray coating: a review. *Surface Engineering*, *38*(4), 324-365.
[47] Kumar, S., & Kumar, R. (2021). Influence of processing conditions on the properties of thermal sprayed coating: a review. *Surface Engineering*, *37*(11), 1339-1372.
[48] Kumar, S., Handa, A., Chawla, V., Grover, N. K., & Kumar, R. (2021). Performance of thermal-sprayed coatings to combat hot corrosion of coal-fired boiler tube and effect of process parameters and post-coating heat treatment on coating performance: a review. *Surface Engineering*, *37*(7), 833-860.
[49] Kumar, S., Kumar, M., & Handa, A. (2020). Erosion corrosion behaviour and mechanical properties of wire arc sprayed Ni-Cr and Ni-Al coating on boiler steels in a real boiler environment. *Materials at High Temperatures*, *37*(6), 370-384.
[50] Zhan, X., Xu, H., Zhang, Y., Zhu, X., Yin, H., & Zheng, Y. (2022, June). Deepthermal: Combustion optimization for thermal power generating units using offline reinforcement learning. In *Proceedings of the AAAI Conference on Artificial Intelligence* (Vol. 36, No. 4, pp. 4680-4688).
[51] Gupta, M., Kumar, R., Walia, H., & Kaur, G. (2021, October). Airlines based twitter sentiment analysis using deep learning. In *2021 5th International Conference on Information Systems and Computer Networks (ISCON)* (pp. 1-6). IEEE.
[52] Hristea, F., & Caragea, C. (2022). Preface to the Special Issue "Natural Language Processing (NLP) and Machine Learning (ML)—Theory and Applications". *Mathematics*, *10*(14), 2481.
[53] Kaur, G., Gupta, M., & Kumar, R. (2021). IoT based smart healthcare monitoring system: A systematic review. *Annals of the Romanian Society for Cell Biology*, 3721-3728.
[54] Kaur, G., Singh, V., Chawla, S. K., & Bhasin, M. (2020). A Survey on Character Recognition From Handwritten Documents.
[55] Zucco, C., Calabrese, B., Agapito, G., Guzzi, P. H., & Cannataro, M. (2020). Sentiment analysis for mining texts and social networks data: Methods and tools. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, *10*(1), e1333.
[56] Ullah, Z., Al-Turjman, F., Mostarda, L., & Gagliardi, R. (2020). Applications of artificial intelligence and machine learning in smart cities. *Computer Communications*, *154*, 313-323.
[57] Sarker, I. H., Kayes, A. S. M., & Watters, P. (2019). Effectiveness analysis of machine learning classification models for predicting personalized context-aware smartphone usage. *Journal of Big Data*, *6*(1), 1-28.
[58] Kumar, K., Kumar, S. and Gill, H.S. (2022), "Role of Surface Modification Techniques to Prevent Failure of Components Subjected to the Fireside of Boilers", Journal of Failure Analysis and Prevention, DOI: 10.1007/s11668-022-01556-w.
[59] Khanna, V., Singh, K., Kumar, S., Bansal, S., Channegowda, M., Kong, I, Khalid, M. and Chaudhary, V. (2022), "Engineering electrical and thermal attributes of two-dimensional graphene reinforced copper/aluminium metal matrix composites for smart electronics", ECS Journal of Solid State Science and Technology, Vol. 11, 127001. https://doi.org/10.1149/2162-8777/aca933
[60] Thakur, S., Sharma, A., Kaur, G., & Singh, G. (2020). Machine Learning: A Paradigm Shift in Industrial Sector. Advances and Applications in Mathematical Sciences Volume 19, Issue 6, April 2020, Pages 509-515.

© All Rights Reserved to CGCIJCTR