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Eruptions and Disruptions of Machine Learning In the Health Sector

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Abstract— Machine learning (ML) has affected the way healthcare is being approached and offers tremendous opportunities for enhanced diagnosis, improved personalized treatment, predictive analytics and drug research and development among several increasing possibilities. For instance, the treatment and management of technostress is gaining the interest of machine learning. However, like any disruptive technology, ML also brings significant challenges and disruptions to the healthcare sector. These disruptions space include security and privacy dilemma, ethical issues, legal concerns, and transparency concerns. In this study, we examined the eruptions and disruptions of ML in the healthcare sector, the prospects and the challenges. Ultimately, this study recommends striking a balance between innovation (disruptive technology eruptions) and cautious mitigation of the disruptions that attend such innovations. This is critical to realizing the full power of ML in healthcare.

Keywords— Machine Learning, Disruptive Technology, Predictive Analytics, Healthcare, Ethical Considerations, Technostress

1 INTRODUCTION

Machine Learning (ML) is a branch of artificial intelligence (Tyagi & Chahal, 1 C.E.) that uses algorithms to analyze data and also learns about the data. Hence, it enables computers to make predictions or decisions without being explicitly programmed. The term "machine learning" was first coined in the 1950s and falls within the age when Artificial Intelligence pioneer Arthur Samuel built the first self-learning system for playing checkers (McCarthy & Feigenbaum, 1991; Mintz & Brodie, 2019). **Figure 1** depicts the generic workflow of machine learning task. According to (Quazi, 2022) ML activities involve acquiring data, preprocessing it, selecting which machine learning algorithm to use, training the model, testing it on test data and deploying it for prediction or any specific purpose intended.

ML variants include supervised learning (ML model is trained on labeled data which provides the basis to accurately predict labels for new or unseen data), unsupervised learning (ML model is trained on unlabeled data which provides the basis for discovering patterns and structure in the data), semi-supervised learning (ML model is trained on a combination of labeled and unlabeled data, with the goal of improving the accuracy of the model), reinforcement learning (ML model learns by interacting with an environment and receives feedback in terms of rewards or punishments), ensemble learning (ML with multiple models combined to improve overall performance), deep learning (ML which utilizes neural networks with multiple layers to learn hierarchical representations of data) and Transfer learning (ML model trained on one task is used to improve performance on a different related task)

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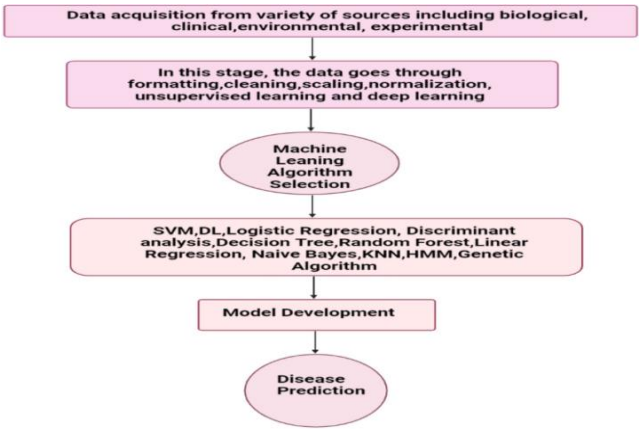

Figure 1: A Generic flowchart of a Machine Learning Workflow (Quazi, 2022)

Today, ML is enabling myriads of products and solutions-- automated translation, image recognition, voice search technology, self-driving cars, and beyond. ML has rapidly advanced in recent years, and it is widely considered to be a disruptive technology (Poduval et al., 2020; Wang & Siau, 1 C.E.) -- a technology/ innovation changing the way things are done, disrupting established business models, and creating new opportunities.

It is apparent that ML has proclivity to impact various industries from finance, education, transportation, manufacturing to healthcare (Alonso et al., 2018; Korkmaz & Correia, 2019; Tizghadam et al., 2019; Wiens & Shenoy, 2018; Wuest et al., 2016). Particularly, the healthcare industry has been rapidly adopting ML techniques to improve patient outcomes (Quazi, 2022), reduce costs (Diwani & Yonah, 2021), and increase efficiency (Samreen et al., 2018).

Research Question: This paper intends to provide answer to the question of what are the impacts and challenges of implementing machine learning in healthcare.

2 RELATED WORKS

This section discussed some related works involving ML in health care. Indeed, ML shows great promise in the diagnosis and treatment of diseases, drug development, and predictive analytics.

Wiens & Shenoy (2018) supported the fact that ML has contributed immensely in several disciplines in the aspects of vision and natural language processing. The study established that the success of ML in various disciplines is underlined by availability of data. Vamatheeyan al. (2019) carried out an in-depth review of various machine learning and deep learning tools in healthcare. The study concluded that ML can be used in several aspects of drug discovery and identification despite the challenges that the use is currently facing. Ernest et al. (2016) utilized artificial Neural Network for the prediction of prostate cancer. The study posited that the use of Artificial Neural network leads to reduction in unnecessary cancer biopsies. Khera & Kumar (2020) reported 90% accuracy in the use of supervised machine learning in gait analysis domain studied with Support Vector Machine as the best classifier. The study showed that ML is suitable for clinical Diagnosis. Dev et al. (2022) Used Principal Component Analysis to perform dimensionality reduction and three machine learning models for prediction. The study was able predict with balance stroke occurrences. The study reported that a perceptron neural network gave the highest accuracy rate. Kumar et al. (2023) established that ML and AI automation-augmentation interdependence, along with socio-technical systems are useful for technostress management at organizational level. The study was carried out by using exploratory qualitative method.

3. EXAMPLES OF MACHINE LEARNING ALGORITHMS

Machine learning paradigms are numerous. Broadly classified as supervised, unsupervised, semi-supervised and reinforcement learning; there are several techniques that lace this classification. From literatures some of the ML algorithms in use are:

3.1 *Decision Trees*: Decision trees are useful for modeling the relationships between different predictors and the outcome.

3.2 *Random Forests:* Random forests are an extension of decision trees that work by creating an ensemble of decision trees and combining their predictions.

3.3 *Support Vector Machines (SVM):* SVMs are used to classify data into different categories based on the similarity between different predictors.

3.4 *Neural Networks*: Neural networks are used to model complex relationships between different predictors and the outcome.

3.5 *Logistic Regression:* Logistic regression is a statistical method that can be used to model the relationship between different predictors and the outcome.

3.6 *Naive Bayes:* Naive Bayes is a probabilistic algorithm that is commonly used for classification tasks. It works by applying Bayes' theorem and assuming that the features are conditionally independent given the class. Naive Bayes can handle large datasets and is particularly useful in text classification and spam filtering.

3.7 *K-Nearest Neighbors (KNN):* KNN is a simple and effective algorithm for classification and regression tasks. It works by finding the k nearest neighbors to a

given data point and using their labels or values to make a prediction. KNN can handle non-linear decision boundaries and works well with small datasets.

3.8 *Gradient Boosting:* Gradient Boosting an ensemble learning algorithm combines multiple decision trees to create a strong learner; working iteratively it adds new trees to the model that corrects the errors made by the previous trees.

3.9 *Long Short-Term Memory (LSTM):* LSTM is a type of neural network that is designed to work with sequential data, such as time series or natural language text. It uses a specialized architecture that can retain information over long periods of time, making it well-suited for tasks like speech recognition, language translation, and sentiment analysis.

3.10 *Convolutional Neural Network (CNN):* CNN is a type of neural network that is designed to work with images and other multidimensional data. It uses a series of convolutional and pooling layers to extract features from the input data and can achieve state-of-the-art performance on tasks like object recognition and image segmentation.

3.11 *Generative Adversarial Networks (GANs):* GANs are a type of neural network that is designed for generative modeling. They work by training two networks simultaneously: a generator network that produces synthetic data, and a discriminator network that tries to distinguish the synthetic data from real data. GANs can be used for tasks like image synthesis, data augmentation, and video prediction.

3.12 Bayesian Networks:

Bayesian Networks are a probabilistic graphical model that represents the relationships between variables using a directed acyclic graph. They can be used for tasks like decision making, prediction, and diagnosis. Bayesian Networks are particularly useful in situations where uncertainty is present, as they can handle probabilistic reasoning.

3.13 Deep Belief Networks (DBNs)

DBNs are a type of neural network that is designed to learn hierarchical representations of data. They work by stacking multiple layers of Restricted Boltzmann Machines (RBMs) on top of each other, allowing the model to learn increasingly abstract features of the data. DBNs can be used for tasks like image recognition, speech recognition, and natural language processing.

There are quite a number of machine learning techniques available and the aforementioned is definitely not exhaustive.

4. ERUPTIONS OF MACHINE LEARNING IN THE HEALTH SECTOR

ML is essential for many aspects of healthcare. It has found application in medical research, medical diagnosis, Image analysis, drug discovery, curbing treatment cost and establishing the relationship between diseases and symptoms amongst many other applications. Some of these areas of application as seen in literature and depicted in **Figure 2** are discussed further:

4.1 Providing Improved Diagnosis

ML algorithms evaluate volumes of patient data and uncover patterns in datasets (Lee & Yoon, 2017). Utilizing ML enhances early and more accurate diagnosis with better patient outcomes. The use of ML impacts healthcare cost positively (Javaid et al., 2022).

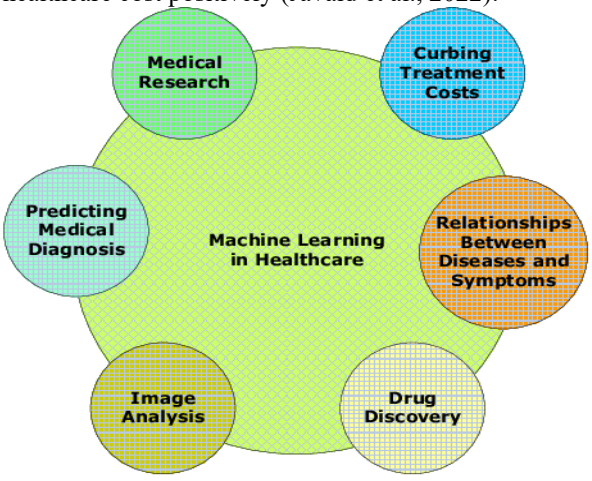

Figure 2: Applications of machine learning in healthcare (Diwani & Yonah, 2021)

Prior to the emergence of ML, accessing diagnosis can be cumbersome, sometimes impossible or out of reach. Sometimes people spend more time on waiting lists and die been access their medical appointments (Lee & Yoon, 2017).

Studies buttress the fact that ML interventions in diagnosis enhance accuracy and speed of medical diagnoses. A study by (Ernest et al., 2016) shows that Machine Learning can be deployed for early detection and diagnosis of Prostate cancer which is a most leading cancer among elderly men with high fatality rate. Another research by (Das et al., 2021) posited that machine learning algorithm was able to accurately diagnose skin cancer in images with an accuracy level that were comparable to certified dermatologists. Additionally, applied transfer learning with deep convolutional Neural Network was utilized to accurately diagnose pneumonia in chest X-rays (Rahman. al., 2020).

In addition to ML's improving diagnosis' accuracy, it expands access to medical diagnosis in areas where healthcare services are limited. For instance recent studies (M. M. al., 2020; Guo & Li, 2018) attest to the role ML

algorithms are playing in accurate diagnosis of malaria for people living in rural areas of sub-Saharan Africa where access to healthcare services is limited.

Further studies show that machine learning is playing vital role in the area of fall management, gait and mobility decline especially with the elderly in mind (Khera & Kumar, 2020; *WHO*, n.d.). The United Nation in 2021 approximated the population of the elderly (aged 65 and above) to 703 million. They noted that the population is projected to increase to 1.5 billion by 2050 (Yacchirema et al., 2019). Hence, the population of the elderly portends significant implications world-wide socially, economically and especially for the health care systems. Addressing the mobility challenges in the elderly via the use of ML will contribute immensely to improving their quality of life.

4.2 Enhancing Personalized Treatments and Precision Medicine

There is a paradigm shift in the way people access health care today. Health care is increasingly becoming personalized and has rewarding advantages (Johnson et al., 2022). ML technique is a major contributing success factor to precision medicine and personalized treatment plans. Personalized treatment thrives on data retrieved via continuous monitoring of individual patients (Johnson et al., 2022). The generated data forms the foundation resource that machine learning algorithms can utilize to learn and adapt continuously with increasing accuracy in treatment.

4.3 Predictive Analytics

According to (Calster et al., 2019) there is an upsurge of interest in using predictive analytics for improving healthcare. This clinical prediction models are utilized for Personalized medicine, Clinical management decisions and even to counsel Patients. ML algorithms can analyze patient data to predict health outcomes such as the likelihood of readmission or complications after surgery (Kalagara et al., 2019). While it is possible to carry out predictive analytics without machine learning (Peterson, 2019), ML extends the possibilities for prediction in predictive analytics especially as the volume of data increases. ML enhances predictive analytics in several fields including healthcare in a number of ways (Calster et al., 2019; Dev et al., 2022; Kilic, 2020; Oludele et al., 2022). These include, as seen in literature,

4.3.1 Improved Accuracy

ML algorithms analyze vast amounts of healthcare data and identify patterns that are not immediately apparent to humans. This can lead to more accurate predictions of patient outcomes and disease risk. However, utilizing predictive algorithms not just in discrimination, but also in calibration is essential. The idea of knowing those who have a particular disease as against different levels of the disease progression are also critical in diagnosis and that of having various characterized population such as the old, the young, past and current patients remains a challenge to grapple with vis-à-vis accuracy (Calster et al., 2019).

4.3.2 Early Diagnosis

Early diagnosis plays essential role in the management of high risk diseases such as cancer and cardiovascular diseases. ML is utilized to analyze patient's data and identify risk factors for diseases which are very useful in preventive health care. Hence ML assists clinicians in detecting diseases earlier and thus they can provide more effective treatment. (Kilic, 2020) agree in their study of the place of artificial intelligence and machine learning in cardiovascular healthcare that early diagnosis of diseases make treatment efficiency increase especially in the area of cardiovascular diseases.

4.3.3 Optimal Resource Allocation

ML algorithms are utilized to optimize resource allocation in healthcare systems. For instance, they can be used to predict patient demand for services, such as hospital beds or imaging equipment, and allocate resources more efficiently.

4.3.4 Cost Reduction

Machine learning adoption eventually leads to reduced costs by identifying inefficiencies in processes and recommending improvements.

4.4 Drug Discovery and Development

Drug discovery and development domain is enjoying the use of machine learning algorithms as attested to by (Cassidy, 2020; Farnoud et al., 2022; Vijayan et al., 2022). Current literatures show that Machine learning is being used in drug development and discovery for several purposes:

4.4.1 Predictive Modeling

Machine learning is used for building predictive models that can identify promising drug candidates and predict their efficacy or toxicity. These models can then be trained on large datasets of chemical compounds, genomic data, and other relevant information to get insight into patterns and correlations that may not be apparent to human researchers.

4.4.2 Target Identification

Machine learning is utilized in analyzing genomic and proteomic data. This can lead to identifying new drug targets or genes and proteins that are associated with specific disease condition(s), and then predict which compounds are most likely to bind to those targets and affect their activity.

4.4.3 Clinical Trial Design Optimization

Machine learning can be used to optimize clinical trial design by predicting which patient populations are most likely to benefit from a new drug and identifying potential side effects. This can help reduce the time and cost of clinical trials and improve the chances of success.

4.4.4 Drug Repurposing

Machine learning has found application in the area of identifying new uses for existing drugs via the analysis of large amounts of data which includes electronic health records, public data sources and other relevant data. This has the possibility of identifying drugs that may be effective for treating new conditions or diseases.

5. DISRUPTIONS OF MACHINE LEARNING IN THE HEALTH SECTOR

Machine learning utilization success story, like many disruptive technologies, has disruptive concerns that are critical and need to be addressed (Azencott, 2018; Char et al., 2020; Mahesh, 2018; Vayena et al., 2018). They include:

5.1 Privacy and Security Concerns

With the increasing use of ML in healthcare, there are concerns about the security and privacy of patient data. ML algorithms need access to large amounts of patient data to be effective, but this also raises the risk of data breaches or misuse of personal information. (Azencott, 2018) Agree that Machine learning has great impact upon the society with increasing area of applications. However, as Precision medicine gain popularity, heavily individualized data is usually required which might become opportunity for privacy breach. The researchers argued that the use of anonymization is not enough. Anonymization is a technique whereby the identities of the owners of a particular data are usually kept away. But, with anonymization is also the need to checkmate the possibility of giving out auxiliary information which may inadvertently give away the identity of the individual(s) involved.

5.2 *Ethical Concerns*

The nature and attribute of data, if not subjected to thorough scrutiny, can inadvertently impose bias within a machine learning solution. Hence, ML algorithms can be biased, leading to unequal treatment or unfair decisions. Another essential concern relates to the ethical implications of using ML algorithms in systems that make 'life-or-death' decisions in healthcare.

(Calster et al., 2019) raised another ethical question when they stated that several of the predictive algorithms have been developed using financial support from public institutions. However, should solutions provided from using these Predictive algorithms belong to the community or be made fully publicly available? On the other hand, when the investment involves private companies, the challenge becomes that of seeking a balance between the offer the product is intended for and making a return.

5.3 Legal Concerns

ML algorithms may raise legal issues such as liability and accountability. The question of "Who is responsible if an algorithm makes a mistake that results in harm to a patient?" is an important one. Legal frameworks for pursuing Information Technology are still developing and the challenges that jurisdictions place on implementations of legal frame works still makes pursuing justice difficult. Having a world level legal instrument is essential to ensure that people and organizations can easily answer for their roles in the use and deployment of technologies that cross the line of legality.

5.4 Transparency Concerns

ML algorithms are often viewed as a "black box". Their operations can be complex and difficult to understand, making it difficult to identify errors or biases. ML in some instance is able to learn and extends to learning how to learn. However, at what point in its learning can we determine if it is learning the right things or learning what can be destructive? The fear of singularity of Artificial Intelligence is still an ongoing relevant discussion.

6. MACHINE LEARNING PROSPECTS AND CHALLENGES

ML area of application in healthcare is increasing in scope and the horizon portends more prospects and challenges (Gerke et al., 2013; Mahler et al., 2021; Zhou et al., 2017). Various literatures show that the areas of prospects and challenges include:

6.1 Integration of ML with Electronic Health Records (EHRs):

(Mahler et al., 2021) opined that Machine learning use provides several health care solutions. For instance the Integration of ML with EHRs has resulted in the improvement of current state of accuracy and efficiency of diagnosis and treatment tremendously. However, there are challenges surrounding data privacy and interoperability between different systems which are often developed in silos or custom made to the specific needs of the organization that commission the development of such systems.

6.2 The Challenge of Data Quality and Quantity

(Gerke et al., 2013) examined many promises of machine learning and did agree that machine learning also has many problems especially in the area of data. Since Machine Learning is heavily data driven, the effectiveness of ML algorithms depends on the quality and quantity of data available. The challenge of ensuring the availability, accessibility and authenticity of data, in terms of its accuracy and how representatives of various categories of patients, remains a daunting task.

6.3 Need for Regulation and Standardization

The use of ML in healthcare becomes more widespread, (Mahler et al., 2021) states that there is a need for regulations and standards to ensure that the technology is being used safely and effectively. There is also a need for standardization of data and algorithms to ensure that they are interoperable and can be shared across different healthcare systems.

6.4 Training and Retraining

ML requires specialized skills and expertise, and there is a need for healthcare professionals to be trained in the use of this technology. This includes not only clinicians but also data scientists, analysts and engineers, who are responsible for developing and implementing ML algorithms.

7. CONCLUSION

This paper has made significant contributions in highlighting the various areas of impact of machine learning and emphasizing the areas of concerns while providing possible approaches for ameliorating the downsides of the incorporation of machine learning to health care. The paper has made it crystal clear that Machine learning leaning inroad into healthcare sector has resulted in improved diagnosis, enhanced personalized treatments with specificity to individuals, energized the domain of predictive analytics, and has impacted positively drug development efforts. More so, ML is continuously breaking new grounds in health care. However, issues surrounding security and privacy, ethical considerations, legal issues, and the lack of transparency (explainable Artificial Intelligence) of some ML algorithms remain a concern. It is, therefore, pertinent to endeavor to maintain and sustain balance between innovation and caution by ensuring that ML is being used safely, effectively and efficiently. This requires addressing challenges that bedevil integrating ML with electronic health records, ensuring data quality and representative quantity to check bias and variance, improving regulations and standardization that will guide the field and its practitioners, and continuous manpower training. It is sacrosanct to note that with careful planning and implementation, machine learning can transform healthcare in numerous spheres.

8. FUTURE WORKS

Machine learning in healthcare is an ongoing research interest and the impact is growing tremendously. Future research can be done to enhance explainability and interpretability of machine learning models, address bias and fairness and integrate ML into clinical workflows.

REFERENCES

.

Alonso, M. N., Batres-Estrada, G., & Moulin, A. (2018). Deep Learning in Finance: Prediction of stock returns with long short-term memory networks. *Big Data and Machine Learning in Quantitative Investment, Pp*, 251–277.

Azencott, C. A. (2018). Machine learning and genomics: precision medicine versus patient privacy. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *376*, 2128. https://doi.org/10.1098/rsta.2017.0350

Calster, B. Van, Wynants, L., Timmerman, D., Steyerberg, E. W., & Collins, G. S. (2019). Predictive analytics in health care: how can we know it works? *Journal of the American Medical Informatics Association*, *26*(12), 1651–1654. https://doi.org/10.1093/jamia/ocz130

Cassidy, J. W. (2020). *Applications of machine learning in Drug Discovery I: Target discovery and small molecule drug design*. Artificial Intelligence in Oncology Drug Discovery and Development.

Char, D. S., Abràmoff, M. D., & Feudtner, C. (2020). Identifying Ethical Considerations for Machine Learning Healthcare Applications. *The American Journal of Bioethics*, *20*(11), 7–17. https://doi.org/10.1080/15265161.2020.1819469

Das, K., Cockerell, C. J., Patil, A., Pietkiewicz, P., Giulini, M., Grabbe, S., & Goldust, M. (2021). Machine learning and its application in skin cancer. *International Journal of Environmental Research and Public Health*, *18*, 24.

Dev, S., Wang, H., Nwosu, C. S., Jain, N., Veeravalli, B., & John, D. (2022). A predictive analytics approach for stroke prediction using machine learning and neural networks. *Healthcare Analytics*, *2*. https://doi.org/10.1016/j.health.2022.100032

Diwani, S. A., & Yonah, Z. O. (2021). Holistic diagnosis tool for early detection of breast cancer. *International Journal of Computing and Digital Systems*, *10*(1), 417–432. https://doi.org/10.12785/IJCDS/100141

Ernest, O., Oludele, A., & Oluwaseun, E. (2016). Early Detection and Diagnosis of Prostate Cancer using Artificial Intelligence Concept. *International Journal of Computer Applications*, *149*(6), 42–46. https://doi.org/10.5120/ijca2016911433

Farnoud, A., Ohnmacht, A. J., Meinel, M., & Menden, M. P. (2022). Can artificial intelligence accelerate preclinical drug discovery and precision medicine? *Expert Opinion on Drug Discovery*, *17*(7), 661–665. https://doi.org/10.1080/17460441.2022.2090540

Gerke, S., Babic, B., Evgeniou, T., & Cohen, I. G. (2013). Machine learning: Much promise, many problems. *Artificial Intelligence and Software Engineering, Pp*, 189–212.

Guo, J., & Li, B. (2018). The Application of Medical Artificial Intelligence Technology in Rural Areas of Developing Countries. *Health Equity*, *2*(1), 174–181. https://doi.org/10.1089/heq.2018.0037

Javaid, M., Haleem, A., Singh, R. P., Suman, R., & Rab, S. (2022). Significance of machine learning in Healthcare: Features, pillars and applications. *International Journal of Intelligent Networks*, *3*, 58–73.

Johnson, A. E., Brewer, L. P. C., Echols, M. R., Mazimba, S., Shah, R. U., & Breathett, K. (2022). Utilizing artificial intelligence to enhance health equity among patients with heart failure. *Heart Failure Clinics*, *18*(2), 259–273.

Kalagara, S., Eltorai, A. E., Durand, W. M., DePasse, J. M., & Daniels, A. H. (2019). Machine learning modeling for predicting hospital readmission following lumbar laminectomy. *Journal of Neurosurgery: Spine*, *30*(3), 344–352.

Khera, P., & Kumar, N. (2020). Role of machine learning in Gait Analysis: A Review. *Journal of Medical Engineering & Technology*, *44*(8), 441–467.

Kilic, A. (2020). Artificial Intelligence and Machine Learning in Cardiovascular Health Care. *The Annals of Thoracic Surgery*, *109*(5), 1323–1329. https://doi.org/10.1016/j.athoracsur.2019.09.042

Korkmaz, C., & Correia, A. P. (2019). A review of research on machine learning in educational technology. *Https://Doi.Org/10.1080/09523987.2019.1669875*, *56*(3), 250–267. https://doi.org/10.1080/09523987.2019.1669875

Kumar, A., Krishnamoorthy, B., & Bhattacharyya, S. S. (2023). Machine learning and artificial intelligence-induced technostress in organizations: a study on automation-augmentation paradox with socio-technical systems as coping mechanisms. *International Journal of Organizational Analysis*, *ahead-of-p*(ahead-of-print). https://doi.org/10.1108/IJOA-01-2023-3581

Lee, C. H., & Yoon, H. J. (2017). Medical big data: promise and challenges. *Kidney Research and Clinical Practice*, *36*(1), 3. https://doi.org/10.23876/J.KRCP.2017.36.1.3

Mahesh, B. (2018). Machine Learning Algorithms-A Review Machine Learning Algorithms-A Review View project Self Flowing Generator View project Batta Mahesh Independent Researcher Machine Learning Algorithms-A Review. *International Journal of Science and Research*. https://doi.org/10.21275/ART20203995

Mahler, M., Auza, C., Albesa, R., Melus, C., & Wu, J. A. (2021). Regulatory aspects of artificial intelligence and machine learning-enabled software as medical devices (SaMD). *Precision Medicine and Artificial Intelligence, Pp*, 237–265.

Masud et. al., M. M. (2020). Leveraging Deep Learning Techniques for Malaria Parasite Detection Using Mobile Application. *Wireless Communications and Mobile Computing*, *2020*, 1–15. https://doi.org/10.1155/2020/8895429

McCarthy, J., & Feigenbaum, E. (1991). Arthur L. Samuel: Pioneer in Machine Learning. *ICGA Journal*, *14*(1), 19–20. https://doi.org/10.3233/ICG-1991-14105

Mintz, Y., & Brodie, R. (2019). Introduction to artificial intelligence in medicine. *Https://Doi.Org/10.1080/13645706.2019.1575882*, *28*(2), 73–81. https://doi.org/10.1080/13645706.2019.1575882

No Title. (n.d.). https://www.un.org/development/desa/pd/news/world-population-ageing-2020-highlights

Oludele, A., Sunday, I., Afolashade, K., & Uchenna, N. (2022). Security Test Using StegoExpose on Hybrid Deep Learning Model for Reversible Image Steganography. *International Journal of Computer Trends and Technology*, *70*(5), 7–14. https://doi.org/10.14445/22312803/ijctt-v70i5p102

Peterson, E. D. (2019). Machine Learning, Predictive Analytics, and Clinical Practice. *JAMA*, *322*, 23. https://doi.org/10.1001/jama.2019.17831

Poduval, M., Ghose, A., Manchanda, S., Bagaria, V., & Sinha, A. (2020). Artificial Intelligence and Machine Learning: A New Disruptive Force in Orthopaedics. *Indian Journal of Orthopaedics*, *54*(2), 109–122. https://doi.org/10.1007/S43465-019-00023-3/METRICS

Quazi, S. (2022). Artificial intelligence and machine learning in precision and genomic medicine. *Medical Oncology*, *39*, 8. https://doi.org/10.1007/s12032-022-01711-1

Rahman al., T. R. (2020). Transfer Learning with Deep Convolutional Neural Network (CNN) for Pneumonia Detection Using Chest X-ray. *Applied Sciences*, *10*, 9. https://doi.org/10.3390/app10093233

Samreen, S., Aluvalu, R., & Jabbar, M. A. (2018). The Future of Health care: Machine Learning. *Article in International Journal of Engineering & Technology*, *7*(4), 23–25. https://doi.org/10.14419/ijet.v7i4.6.20226

Tizghadam, A., Khazaei, H., Moghaddam, M. H. Y., & Hassan, Y. (2019). Machine Learning in Transportation. *Journal of Advanced Transportation*, *2019*. https://doi.org/10.1155/2019/4359785

Tyagi, A. K., & Chahal, P. (1 C.E.). Artificial Intelligence and Machine Learning Algorithms. *Https://Services.Igi-Global.Com/Resolvedoi/Resolve.Aspx?Doi=10.4018/978-1-6684-6291-1.Ch024*, 421–446. https://doi.org/10.4018/978-1-6684-6291-1.CH024

Vamathevan et. al., J. V. (2019). Applications of machine learning in drug discovery and development. *Nature Reviews Drug Discovery*, *18*(6), 463–477. https://doi.org/10.1038/s41573-019-0024-5

Vayena, E., Blasimme, A., & Cohen, I. G. (2018). Machine learning in medicine: Addressing ethical challenges. *PLOS Medicine*, *15*, 11. https://doi.org/10.1371/journal.pmed.1002689

Vijayan, R. S. K., Kihlberg, J., Cross, J. B., & Poongavanam, V. (2022). Enhancing preclinical drug discovery with artificial intelligence. *Drug Discovery Today*, *27*(4), 967–984. https://doi.org/10.1016/j.drudis.2021.11.023

Wang, W., & Siau, K. (1 C.E.). Artificial Intelligence, Machine Learning, Automation, Robotics, Future of Work and Future of Humanity: A Review and Research Agenda. *Https://Services.Igi-Global.Com/Resolvedoi/Resolve.Aspx?Doi=10.4018/JDM.2019010104*, *30*(1), 61–79. https://doi.org/10.4018/JDM.2019010104

Wiens, J., & Shenoy, E. S. (2018). Machine Learning for Healthcare: On the Verge of a Major Shift in Healthcare Epidemiology. *Clinical Infectious Diseases*, *66*(1), 149–153. https://doi.org/10.1093/CID/CIX731

Wuest, T., Weimer, D., Irgens, C., & Thoben, K. D. (2016). Machine learning in manufacturing: advantages, challenges, and applications. *Http://Mc.Manuscriptcentral.Com/Tpmr*, *4*(1), 23–45. https://doi.org/10.1080/21693277.2016.1192517

Yacchirema, D., de Puga, J. S., Palau, C., & Esteve, M. (2019). Fall detection system for elderly people using IOT and Ensemble Machine Learning Algorithm. *Personal and Ubiquitous Computing*, *23*(5–6), 801–817.

Zhou, L., Pan, S., Wang, J., & Vasilakos, A. V. (2017). Machine learning on big data: Opportunities and challenges. *Neurocomputing*, *237*, 350–361. https://doi.org/10.1016/j.neucom.2017.01.026