Spectrum of Engineering Sciences
ISSN (e) 3007-3138 (p) 3007-312X Volume 3, Issue 6, 2025

INTEGRATING NEURAL NETWORKS AND AI IN DATA SCIENCE: ADVANCING PREDICTIVE MODELING AND DECISION-MAKING IN COMPLEX COMPUTER SYSTEMS

Ali Irtaza,[1] Muhammad Yasir Butt,[2] Muhammad Awais[3] Suleman Khan[4]
[1]*University of Gujrat, Gujrat.*
[2] *Lecturer, Department of Mathematics, GIFT University, Gujranwala.*
[3]*BS Software Engineering, Department of Software Engineering, GIFT University, Gujranwala.*
[4]*BS Software Engineering, Department of Software Engineering, GIFT University, Gujranwala.*

aliirtaza512@gmail.com[1] yasirbuttnust@gmail.com[2] muhammadawaismuhammadrafiq@gmail.com[3]
skcoder99@gmail.com[4]

DOI: https://doi.org/10.5281/zenodo.16354200

Keywords
Decisions-Making, Predictive Analytics, Neural Networking, Data Science, Artificial Intelligence, Machine Learning.

Article History
Received on 08 june 2025
Accepted on 20 June 2025
Published on 29 June 2025

Corresponding Author: *
Ali Irtaza

Abstract
In the modern world of technological advancements in every field of life, Artificial Intelligence (AI) and Machine Learning (ML) have revolutionized the world due to their innovative features in decision-making and predictive analytics across the healthcare and manufacturing industries. The integration of AI and ML enables the storage and processing of vast amounts of data, the recognition of complex patterns, and the development of new efficiencies in adapting to any environment. This research has focused on providing a detailed and comprehensive review of the fundamental and theoretical foundations of ML and AI, as well as their applications in practice. It emphasizes and highlights the high potential of these technologies in enhancing decision-making capacity and accuracy, as well as predictive ability. A thorough review of previous related research has been conducted in the context of the study under observation. This review identified some key developments, advancements, and challenges, and also suggests future directions for achieving greater success in AI and ML. The findings of this research indicate that ML and AI-based applications and systems can improve predictive accuracy and enhance decision-making efficiency. It is also explored that this has far-reaching implications in all fields of life, including healthcare, finance, and manufacturing. This study accentuates the capacity and potential of Machine Learning (ML) and Artificial Intelligence (AI) to transform and revolution the data-driven process and predictive modeling. This research points the way and paves the way for future innovations.

INTRODUCTION

Since the invention of Machine Learning (ML) and Artificial Intelligence (AI), these technologies have significantly controlled the most complex tasks performed through computers, and both have taken control of human decision-making by helping them in their choices. AI has taken

control of all electronic devices and applications by enhancing their working measures. AI performs the work intelligently, which a human would need to work on for several hours; thus, it performs well and exceeds the capabilities of an ordinary human mind. It is better in problem-solving, more efficient in pattern recognition, and also a big help in learning and understanding things in the present, past, and future.

It is said that Machine Learning (ML) is a part of AI. ML is a subset of AI, based on statistical and algorithmic simulations and models. Algorithms and statistical models can be enhanced to improve their performance on various tasks through data analysis and experience.

Across the globe, various industries have undergone significant transformations due to the rise of big data and the increased availability of computational power. This modern system has triggered and accelerated the adoption of ML and AI, revolutionizing industries. In the world, there is not a single industry that is working solely without AI and ML. Earlier, in traditional contexts, decision-making was to a certain extent rules-based and was commonly taken as dependent on human input.

It is observed that ML and AI collectively have revolutionized the world because the integration of both is found to have the ability to analyze large and massive datasets, and they also can identify different patterns in various fields. They both, with time, have, have developed a capacity to make decisions without human involvement and interference. This new capacity has proven sufficient, bringing improvements in operational efficiency, predictive capabilities, and accuracy.

Real-time data is becoming an integral part of AI and ML; therefore, adaptive and real-time decision-making are key capabilities of ML and AI systems. This development has introduced the ability to regulate strategies in real-time, based on outcomes in real-time environments. For example, in monetary and financial markets, AI-based trading is ongoing and adapted to market fluctuations by analyzing past trends and adjusting to new trends and strategies in response to current market conditions. ML and AI, also proved very beneficial in healthcare, for example, their algorithms can predict complicated diseases, and they can suggest treatments and plan a diet based on patients' condition and chronic history and provide real-time health data. This advancement of AI and ML is beneficial in data storage. This development is also helpful in dispensing power and helps in the smooth running of algorithmic performances and techniques. Practitioners and researchers have worked extensively to explore various approaches, including supervised and unsupervised methods, reinforcement learning, and entrepreneurial techniques, to inform their decisions.

Thus, the integration approach has improved the performance of various computer software and applications over time, resulting in increased

adoption in finance, industry, manufacturing, and healthcare.

In this regard, this research paper has explored a practical application by examining a theoretical underpinning, and it has identified challenges associated with ML and AL that arise from their integration in adaptive decision-making predictive analytics. This research focuses on the evolution of AI and ML, aiming to explore the potential of these advanced technologies, which have transformed industries and healthcare by improving decision-making processes. The significance of AI and ML has been highlighted in the findings of this study, which reveal a profound revolution and effectiveness in various domains.

Statement of the Problem

In offices, the complexity of decision-making was already in need of a solution, and the invention of AI and ML fills this gap. Various industries have absorbed it for more effective and efficient solutions. Earlier, traditional decision-making approaches were often prone to making wrong decisions and poor judgments, resulting in errors and biases. Over time, conventional decision-making approaches made the situation worse when faced with real-time decision-making, complicating it and making it more challenging. Then, Artificial Intelligence (AI) and its sub-part, Machine Learning (ML), also brought potential solutions. One of the primary reasons for the imperfection of traditional systems was the inability to make real-time decisions, and more importantly, the failure to effectively address these challenges. Later on, Artificial Intelligence (AI) and the integration of Machine Learning (ML) emerged as a blessing, providing potential to resolve these issues and challenges. However, AI and ML are many steps ahead of traditional systems. A point worth noting is that these new inventions and facilities are not without challenges, as nothing is flawless. There is always room to make it more efficient. Thus, despite the impending and potential benefits AI and ML, these is a gap which need to address to understand their functions and theoretical foundations better, as well as there is need to understand practical implications and their limitations, so that maximum benefit may be achieved that is to harness full potential need to address challenges which are associated with their adoption. This current study aims to explore and investigate the integrated role of AI and ML in adaptive decision-making and predictive analytics. This research also aims to investigate and examine the various challenges and opportunities associated with their adoption across different fields and industries.

Aims of the Study

To examine the practical implications and theoretical foundations of Machine Learning (ML) and Artificial Intelligence (AI) in adaptive decision-making and predictive analytics.

To investigate and identify different limitations and challenges supplementary and associated with

the adoption of ML and AI in various fields, and to explore potential solutions and further directions.

Research Questions

- **RQ1.** How do ML and AI support adaptive predictive analytics and decision-making in complex systems, and what are the challenges and key benefits associated with their adoption?
- **RQ2.** What are the possible and potential implications of ML and AI in different fields and industries, and the way organizations overcome different limitations and biases associated with these new technologies to achieve improved outcomes?

2. Literature Review

Since the beginning of this century, a revolution has occurred in the world of science and technology, with the emergence of AI and ML having significantly altered traditional concepts of networking and applications. Over the past two decades, AI and ML have evolved and surpassed all previous electronic gadgets. These two have not only upgraded all applications but also introduced new inventions, making the world a completely different place, one that is totally unlike the previous century. There is a fact that, as these inventions came in to being, a lot of research has also been done on these inventions, to know how these are beneficial as compared to the previous inventions and overcome the challenges, as well as it has been tried to learn either these new inventions are also facing challenges and of what type of challenges they are facing. Earlier, various research works were conducted on developing neural networks and decision-making trees for classification and pattern recognition. At a very early stage, a study was conducted [1], when ML was in its infancy. The researcher provided a comprehensive overview of ML. defining it as "ML is a study of computer algorithms which can improve automatically through experience." Later, at the onset of the new century [2,3,4] explored the idea that "AI has the ability and potential to create systems that can think and very rational and can act rationally." They wrote that AI contains models of algorithms, probabilistic reasoning, and logical reasoning. The presence of these models is itself an emblem that AI can rethink and act for itself. Later, Bishop and Bishop and McDonald [5,6] explored the existence of another model in ML, known as the 'Bayesian Model' and 'Probabilistic Inferences'. He said that these models demonstrate the ability to improve predictive accuracy by integrating prior knowledge and can also update this knowledge with real-time data.

Researchers [7] explored the functions and role of deep learning, stating that it aids in predictive analytics and pattern recognition. It is also effective in demonstrating performance in convolutional neural networks (CNNs). It can outclass traditional ML models in more advanced tasks, such as image and speech recognition. It helps in various language-assisting models and applications that detect specific language terms used in a language with a single click. There are many software tools,

such as AntConc and SPSS, which all work with the help of AI and ML. Goodfellow et al. [8,9,10] contributed to ML by introducing a critical network named the generative adversarial network (GANs). GANs enabled AI systems to generate new data samples that resembled real data samples and could reinforce themselves. This addition revolutionizes AI more than any previous one since the beginning of the century. They emphasized the importance of GANs, stating that they can be highly beneficial for humanity through AI, potentially transforming the universe. Later on, many research works explored the importance and potential of reinforcement learning in AI [11,12,13] and the value and importance of transfer learning in ML and AI, and showcased the more substantial promise in developing effective and efficient AI systems [14,15]. They all did a great deal of work and made AI more efficient, but challenges remain, including loose holes in ML and AI. Researchers [16,17] underscored and highlighted the delimitations and limitations of deep learning models. According to them, these models face issues in handling abstract reasoning and problem-solving other different tasks. They argue that future AI systems should be equipped with symbolic reasoning and incorporate cognitive models to achieve and benefit from the best and most adaptive intelligence. The integration of symbolic reasoning and cognitive models can yield more fruitful results. In this way, it would be more transparent and easier to explain. Other researchers have focused on the need for more transparent and explainable models, which may incorporate cognitive models and adaptive intelligence, as seen in AI models. According to them, this approach would enable AI to work more efficiently compared to the previously introduced system [18]. Thus, the above all thorough readings or literature review made it clear that a more comprehensive research is needed to arrange in order to explore the theoretical foundations, fundamentals, challenges and tasks associated with this new technology of ML and AI and practical applications in predictive analytics and decision making, so that more benefits may be get from these electronic brains. Primarily, research needs to address the potential of AI and ML in decision-making, which should be real-time and problem-solving in various industries, and address different hurdles, limitations, and problems associated with these highly modern technologies [19]. The primary aim of this research is to address the aforementioned gap by conducting a thorough examination of the key role of ML and AI in predictive analytics and adaptive decision-making. The secondary aim of this research is to explore the challenges and opportunities associated with the adoption process in various work fields.

3. AI Empowerment in Adaptive Decision-Making

3.1. Role of Unsupervised and Supervised Learning in Informed Decision-Making

Supervised techniques involve instructing a computer to categorize and tag data, providing labels that enable the computer to work within predefined parameters or according to existing knowledge. It uses input-output pair models to map and rearrange the input in a correct way to produce the desired output. Supervised decision-making is used in tasks such as forecasting, spam detection, and image recognition. This application is typically used in regression tasks, classification tasks, and goals where outcomes need to be predicted. Support Vector Machine (SVM), Decision Tree, and Neural Network models are among the most well-known applications that utilize supervised learning models, which can be employed for tasks such as image classification, predictive maintenance, and sentiment analysis, among others.

While unsupervised learning in AI is a type of learning where a mathematical algorithm operates in a way that has no predefined tagging, labeling, or output, it is a sort of learning where computers learn from data. However, no correct answers are given; computers themselves work and locate answers from their database. Computers attempt to identify patterns, such as grouping common and uncommon items and distinguishing between unusual ones. In this way, they work on grouping and classification based on some commonalities and differences, and write answers for us. For example, a child has a box of mixed toys and asks them to sort them out, without telling them to follow the process. This process is beneficial when we do not have labeled data but still want classification of our tasks until saturation. Thus, up unsupervised learning model is based on pre-existing labels. For example, clustering algorithms include hierarchical clustering and K-means. These models of AI group similar data points into significant segmented clusters. This technique is used, especially in customer profiling, market segmentation, and anomaly detection. This allows business to gain deep insight with full naked record and keep an eye on customers' behavior and preferences.

3.2 Reinforcement Learning in Shaping Adaptive Strategies

This section focuses on the point that integrating neural networking with AI enhances modeling and supports making informed decisions across complex computer systems. Systems learn by trying actions and form results; once a wrong action is taken, it works well the next time. It is observed that Reinforcement Learning (RL) is a method by which AI learns by trying various actions and learning from the outcomes. Trial and error also works well in computing and is referred to as reinforcement in the learning process. In AI, the reinforcement learning approach, also known as trial-and-error AI, rewards good activities and penalizes bad ones. Over time, it identifies and fixes problems, determines the best strategies for success, and learns from its experiences. Thus, computers learn and continually add to their

memory, making fewer mistakes the next time, just like the human brain. Hence, AI in computers acts like a human who learns, makes mistakes, learns from them, and ultimately corrects the issues to make successful decisions. Reinforcement learning is being applied in numerous real-life applications that run on computers. For instance, in the stock and trade market, AI is efficiently working in computers, it detects how to react to price changes. Different games are also performing well due to AI involvement in computers, such as Chess, Poker, Go, and many other games on mobile devices, where these applications learn by themselves through trial and error, losing a game to learn how to win the next time. AI, in these games, wins by placing the game many times. Trial and error, along with repetition, make it wiser and more intelligent, allowing it to devise more winning ideas. It works like a human brain, but more efficiently than a layman; it learns more quickly and performs well. In robotics, Reinforcement Learning (RL) enables robots to walk, talk, avoid obstacles, pick and choose, and respond to their environment. The system has a human brain-like capacity; if it learns that something is wrong, the robotic system avoids it next time, thus learn through reinforcement and trial and error. Self-driving cars utilize Reinforcement Learning (RL) to take actions and, over time, learn to make the best driving decisions in changing traffic conditions. These cars, along with maps, detect traffic congestion on the expected route and make prior decisions so that passengers may reach their destination on time. Reinforcement Learning (RL) enables AI to work more efficiently, flexibly, and effectively. Thus, RL enables AI to adapt to complex and unpredictable situations.

4. Machine Learning Techniques in Predictive Modeling

4.1 Simple Machine Learning Models for Predicting Future Outcomes

The models of Machine Learning (ML) contain various tools that are highly supportive in the process of learning on computers, i.e., from past data and predicting future outcomes. Based on all available data, they can make informed decisions and provide accurate predictions. These AI models are widely used in predictive analysis to understand new trends and patterns in various fields. Some of the famous models working in this regard are decision trees, linear regression, gradient boosting machines, and random forests. Each of these models is superb and works as an efficient way. The main goal of all these models is the same. These models perform data analysis and make intelligent predictions, enabling them to plan the best course of action. These models are implemented in the software systems of various companies, allowing them to work efficiently, improve planning, mitigate risks, and make informed decisions. For instance, if a store has a collection of clothing and wants to know which style and fabric will be more appreciated in the coming season, based on the upcoming weather conditions and the preferences of its

customers. The clothing store would use software on a computer that may contain a decision tree model, which can analyze past data and make predictions. It can check weather conditions, the price and affordability of people, where the store is located, and check prices, as well as inform about sales and detect customers' preferences. Thus, a computer system containing a tree model can predict which types of jackets should be in the store to maximize sales and profit. Store managers can store the right amount of stock in advance, avoiding the risk of running out of items. It reduces the chances of being tagged as 'sold out' and enhances the ability to provide more items, making it more available and more profitable.

4.2 Predictive Model Evaluation and Results

Table 1 presents a comparison of the performance of different machine learning models used in predictive analytics.

Algorithm Model	Success Rate (%)	Application	System Complexity
Linear Regression	73%	Market Demand Estimation	Easy
Decision Tree	80%	Anomaly Detection in Transactions	Normal
Random Forest	85%	Customer Loyalty Maintenance	Hard
Neural Network	90%	Automated Image Detection	Hard

5. Obstacles and Emerging Opportunities

5.1 Data Imbalance and Ethical Challenges

ML and AI depend on data feeds provided by humans. They learn from the data they are given. If the data is biased and unfair, the model would provide biased and one-sided results. For example, photo recognition system work on recognition of white and fair color people' photos, as it is trained at the time of its making, but later on, if a black and tan color person try to recognize face it denied due to dark color, because being trained with white color people, this lead to unfair treatment and lead to mistake. Another example is when software is purchased for use by the HR department in hiring processes. That software learns from the trial-and-error section that, if previously by chance more

men were selected, the software would next time have an opinion that men are better office workers. However, this time, more intelligent women have applied for a job, but the computer is suggesting a selection based on previous records. Thus, AI may be wrong and biased in its decisions and unethical as well. Therefore, to mitigate such problems, we need to address them by updating the software with new data warehousing capabilities. In this way, AI would learn from new data and produce the best results. Thus, it is the company's responsibility to keep an eye on updated software and should continually update its AI. In this regard, clear steps should be taken, such as regular auditing and training for data entry personnel, to ensure the accuracy of data. Thus, AI tools can be used fairly and safely for everyone.

5.2 Model Interpretability and Transparency

Many models are very complex and not easy to understand their functions and types. One of them is a machine learning model. It is challenging to know how a machine can make decisions that consider both the future and the past. One of the specific functions of machine learning is deep neural learning. People lose interest when they cannot see how decisions are being made and on what grounds. This situation is also problematic in identifying and correcting mistakes, as well as addressing unfair attitudes or behaviors within the system. Nowadays, researchers are working on explainable AI, also known as XAI, to make AI models more comprehensive and transparent. These models would be easier to handle, use and understand.

For instance, researchers are addressing healthcare issues by using explainable XAI. These tools may aid in diagnosing diseases, as well as explain the causes behind them and how they can be treated. XAI can write prescriptions based on key symptoms. Additionally, XAI can describe the key symptoms and results of the patient's tests, and can make decisions to improve accuracy.

XAI is also helpful in banking; for example, it is used in approving loans based on credit score, income, and other factors. It helps people understand that the system is fair and decisions are made based on actual personal details. Thus, AI can be made more efficient, trustworthy, and ethical by identifying the most critical data, which is achieved through feature attribution. It is then complemented by explaining how AI works, enhancing model interpretability, and providing clear explanations. Thus, by engaging in these performances, people will gain more trust and use it more responsibly.

5.3 Scalability and Real-Time Variation

One of the problems faced when using AI is its smooth operation. As AI is used for larger and more complex systems, it becomes difficult to keep the system running smoothly over an extended period. One thing that needs to be ensured is that it can continue to work without shutting down. Another primary task that needs to be addressed is whether the model can handle the additional

workload without exhibiting signs of slowing down or shutting down. Thus, to resolve this issue, future research should focus on developing the best software systems to manage data at a larger level efficiently. For instance, cloud computing should allow data to be stored and processed on remote services. These help AI models work and run faster, more easily, and smoothly. In this regard, edge computing is considered best. It allows devices to work correctly, such as sensors and smartphones, saving time and reducing the need to share every detail with the cloud. It is also noted that there are special hardware tools, such as GPUs (Graphic Processing Units) and TPUs (Special Chips for AI); these help to speed up the performance and training of all AI models.

Thus, by bringing improvements in the devices by implanting AI in them, we, human beings, are on the way to use it more innovatively, going to make it more useful and going to make it more real-world and fit to situation that suits real-time language translation, in traffic control systems and large-scale pharmacies.

Answering the Research Questions

RQ1. How do AI and ML help with adaptive decision-making and predictive analytics in complex systems, and what are the main benefits and challenges of using them?

This investigation establishes that Machine Learning (ML) and Artificial Intelligence (AI) are ingenious, highly advanced inventions that enable us to make informed decisions and achieve accurate predictions, even in rapidly changing situations and complex settings. It is made possible by using data that learns from previous data and adjusts it to the new situation and information, just like the human brain, which processes knowledge through association and schema. The significant benefits of using ML and AIAI are that they enable better decision-making. However, there are also some hurdles and challenges to overcome. The hurdles include biased data, issues, and difficulty in comprehending how AIU makes decisions, as well as the need for more powerful systems to handle the large amount of stored data. Thus, to reap more benefits from IA, these hurdles need to be addressed in ML and AI.

RQ2. What are the potential implications of AI and ML on various industries, and how can organizations overcome the limitations and biases associated with these technologies to achieve improved outcomes?

This investigation found that ML and AI are emerging technologies that, when combined, can bring significant improvements in various industries. They can work more innovatively and efficiently, aiding in decision-making and accurate prediction. These new technologies can bring even more revolution to industries by reducing errors, enhancing efficiency, supporting better planning, and making systems run smoothly in complex environments. This research suggests that to address AI's biases and limitations, organizations should invest in research that is explainable to AI,

based on fairness, accountability, and the ability to scale systems. Thus, by focusing on this area, different industries and companies can utilize ML and AI in a transparent, fair, and more effective manner to improve performance and achieve better results and outcomes.

6. Conclusion and Results

Conclusion

It is concluded that Machine Learning and Artificial Learning have changed the face of the world. The primary reason is its decision-making power, its ability to predict and generate possible answers, by helping to adjust systems and handle capacity in a changing environment. This research investigated how ML and AI are supportive of decision-making and predictive analytics. These devices encompass both real-world applications and fundamental concepts. The findings of this research are highly beneficial and essential for high-level organizations, including shopping malls, factories, firms, and stores, to improve their business operations. These would be more beneficial in achieving better results.

Results

The results of the study show that ML and AI have the strong power to improve adaptive sorts of decisions and predictive analytics. It is finalized from this research that by using unsupervised and supervised and by applying reinforcement learning methods, companies and organizations can build efficient and accurate models and those models can help them in getting success in all fields of life and can help get more profit by taking wise decisions like a High IQ based human being but work more efficiently being a machine which is feed by desired data and which later on developed capacity to thing, assume and imagine more speedily. However, it is also correct that to get more benefits from these technologies, different challenges such as biased data, complex models that are hard to understand, and system limitations must be resolved.

Future Directions

In the future, ML and AI are at the forefront of technology, continually yielding more fruitful results. They will both be more helpful than any other device by making more intelligent decisions, improving predictions, and exploring new opportunities in various fields of life. All these technologies are on the growth path, and it is essential to focus on making them explainable, accountable, fair, and scalable. Doing so, with ethical measures in place, would ensure that ML and AI are used effectively and responsibly to support business growth and achieve better results.

Work Cited

[1] T. M. Mitchell, "Does machine learning really work?" AI magazine, vol. 18, no. 3, pp. 11-11, 1997.

[2] S. J. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach," Prentice Hall, 1995.

[3] P. Norvig and S. J. Russell, "Intelligenza artificial. Un approccio moderno," 2010.

[4] S. Russell and P. Norvig, "Intelligence artificielle: Avec plus de 500 exercices," Pearson Education France, 2010.

[5] D. V. Bishop, "What causes specific language impairment in children?" Current Directions in Psychological Science, vol. 15, no. 5, pp. 217-221, 2006.

[6] D. V. Bishop, D. McDonald, S. Bird, and M. E. Hayiou-Thomas, "Children who read words accurately despite language impairment: Who are they and how do they do it?" Child Development, vol. 80, no. 2, pp. 593-605, 2009.

[7] Y. LeCun, Y. Bengio, and G. Hinton, "Deep learning," Nature, vol. 521, no. 7553, pp. 436-444, 2015.

[8] I. Goodfellow, Y. Bengio, A. Courville, and Y. Bengio, "Deep learning," MIT Press, vol. 1, no. 2, 2016.

[9] J. Heaton, "Ian Goodfellow, Yoshua Bengio, and Aaron Courville: Deep Learning," Genetic Programming and Evolvable Machines, vol. 19, no. 1, pp. 305-307, 2018.

[10] T. Salimans, I. Goodfellow, W. Zaremba, V. Cheung, A. Radford, and X. Chen, "Improved techniques for training GANs," Advances in Neural Information Processing Systems, vol. 29, 2016.

[11] A. G. Barto, "Reinforcement Learning: An Introduction," by Richard S. Sutton, SIAM Review, vol. 6, no. 2, pp. 423, 2021.

[12] R. S. Sutton and A. G. Barto, "Reinforcement Learning: An Introduction," 1998.

[13] J. E. R. Staddon, "The Dynamics of Behavior: Review of Sutton and Barto: Reinforcement Learning: An Introduction," Journal of the Experimental Analysis of Behavior, vol. 113, no. 2, 2020.

[14] J. Yosinski, J. Clune, Y. Bengio, and H. Lipson, "How transferable are features in deep neural networks?" Advances in Neural Information Processing Systems, vol. 27, 2014.

[15] Y. Bengio, E. Laufer, G. Alain, and J. Yosinski, "Deep generative stochastic networks trainable by backprop," in International Conference on Machine Learning, pp. 226-234, 2014.

[16] G. Marcus, "Deep learning: A critical appraisal," arXiv preprint arXiv:1801.00631, 2018.

[17] A. Rajkomar et al., "Scalable and accurate deep learning with electronic health records," NPJ Digital Medicine, vol. 1, no. 1, pp. 18, 2018.

[18] S. Bakas et al., "Identifying the best machine learning algorithms for brain tumor segmentation, progression assessment, and overall survival prediction in the BRATS challenge," arXiv preprint arXiv:1811.02629, 2018.

[19] A. Adadi and M. Berrada, "Peeking inside the black-box: A survey on Explainable Artificial Intelligence (XAI)," IEEE Access, vol. 6, pp. 52138-52160, 2018.