A Review on Exploring Artificial Intelligence Applications, Advancements, Issues, and Future Challenges

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

AI Usage Declaration

AI has been used to check language correction.

REVIEW

A Review on Exploring Artificial Intelligence Applications, Advancements, Issues, and Future Challenges

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Abstract

Artificial intelligence (AI) is a transformative technology with diverse applications that is transforming several industries. AI is the use of systems and technology to replicate human intelligence and solve common real-world issues. Machine learning (ML) and deep learning are AI technologies that use algorithms to more accurately predict occurrences without the need for human intervention. Explainable Artificial Intelligence (XAI) refers to AI that can explain decisions or forecasts to human users. XAI seeks to improve AI systems' transparency, trustworthiness, and accountability, particularly when utilized in high-risk applications such as healthcare, finance, or security. This review article provides a thorough overview of the literature on AI techniques with various applications. It emphasizes the value of interdisciplinary study as well as the enormous potential of artificial intelligence. Combining domain knowledge and AI can transform entire sectors, solve difficult problems, and improve quality of life in general. To reduce potential hazards and address societal concerns, ethical considerations and responsible development of AI technology are crucial.

Keywords: Artificial intelligence, Automation, Robotics, Explainable artificial intelligence interdisciplinary

1. Introduction

AI, often known as machine intelligence, refers to machine intelligence. It differs from human and other animal intelligence in that it includes abilities such as learning and problem-solving [1,2]. AI research in computer science is focused on the study of "intelligent agents". These agents are devices that can perceive their surroundings and take activities that increase their chances of achieving their goals. AI is a method that refers to a system or a machine that imitates human

intelligence to accomplish real-world operations [3—5]. AI enables the system to be trained from data and to reason and learn from experience to address specific challenges [6,7]. Based on the facts, it can heuristically refine itself [8—10]. AI applications include enhanced web search engines, self-driving cars, games, human speech recognition, recommendation systems, and healthcare, among other things [11—13]. The use of AI in the transportation industry has significantly improved the development of autonomous vehicles, traffic control systems, and road safety [14,15]. AI algorithms may be used to analyze real-time data from cameras and sensors to effectively plan routes and predict traffic, which will save time and fuel [16—18]. Robotics and automation powered by AI also improve surgical processes by increasing precision and lowering risks [19,20]. AI is being used in healthcare for drug discovery, medical diagnostics, and individualized treatment programs [21—23]. Large-scale patient data are analyzed using machine-learning algorithms to help with early disease identification and prognosis [24,25]. The impact of AI extends to environmental sciences and sustainability, where it helps with renewable energy sources, resource management, and climate modeling [26—30]. AI-powered monitoring systems offer prompt responses and early detection of natural disasters [31—33]. AI was developed in the computer science sector around 1950 [33], and it mimicked the human mind to create machines that can analyze [34], methodize [35,36], and perform based on the data presented to the system [37], which will be advantageous when massive amounts of datasets are employed [38—40].

AI machines are widely employed in the industrial domain [41,42], prompting greater research in engineering domains such as NLP (natural language processing) [43], disease detection and medicine [44], and science [45]. AI computers used to learn from their previous experiences [46,47], which was useful in problem-solving, and it has been applied in several application areas to improve AI machine performance [48]. Various definitions of AI have been proposed in the literature, each encompassing the core notions of non-human intelligence taught to do specific jobs [47,49,50]. The term AI refers to systems that simulate cognitive functions commonly associated with human characteristics such as learning, speaking, and problem-solving [51,52]. AI in the context of its ability to comprehend and learn from external data independently to reach specified results through flexible adaptation [53,54]. Big data has enabled algorithms to deliver excellent performance for specific tasks (robotic vehicles, game

playing, autonomous scheduling, etc.) and a more pragmatic application of AI rather than the more cognitive-human level AI where the complexities of human thinking and feelings have yet to be effectively translated [55,56]. The common thread running through all definitions is machines' increasing ability to perform specific jobs and functions now performed by people in the workplace and society as a whole [57,58]. AI is one of the newest and most profound fields of study in the modern world. AI research is guided by certain objectives and employs specific instruments [59,60]. Chat GPT is among the most significant and recent advancements in the world of AI [61,62]. With the release of its prototype, it has caused a storm in the online community [63]. It has been conducted a survey analysis on Chat GPT [64]. The focus is on Google Bard AI, Chat GPT, and Chatbots [65—67]. This study aims to inform readers about the examination of several reviews and research projects related to Chatbots, Chat GPT, and Google Bard AI, as well as a quick comparison [68—70].

Precisely pinpointing the position and profundity of underground utility assets has emerged as a significant obstacle in the building sector, where unintentional impacts can result in substantial financial damages and raise safety issues [71—73]. Even while the database of as-built utility locations is getting increasingly precise, it is still necessary to have the ability to precisely identify buried utilities to reduce the dangers involved with digging [74,75]. The current method is time-consuming and expensive, involving the deployment of experienced agents to survey and identify subterranean utilities at places of interest [76,77]. With the development of AI, there is now a chance to perform virtual sensing of underground utilities by fusing logic, knowledge, and robotics (such as drones) [78—80]. Since the field of AI was founded in 1956, there have been two opposing paradigms: connectionism (or sub-symbolism) and symbolism [81]. By the end of the 1980s, symbolism dominated AI research; but, in the 1990s, connectionism gained traction and is progressively replacing symbolism [82]. Through powerful data analysis and machine learning algorithms, AI technology is changing healthcare by providing predictive diagnosis, individualized treatment plans, and drug discovery [83—85]. AI is used in finance to improve decision-making processes and ensure the security of financial transactions through algorithmic trading, risk management, and fraud detection [86]. AI applications such as satellite image analysis promote environmental conservation by monitoring deforestation, tracking wildlife movement patterns, and optimizing resource

management for long-term growth [87–89]. AI-powered robotics play an important role in manufacturing, automating difficult jobs, assuring quality control, and increasing overall production efficiency. Precision farming, which incorporates automated crop monitoring, predictive analytics for yield optimization, and autonomous machinery for planting and harvesting, enhances agriculture [90–92]. With tools for contract analysis, legal research, and prediction of case outcomes, AI technology is revolutionizing the legal business, reducing legal processes, and increasing the productivity of legal personnel [93–95]. AI applications boost social services in areas such as public safety, where predictive policing and emergency response systems assist law enforcement agencies in responding more effectively to crises and allocating resources more efficiently [96–98]. Concerns have been raised concerning job displacement as a result of AI technology, as automation and AI-driven systems may replace specific jobs, resulting in unemployment and economic inequality [99,100]. The increased use of AI in surveillance, data mining, and facial recognition raises privacy concerns, endangering individual privacy rights and even enabling mass surveillance [101]. Machine learning models may mistakenly learn and reproduce discriminatory patterns contained in training data, which can perpetuate and even exacerbate existing societal prejudices [102,103]. Power concentration is a problem, with a few large tech companies holding advanced AI systems, potentially leading to monopolies and limiting market fairness [104–106]. As AI systems make decisions that affect human lives, ethical quandaries arise, raising concerns about responsibility, transparency, and the possibility of unintended effects [107–109]. As AI-powered technology replaces human interactions in a variety of settings, social isolation may increase, potentially contributing to a loss in social skills and community engagement [110,111]. The digital divide deepens as AI usage varies among communities, resulting in differences in access to technology and worsening existing social and economic inequities [112–114]. The potential exploitation of AI in cyber-attacks poses security risks since advanced algorithms could be used to exploit weaknesses, infiltrate systems, and weaken digital infrastructure [115–117]. As society becomes more reliant on technology for decision-making and problem-solving, reliance on AI systems may result in a loss of vital skills and expertise [118]. It is a concern that AI algorithms may influence and Mold consumer choices, preferences, and even creative expressions, potentially homogenizing cultural and artistic variety [119,120].

The novelty of this review article lies in its comprehensive exploration of artificial intelligence (AI) from a multidimensional perspective, providing a holistic understanding of its advancements, applications, and challenges. Unlike previous research, which generally focuses on specialized domains or narrow parts of AI, this work combines an in-depth examination of fundamental principles, ethical implications, and technical challenges with an evaluation of cutting-edge applications and future trends. A detailed discussion on the ethical challenges such as bias, privacy, and societal impact, emphasizes the need for responsible AI development and deployment. The research bridges the gap between technical advancements and their societal consequences, offering insights into balancing innovation with regulation and addressing interpretability and transparency concerns. By encompassing a wide spectrum—from foundational principles to emerging applications and unresolved challenges—the study serves as a critical resource for researchers, policymakers, and practitioners aiming to navigate AI's complexities. It outlines actionable recommendations for fostering a future where AI complements human intelligence, promoting trust, inclusivity, and ethical innovation. This review article stands out for its integrative approach, enabling readers to grasp AI's transformative potential while highlighting the pathways for addressing its challenges.

2. AI technology

AI is a branch of informatics that focuses on creating computers that can perform a variety of tasks. It frequently incorporates tasks related to the human brain, such as learning, problem-solving, emotion recognition, dealing with ambiguity, and even displaying creativity [1,2]. AI systems accomplish these capabilities by following human-defined rules or learning from sample data. The history of AI as an information technology is lengthy [3–5]. The first successful generation of AI systems, which peaked around the year 2000, relied on explicitly written rules [6]. This form of technology is known as knowledge technology because it involves the development of a coherent set of rules and knowledge [7]. These rules are used by algorithms to discover the most likely solution to specific issues, such as determining the quickest route [8–10]. AI has been incorporated into different facets of our lives for a long time [11]. Consider the computer systems that power services such as Spotify and Netflix [12,13]. These systems observe and analyze users' choices, gradually learning their preferences

[14]. As a result, these streaming services may deliver personalized music and video recommendations that are tailored to each user's preferences [15]. Similarly, intelligent components are included in computer games [16]. Virtual opponents in first-person shooters analyze their surroundings to successfully locate cover and strategize [17,18].

Furthermore, online retailers use AI to predict client behavior and display relevant products to customers [19]. AI is already pervasive in our daily lives, with industry titans such as Apple, Google, Amazon, Microsoft, and others incorporating it into their virtual personal assistants [20—22]. Furthermore, self-driving cars use algorithms to make decisions and constantly improve their driving abilities through acquired experience [23]. AI may be used to generate news stories on corporate results, identify objects, guide robotic Hoover cleaners, facilitate language translation during chats, and even forecast house burglaries [24]. Companies use chatbots to provide online customer support, optimize processes, manage inventories, and supply chain networks, and estimate current commodity prices and product demand [25—27]. These examples demonstrate that AI is not a far-off notion; rather, it is a present reality in which many businesses are now actively involved [28—30].

2.1. Idea and concept of AI

2.1.1. Basic idea of AI

AI is a subfield of computer science that focuses on creating machines with intelligence and the capacity to mimic human behaviors and tasks [31]. People in ancient times would have desired to live long enough to witness the amazing creations that were destined to revolutionize the world if they had known about current achievements in the world [32]. When we examine the difficult manner of life they endured, it is common to feel melancholy when we consider this concept [33—35]. However, we must not be overly proud, because future generations will certainly feel the same way about us as they anticipate the advances that will impact the world in fifty years [36]. This long-term forecast reflects the ever-changing nature of our environment, with each passing hour bringing out fresh transformations that demonstrate improved performance. Without a doubt, the topic at hand is AI, which is still being debated [37,38].

2.1.2. Concept of AI

The theory of AI encompasses the simulation of advanced human cognitive functions, such as learning, reasoning, and self-correction, within computers [39]. Machine vision and speech recognition systems are two prime examples of the many AI components [40]. We frequently picture robots or sentient machines when we think of artificial intelligence. However, AI covers a lot more ground than that [41]. It is now regarded as the foundation of the scientific and innovative industries [42]. Nowadays, practically everyone has access to AI at their fingertips, with tools like their phone's S Voice or Siri virtual assistants [43—45]. We no longer need to interact manually because these helpers quickly carry out duties for us based on our voice instructions [46].

Recently, Android revealed that S Voice would soon be able to make reservations for restaurants, arrange appointments at beauty parlors, and even buy airline tickets online [47,48]. Isn't it amazing how the quality of living is improving? Throughout time, people have sought the idea of "easy." For convenience, washing machines were created [49,50]. AI is the result of considerable research and the collection of massive amounts of structured data, the culmination of years of toil [51]. We may now delegate monotonous chores to robots by investing our money, providing us with a sense of relief and luxury [52,53]. With the advent of robots, self-driving automobiles, and thinking machines, it may appear that the world is swiftly approaching its apex [54,55]. This perception, however, is far from accurate and should be reason for concern for everyone who can predict the potential effects of AI on our future [56,57].

2.1.3. Principles of AI

AI is based on the assumption that human intelligence can be thoroughly characterized and copied by machines, allowing them to accomplish jobs ranging from simple to complex. Artificial intelligence's goals revolve around simulating human cognitive processes [58]. AI principles are founded on a set of guiding concepts that guide the development and implementation of the technology [59]. These principles include a wide range of issues of artificial intelligence, including its aims, ethics, and usefulness [60—62]. Following are some key AI principles:

(i) Replicating Human Intellect

AI seeks to mimic human intellect and cognitive capacities, allowing machines to understand, reason, learn, and solve problems in the same way as people do.

(ii) Machine Learning

AI uses machine learning techniques and statistical models to enable machines to learn from data, discover patterns, and make predictions or judgments without being specifically programmed for each circumstance.

(iii) Automation and Efficiency

AI is intended to automate jobs and processes to improve efficiency, productivity, and accuracy. It can complete repetitive or difficult jobs more quickly and consistently than humans.

(iv) Adaptability and Flexibility

AI systems attempt to adapt and develop over time through the acquisition of new experiences and data. They can modify their behavior or decisions in response to changing conditions or feedback.

(v) Ethical Considerations

Addressing ethical concerns and ensuring appropriate use are important aspects of AI research. Fairness, transparency, privacy, accountability, and the avoidance of biases or discrimination in AI systems are all part of this.

(vi) Data-driven Decision Making

To enable informed decision-making, AI relies on data analysis and pattern recognition. It analyses and optimizes outcomes using massive amounts of organized and unstructured data.

(vii) Robustness and Reliability

AI systems are built to be robust, dependable, and resilient, able to work reliably and consistently even under difficult or unforeseen settings.

(viii) Collaboration with Humans

AI strives to operate in conjunction with humans, supplementing rather than replacing human talents. Human-AI collaboration can maximize both parties' capabilities to obtain better results.

(ix) Continuous Learning and Improvement

AI systems are designed to continuously learn and improve their performance over time. They can adapt to changing settings, learn new things, and improve their models and algorithms.

(x) Societal Impact

The principles of AI acknowledge the possible societal impact and ramifications of its development and implementation. They advocate for responsible innovation, taking into account the broader social, economic, and ethical consequences of AI technology.

3. Background and significance of AI

The field of labor is being revolutionized by AI, which has emerged as a revolutionary technology across industries. This article examines the diverse uses of AI in many professional fields [63]. The effects of AI on sectors like healthcare, banking, manufacturing, transportation, customers, etc [64]. The review gives an overview of how AI is being used in each field, identifies the advantages and difficulties of doing so, and looks ahead to possible ethical issues [65–67]. This review tries to demonstrate the promise of AI in improving efficiency, productivity, and decision-making across several job domains by studying these varied uses of AI [68]. Due to their potential to revolutionize several industries, AI and ML have drawn a lot of interest in recent years. The four main categories of supervised learning, unsupervised learning, reinforcement learning, and deep learning are covered in-depth in this research paper's examination of AI and ML methodologies [69]. This study seeks to provide a comprehensive grasp of AI and ML's potential and inspire more research in these fields by discussing the developments and difficulties in these fields [70].

3.1. AI on different work domains

3.1.1. AI in computer

In the area of computer vision, AI has made tremendous strides that have made it possible for computers to interpret and comprehend visual data. The applications, developments, and difficulties of AI in computer vision are the main subjects of this research topic [71–73]. The study focuses on investigating how deep learning and transfer learning methods might improve item detection in practical settings [74,75]. In many fields, including driverless vehicles, security systems, and augmented reality, object detection is essential [76]. Modern algorithms, designs, and approaches are examined in this study to increase the precision and robustness of object detection systems in complex and dynamic

situations [77,78]. The outcomes of this investigation will aid in the creation of more effective and trustworthy AI-driven computer vision applications [79,80].

Example: It uses the strength of deep learning and transfer learning approaches to improve object detection performance in such situations. The study examines the efficiency and high accuracy of object detection using cutting-edge deep learning architectures like Faster R-CNN, YOLO, and SSD. The research also looks at the potential of transfer learning, which enables models that have already been trained on substantial datasets to be tailored for particular item detection tasks. The study seeks to enhance the generalization and applicability of object identification algorithms to actual contexts through the use of transfer learning. To verify the efficacy and robustness of the suggested methodologies, the planned research will undertake extensive experiments and evaluations utilizing benchmark datasets and real-world data. Transfer learning is a method that enhances performance and shortens training time by using previously taught models for new tasks. This provides detailed instructions and real-world examples to illustrate how transfer learning is implemented in a variety of deep learning applications. The basic ideas of transfer learning are covered, such as feature extraction, fine-tuning, and domain adaption. The selection of pre-trained models, the selection of suitable layers for transfer, and hyperactive parameter optimization will all become clearer to readers as shown in Fig. 1 [2].

3.1.2. AI in robotics

Significant progress in AI in robotics has transformed robot capabilities and applications in a variety of fields [81]. The developments, uses, and ethical issues related to AI in robots are the main subjects of this research field [82]. The research specifically aims to look into how AI methods can improve human–robot interaction in the area of healthcare robotics [83]. The study looks at cutting-edge AI methods, such as computer vision and natural language processing, to help robots in healthcare settings communicate, comprehend, and react to human commands and gestures [84]. The results of this study will aid in the creation of AI-driven robotic systems that are more effective, trustworthy, and moral, thereby improving patient care and the provision of healthcare services [85].

Example: Enhancing Human–Robot Interaction in Healthcare Robotics using Artificial Intelligence.

A crucial component of robotics is human–robot interaction (HRI), especially in healthcare settings where robots are used extensively to help patients and medical staff. The goal of this study is to better understand how AI approaches might be applied to healthcare robotics to improve human–robot interaction. The study focuses on how AI algorithms, such as computer vision and natural language processing, can be used to help robots interact, comprehend, and react to human directions and gestures. Figure 2 shows the motion-mapping strategy for the HRI system of the tele-operated robotic arm-hand using an enhanced imitation system based on MR subspace. The user space; the MR scene shown to the operator; and the robot's operational environment. The mappings for sensors and grippers are not always direct and identical due to the decoupling of the person from the robot caused by the MR subspace. The MR subspace (S) connects the user's eyes (E), hand (H), camera status (C), and grippers (G) of the robot arm. Reference frames for the target objects, the robot wrist, and the robot arm base are represented by the letters T, W, and B, respectively [3].

3.1.3. AI in transportation

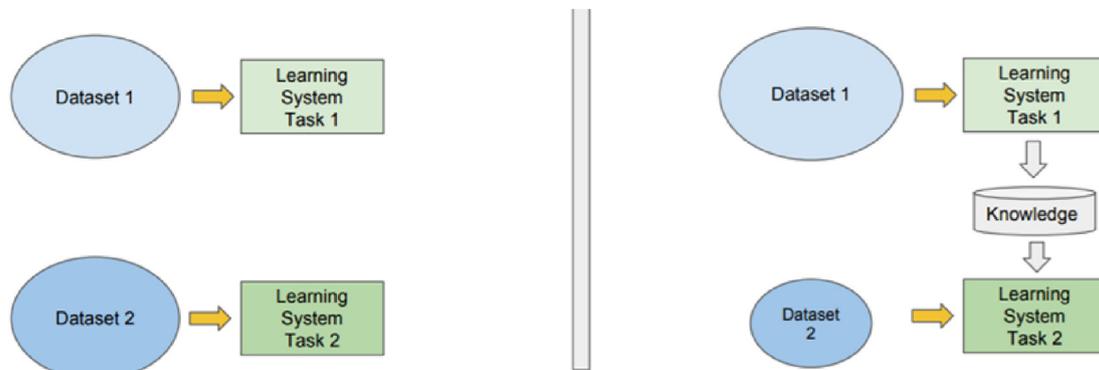Autonomous vehicles (AVs) are a groundbreaking use of AI in the transportation industry.

Fig. 1. Hands-on guide to transfer learning with real-world applications [2].
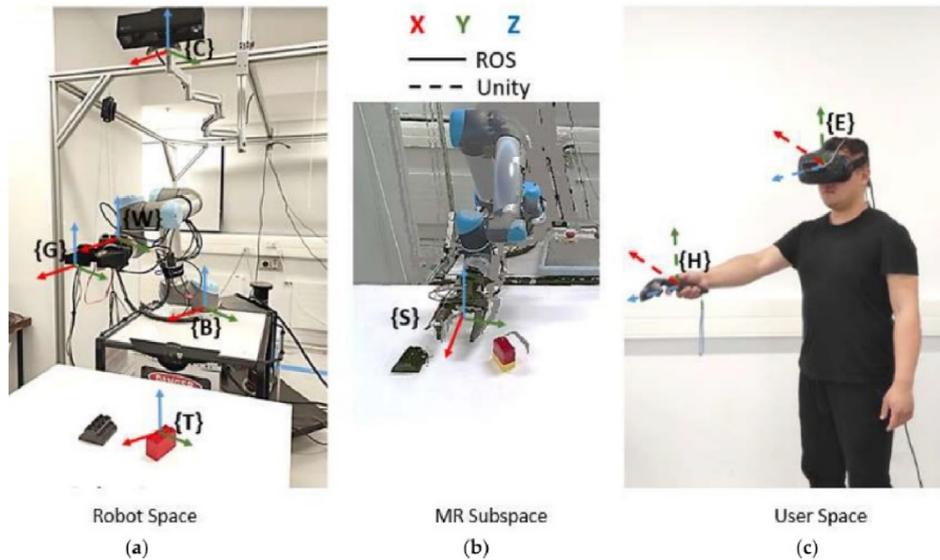
Fig. 2. Motion-mapping approach using AI [3].

They have the power to revolutionize how people and things are transported, bringing with them advantages like higher efficiency, improved safety, and less environmental impact [86]. For navigation and decision-making while driving, AVs use a combination of sensors, machine-learning algorithms, and real-time data processing [87]. Waymo, a division of Alphabet Inc., is a famous example of AI-driven autonomous car technology [88−90]. The self-driving vehicles from Waymo have been put through rigorous testing and have driven millions of kilometers on public roads [91,92]. The vehicles analyze their environment, recognize things, and make judgments in real time using sophisticated computer vision algorithms and deep learning techniques [93−95].

Example: The creation of AI-powered traffic control systems is a well-known use of AI in the transportation sector. These systems use cutting-edge algorithms and in-the-moment data analysis to improve traffic efficiency, lessen congestion, and boost overall transportation effectiveness. The City Brain project, which was implemented in Hangzhou, China, is one illustration of an AI-powered traffic control system. The real-time traffic management system City Brain, created by Alibaba's technology group, employs AI algorithms and big data analytics. To acquire thorough information about the road network and traffic patterns, the system combines data from sources, including traffic cameras, GPS devices, and social media platforms. By analyzing this large quantity of data and using AI algorithms, City Brain can manage traffic congestion, redirect vehicles, and optimize traffic signals as shown in Fig. 3 [4].

3.1.4. AI in healthcare

AI has the potential to significantly improve patient outcomes, increase diagnostic precision, and expedite healthcare procedures [96]. However, it is important to carefully explore the ethical consequences of using AI in healthcare settings [97]. With an emphasis on finding a balance between innovation and patient welfare, this study intends to investigate the ethical issues surrounding the use of AI in healthcare [98−100].

Example: The use of AI algorithms for medical imaging diagnosis is a well-known example of how the technology is being used in healthcare. Medical imaging is essential for identifying a wide range of illnesses and conditions, including cancer, cardiovascular problems, and abnormalities of the nervous system. Healthcare providers can more quickly and accurately identify patients by using AI algorithms to evaluate medical pictures like X-rays, CT scans, and MRI scans. CheXNeXt is an AI system created by Stanford University researchers that analyzes chest X-rays for the identification of various ailments using deep learning methods. The AI model demonstrated outstanding performance in identifying common thoracic abnormalities, such as pneumonia, lung nodules, and pneumothorax. The model was trained on a large dataset of labeled chest X-rays. In comparison experiments, CheXNeXt performed faster and more accurately than radiologists, displaying its promise as an effective diagnostic tool as shown in Fig. 4 [5].

Fig. 3. AI traffic monitoring [4].

3.1.5. AI in finance

The financial sector has been greatly impacted by AI, which has transformed several financial services, including investment management, risk assessment, fraud detection, and customer support [101−103]. Decision-making processes might be revolutionized, risk management approaches could be improved, and customer experiences could be improved with the incorporation of AI technologies like machine learning and natural language processing [103,104]. The goal of this study is to investigate how AI may improve risk management and decision-making in the financial industry [105].

Example: In Fig. 5, a machine learning model is used to verify blockchain-based transactions, and the prediction outcome reveals whether the transaction is honest or dishonest. The training and testing of a dataset based on Bitcoin transactions
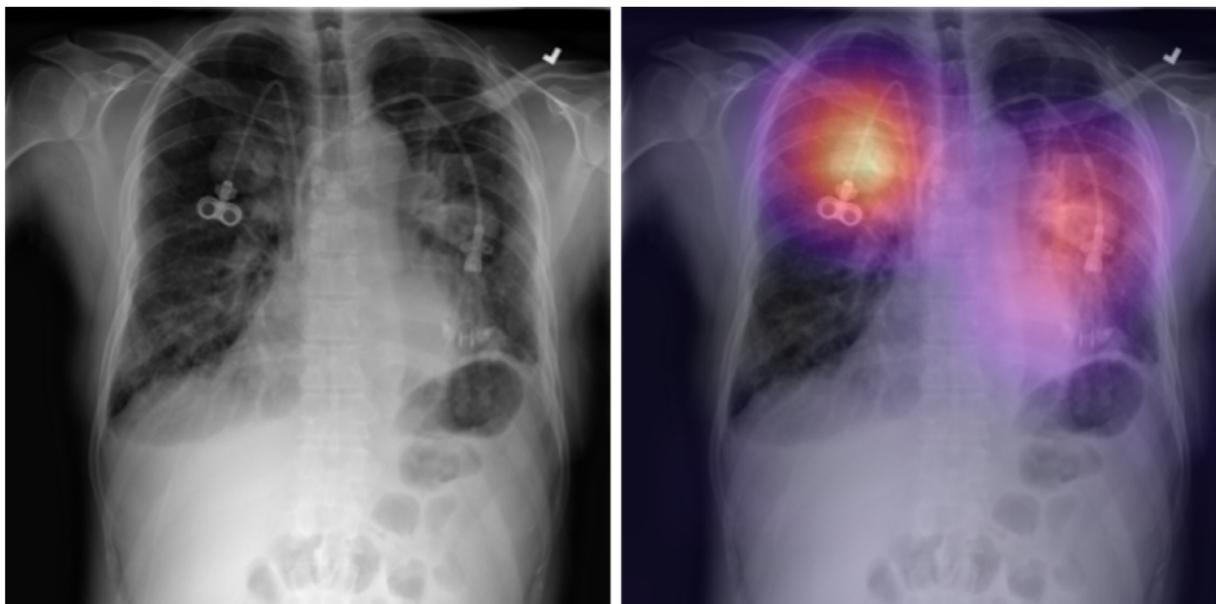

Fig. 4. CheXNeXt AI-Based System to identify the areas of an x-ray image that best represent each disease prediction and highlight those areas [5].
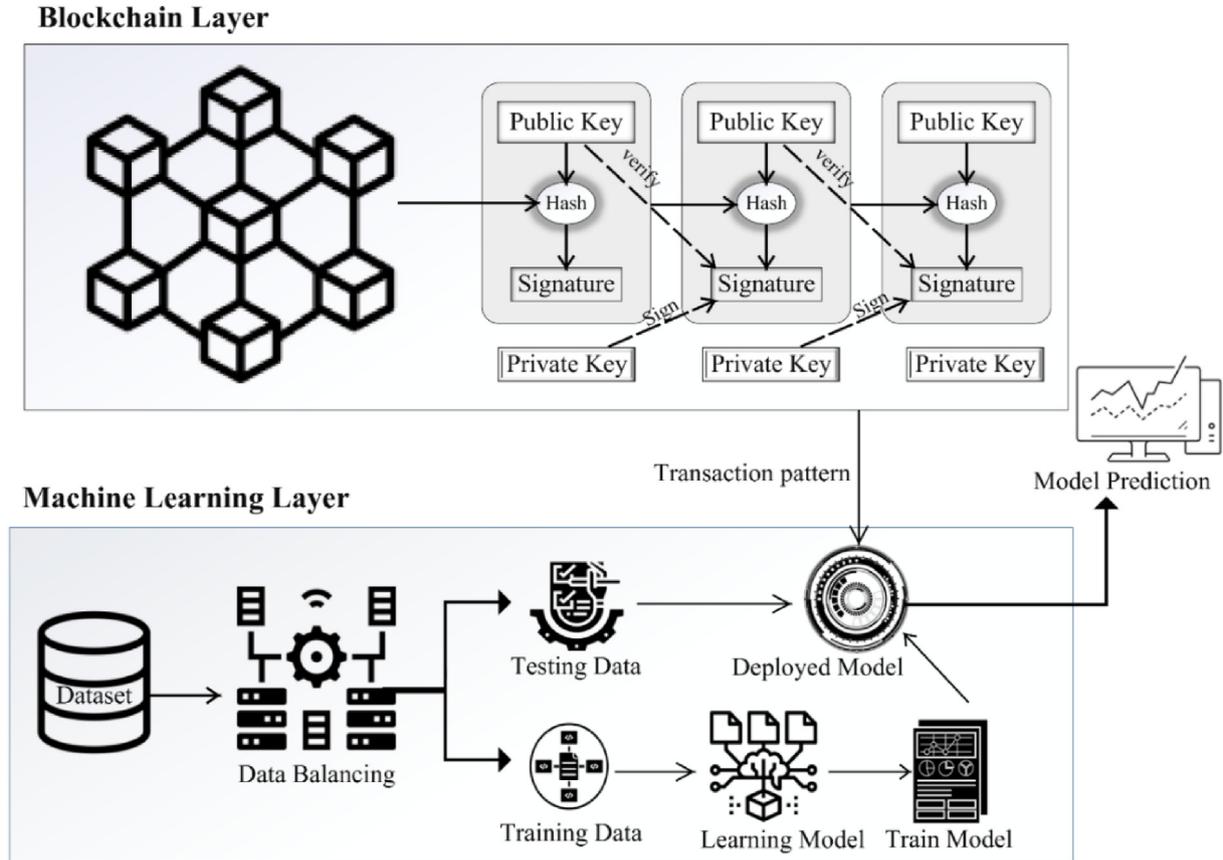
Fig. 5. The suggested blockchain and machine learning system mode [6].

served as the foundation for the machine-learning model's prediction. For the past few years, numerous networks have embraced blockchain technology to ensure security and privacy. Despite the blockchain's intriguing qualities, fraudulence is still a possibility. The malevolent actors might use a variety of techniques, such as a double-spending attack, to carry out illegitimate and fraudulent transactions [6].

3.1.6. AI in forecasting

Numerous industries, from finance and supply chain management to weather forecasting and demand forecasting, rely heavily on predicting [106]. Organizations can make wise decisions, allocate resources efficiently, and prepare for the future with the help of accurate projections [107,108]. With the development of AI technologies, there is rising interest in using AI methods to improve forecasting precision [109,110].

Example: As shown in Fig. 6, forecasting the power load reveals its utilization, patterns, and trends for the future. There is no effective way to keep track of energy production and consumption, and there are a lot of variances between the two. To

solve this issue, many different methods are employed. There is still a problem with choosing a classifier's parameter values correctly. As a result, the optimized values for the classifier's hyper-parameters are chosen using an optimization algorithm in combination with deep learning and machine learning approaches. This research implements a revolutionary deep learning-based algorithm for estimating power load. The implementation of a three-step model also includes the use of a hybrid feature selector (XG boost and decision tee), a feature extraction technique (Recursive Feature Elimination), and an enhanced Support Vector Machine (SVM) and Extreme Learning Machine (ELM) for classification and forecasting. A meta-heuristic approach called the Genetic approach (GA) is used to tune the hyperactive parameters of the ELM, and the Grid Search Algorithm is used to adjust the hyperactive parameters of the SVM [6].

3.1.7. AI in agriculture

Agriculture is essential for maintaining rural economies and guaranteeing global food security. The agricultural industry does, however, confront
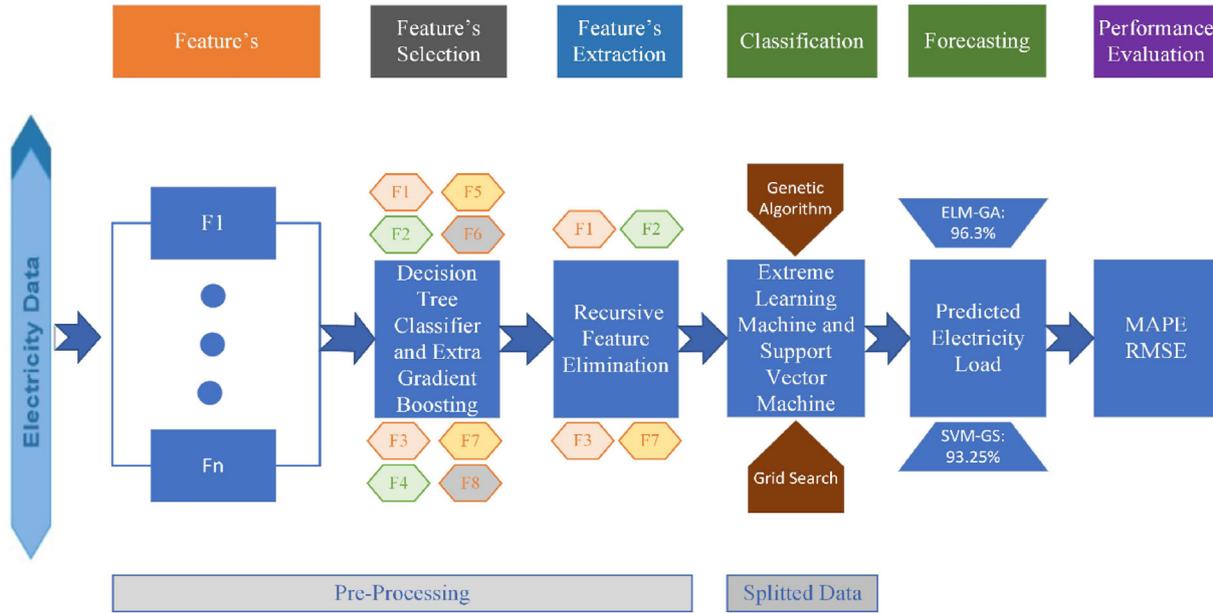
Fig. 6. Enhancing forecasting of electricity load using AI [6].

several difficulties, such as erratic weather patterns, a lack of resources, and the requirement to maximize output and sustainability [111]. To address these issues and make agriculture a more effective and sustainable industry, there has been an increase in interest in utilizing AI technologies [112]. This study intends to investigate how AI is used in agriculture, evaluate its merits and drawbacks, and offer insights into how it might affect crop productivity, resource management, and decision-making [113].

Example: In Fig. 7, this study focuses on tomato farming as a case study for the use of AI in crop disease detection. The efficiency of AI-driven image analysis tools for the early detection and diagnosis of prevalent tomato diseases is examined in the study. Machine learning algorithms will be trained to precisely recognize disease signs using a library of tomato photos and related disease diagnoses. The purpose of the study is to shed light on how AI might be used to manage crop diseases, increase tomato yields, and use fewer chemicals. Plant diseases manifest in a wide range of forms, hues, and other characteristics [9]. Designing more effective control measures to lessen crop loss requires an understanding of this interplay [10]. In addition, our method's difficult aspects include calculating how precisely we can diagnose the condition and the
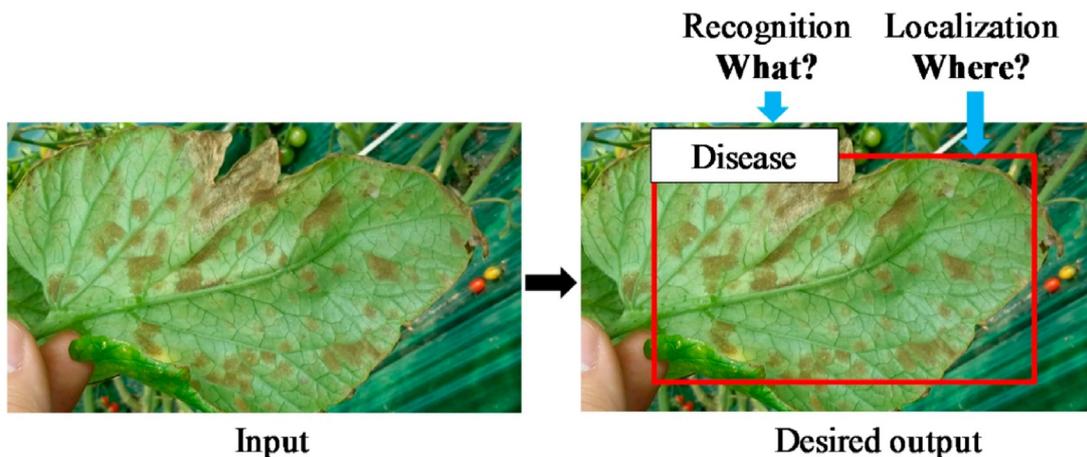

Fig. 7. Using AI to improve crop disease detection [8].

level of infection it manifests. The distinctions between the concepts of image categorization and object detection must now be made clear. In contrast to a detection strategy, which deals with the class and location instances of any specific object in the image (what and where), classification assesses if an image contains any examples of an object class (what) as shown in Fig. 7 [8].

3.1.8. AI in signal processing

Analysis, modification, and interpretation of signals are key components of the core engineering and scientific discipline of signal processing [113]. AI technologies have created new opportunities for signal processing, allowing for the more precise and efficient processing of a variety of signals [114]. To better perform signal analysis, classification, demonizing, and other signal processing tasks, this study area examines the application of AI approaches in signal processing. It aims to determine their efficacy, benefits, and potential constraints in doing so [115].

Example: As shown in Fig. 8, this study focuses on the use of deep learning methods for audio signal processing, specifically to improve speech. The study examines how well deep learning models, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), can de-noise and enhance the quality of speech signals that have been tainted by background noise. The deep learning models will be trained and evaluated using real-world audio recordings that include speech and various types of noise. The goal of the study is to shed light on the possible benefits of AI in audio signal processing and how it affects speech quality

and comprehensibility. This study demonstrates how deep learning methods are used in audio signal processing, with a focus on improving speech. This research offers important insights into the possible advantages of AI in audio signal processing by examining the efficacy of deep learning models in enhancing voice quality and intelligibility in the face of background noise. The results have practical implications for researchers and practitioners in employing deep learning approaches to improve communication systems and speech quality in real-world circumstances, which advances speech enhancement methodologies [11].

3.1.9. AI in image processing

Image analysis, modification, and interpretation are key components in the computer vision field of image processing [116]. AI technology breakthroughs have created new opportunities for image processing, allowing for more precise and effective picture analysis, recognition, augmentation, and comprehension [117]. This study aims to investigate how AI techniques are used in image processing, evaluate their efficacy, benefits, and potential drawbacks, and offer insights into how these techniques affect a variety of fields like object detection, image classification, image restoration, and image synthesis [118].

Example: As Shown in Fig. 9, in the context of object recognition for autonomous driving, this study example focuses on the use of deep learning techniques in image processing. The study looks at how well deep learning models, such as convolutional neural networks (CNNs) and region-based convolutional neural networks (R-CNNs), detect
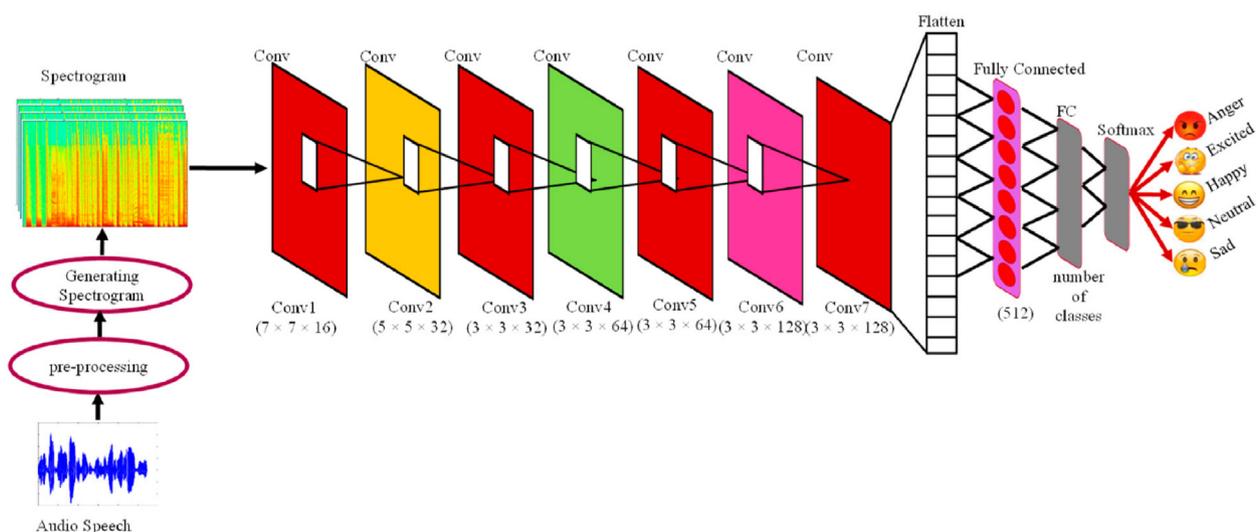

Fig. 8. Speech enhancement using deep learning-based audio signal processing [11].
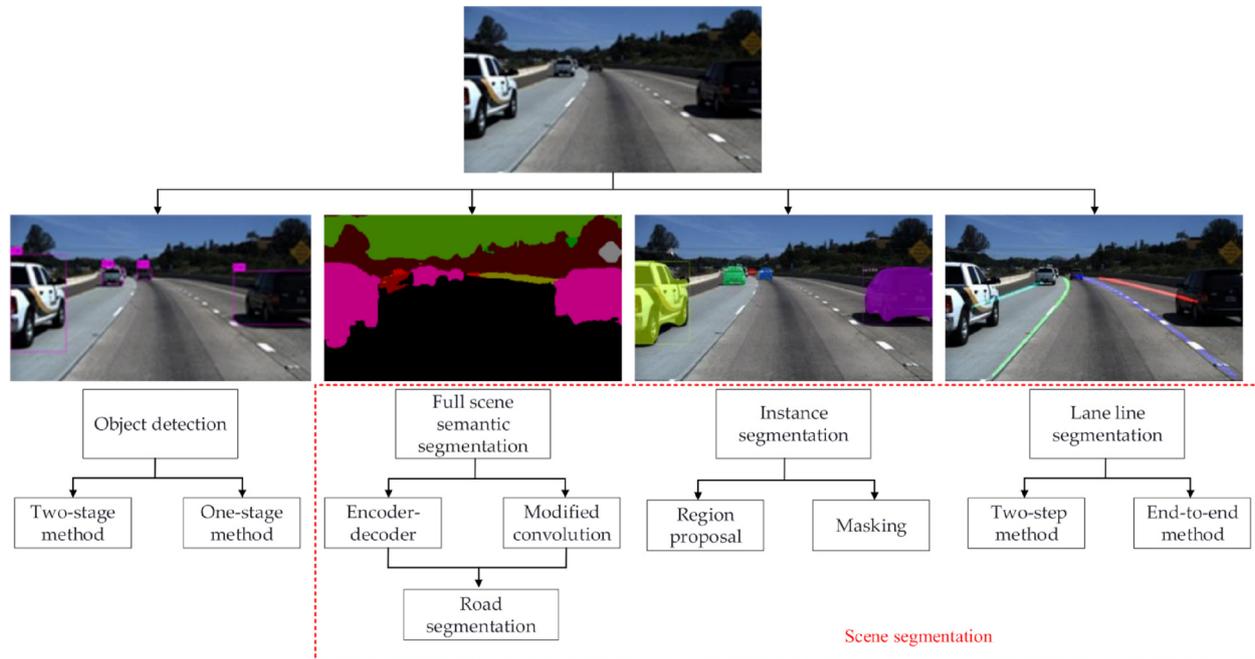
Fig. 9. Object detection in autonomous driving using deep learning [12].

and locate objects of interest in real-time driving scenarios. The deep learning models will be trained and evaluated using datasets from real-world driving, including photos and related object labels. The study intends to shed light on the possible benefits of AI in image processing for applications involving driverless vehicles. The overall structure of this essay. Object identification, full-scene semantic segmentation, instance segmentation, and lane line segmentation are the four work streams that make up the scene understanding research [12].

3.1.10. AI in animation

The production of animated content has undergone a substantial change as a result of the quick advancement of AI technology, making it possible to produce animation that is both more effective and realistic [119]. This study will look into several applications of AI in animation, such as character animation, motion capture, rendering, and narrative [120]. This research aims to shed light on the revolutionary potential of AI technology in the animation business by exploring the advantages, difficulties, and future possibilities of AI in animation [51]. A substantial part of the recent developments in the animation sector can be attributed to the incorporation of AI [52]. The animation pipeline has transformed because of AI techniques like machine learning, computer vision, and natural language processing, which enable

creators to produce more immersive and visually stunning material [53].

Example: As shown in Fig. 10, data on four face groups—American live-action, Japanese live-action, American animation, and Japanese animation—were gathered. 75 faces were separately collected for each group. Since 2000, 75 members of the US Senate and 75 members of the Japanese Senate have provided the human facial profiles that were used. Candidates for the Senate were picked because they come from all of the regions and share the same ethnic makeup as the rest of the country's population. The two candidates who receive the most votes nationwide are chosen to represent the nation in the Senate, which has two senators elected from each state [13].

4. Issues and future challenges

AI technology integration across job domains has the potential to transform companies, increase productivity, and improve decision-making. The broad use of AI does, however, bring about several difficulties and worries. This study will look at the effects of integrating AI into various work domains while taking into account the ethical issues, societal effects, legal frameworks, and technical challenges that come with doing so. This research intends to promote the safe and advantageous integration of AI across many professional settings by addressing these issues and future opportunities.

Fig. 10. AI-based facial animation for feature films [13].

4.1. Ethics

The use of AI brings up issues of privacy, bias, responsibility, and openness. For instance, protecting patient privacy and upholding ethical standards when managing sensitive medical data are essential in the healthcare industry. Biases in AI algorithms can provide biased results in the financial sector. To address these ethical issues, AI development and application must follow strict rules and standards.

4.2. Legal difficulties

The application of AI in the workplace frequently involves significant legal issues. Some of the legal challenges include data protection, intellectual property rights, liability, and regulatory compliance. Industries must traverse legal frameworks and make sure AI systems abide by pertinent laws and regulations, such as industry-specific rules or the General Data Protection Regulation (GDPR) in Europe.

4.3. Data quality

Ensure data quality, eliminate algorithmic biases; make AI models interpretable, and make the system durable, to name a few technical hurdles. Biased AI results may result from problems like biased training data. A lack of interpretability can make it challenging to comprehend how AI systems make decisions, which reduces trust and accountability. A significant difficulty is still maintaining the fairness, ability, and reliability of AI models.

4.4. Collaboration between humans and AI

Collaboration between humans and AI systems must be smooth to be successful in a variety of professional settings. This entails creating user-friendly user interfaces, building efficient human-AI communication channels, and fostering confidence between human workers and AI systems.

4.5. Fairness and bias

AI systems have the potential to reinforce biases found in training data, producing biased decision-making outputs. It is a big problem to address bias and ensure justice across various demographics, cultural contexts, and societal groups. Building trustworthy evaluation processes and impartial AI algorithms are crucial first steps.

5. Conclusions

The integration of AI into several professional fields has the potential to significantly improve productivity, efficiency, and decision-making processes. However, it raises several issues that must be addressed to ensure its responsible and effective implementation. One of the most difficult tasks is negotiating ethical issues like as privacy, bias, accountability, and openness. Because AI systems frequently rely on massive volumes of personal and sensitive data, maintaining strong privacy safeguards is critical to preserving confidence. Algorithmic bias and a lack of openness in decision-making processes can provide unfair results, weakening the confidence of AI systems. Balancing innovation with the protection of individual rights

and society values is critical for achieving ethical AI integration. AI adoption must grapple with complex regulatory frameworks that differ by area and industry. Data protection, intellectual property rights, responsibility for AI-driven choices, and regulatory compliance are among the most pressing legal challenges. For example, establishing compliance with legislation such as the General Data Protection Regulation (GDPR) necessitates careful navigation in order to preserve users' data rights while also enabling innovation. Creating explicit criteria for accountability and liability is crucial, especially in high-risk applications such as healthcare and self--driving vehicles. AI has far-reaching societal repercussions, particularly in terms of job displacement, shifting worker dynamics, and socioeconomic disparities. As AI automates regular work, there is an increasing need for preemptive efforts to limit the potential negative impact on employment. Reskilling and upskilling programs are critical in preparing the workforce for new positions that need human-AI collaboration. Addressing these concerns is critical for promoting an equal and inclusive transition to an AI-driven economy. AI technology must overcome a number of technological barriers before they can be widely adopted. These include poor data quality, algorithmic biases, interpretability issues, and system robustness. For example, making AI models accessible and interpretable is critical in high-risk industries like as healthcare and finance, where decisions can have serious implications. Furthermore, developing strong and dependable AI systems is required to reduce errors and assure constant performance under changing conditions. By confronting the problems of AI integration head on, we can create a future in which AI technologies augment human talents, promote innovation, and contribute to the well-being of individuals and society as a whole. Responsible AI system development and deployment will pave the way for a more intelligent, inclusive, and sustainable future in which AI not only solves complicated issues but also unlocks human potential and improves everyone's quality of life.

Contribution of the authors

All authors contributed equally to the preparation of this manuscript. All authors reviewed the manuscript.

Ethics information

None.

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AI usage declaration

AI has been used to check language correction.

Conflict of interest

This research work has been done by all the listed authors with mutual interest. All the data used in this research work are cited in the manuscript. Therefore, no conflict of interest related to any person or agency for this manuscript.

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