Deep Science Publishing, 2025
https://doi.org/10.70593/978-93-7185-365-1_5

Chapter 5: Exploring the practical applications of artificial intelligence and machine learning

Priyambada Swain

Infosys Limited

Introduction

Artificial intelligence (AI) has become an important area of research during the last few decades. Currently, AI concepts are introduced in industrial, academic, and even in day-to-day applications [1]. The main purpose of AI is to compute expected results based on previous results and associate a sense of logical reasoning to the past data. However, for beginners, the theory behind implementing AI techniques could be confusing and challenging. In addition to theoretical concepts, the implementation of algorithms in real life is also a significant area that creates a substantial interest in this field [2-3]. The area of MLOps – machine learning operations – transforms the model from theory to operations. MLOps enables the development of proper AI pipelines, which eventually aid in integrating AI models into a piece of functional software. The main objective of this article is to introduce the foundational techniques of AI and machine learning, followed by a focus on practical applications, ethical considerations in deploying AI, and use cases in different sectors.

2. Overview of Artificial Intelligence

Artificial Intelligence (AI) deals with the automation of intelligent behaviour. It is the science and engineering of making intelligent machines, especially intelligent computer programs, and it is related to the similar task of using computers to understand human intelligence. AI considers the use of agents that perceive their environment and take actions that maximize their chance of success at some goal. Intelligent behaviour can be exhibited by entities such as animals and humans, being the result of processes within their brains, whereas its traditional foundations can be traced back to Aristotle's theory of its logical principles. Logic and reasoning are therefore involved specific aspects of AI but believed to be only part of the whole [2,4,5].

Artificial Intelligence also considers the automation of intelligent behaviour, in various activities that humans associate with intelligence, such as making inferences and decisions, and implementing behaviour that is insensitive to minor changes in the environment.

The realization of behaviours that are unsupervised and unteachable, for example the sensory recognition and design activities, are also areas that are encompassed within AI. Likewise, speech thrashing against set of predefined rules may be considered as a specific case within the overall thrasher recognition activity.

As an academic discipline, AI evolved from the matrices of computer science. The term Artificial Intelligence was first coined during a conference held on 9th December 1956 at the Dartmouth College in Hanover, USA, and is usually credited to John McCarthy. Present-day AI research defines the field as focused on "intelligent agents": any system that perceives its environment and takes actions that maximize its chances of achieving its goals [6-8].

The evolution of Artificial Intelligence has seen the development of several distinct sub-fields. Each of these sub-fields surpasses the limits of various levels of abstraction: symbolic behaviour, behaviour without explicit symbolic representation, human oriented behaviour, rational behaviour, behaviour oriented towards a defined task, or behaviour that optimizes a performance criterion. The combination of these levels of abstraction constitutes the general AI approach.

2.1. Definition and Scope

Artificial intelligence (AI) can be described as a capable and flexible tool that is applied to fulfil operative goals in various fields, especially those that involve areas of interest for society, present high complexity, as well as resolution at scale and in a timely manner of voluminous amounts of data [9,10]. By these parameters, the presence of intelligence in humans, through the use of experience to adopt decisions, is mimicked. The idea of creating a machine capable of thinking and understanding like humans goes back at least to the 4th century. However, it was not until 1980 that these machines could actually learn or adapt; and it was in 2016 when artificial intelligence began to be considered as "smart".

Effectively, this Steam Engine analogy, proposed by Alan Turing, enables differentiating an intelligent machine capable of performing various tasks in Society. Hence, Industry 4.0 will entirely revolutionize the productive system, disconnected from the growing improvement of digital technologies and artificial intelligence [11-13]. Whether artificial intelligence acts "good or evil" will depend, in part, on how it is regulated, especially in sensitive sectors such as health, security, banking, finances, and public services, reflecting the characteristics of the countries or regions where it is deployed.

2.2. Historical Development

In the mid-20th century, a group of researchers from diverse scientific disciplines proposed a radical idea: creating an intelligent machine with the ability to perform tasks that would require human intelligence if done by a real person. The foundations of AI were drawn assuming that the various processes and functions, mainly cognitive, carried out by the human brain could be reproduced by a machine. If successful, such a machine would be capable of replacing people in some of their daily chores.

Making machines intelligent seemed almost impossible. During the first decades of AI research, the dream was tangible, almost touchable. However, as frustration set in, expectations lowered. Over the years, AI as a discipline has relentlessly evolved. With the birth of AI, there grew a passionate desire in the scientific world to create machines capable of performing highly intellectual tasks such as reasoning, learning, generalizing, making discoveries and decisions, or producing original creative works. In the beginning, the prospect of achieving general intelligence - a machine as intelligent as a normal human - was both alluring and daunting. The prevailing belief was that human brains function akin to highly complex computers processing symbolic information; thus, building an intelligent machine would naturally follow. Yet, despite decades of rigorous research in artificial intelligence, the initial goals remain far from reached.

3. MLOps: Machine Learning Operations

After presenting the fundamentals of artificial intelligence, MLOps is introduced as the bridge from AI theory to practical applications. It provides the necessary steps to develop artificial intelligence models and start testing them. MLOps enables AI implementation under a standard which includes data aggregation, data cleaning, model management, testing and validation, AI deployment, and AI monitoring. Successful implementation in the areas of computational performance, processes, and people orchestrates people, business processes, and technologies for increased enterprise value with AI [2,14-17].

MLOps emerges as the natural evolution of traditional DevOps but applies exclusively to the field of artificial intelligence. The difference between a conventional computer program and an AI system lies in development: In the former, explicitly programmed functions are defined by humans, while in AI systems these functions are replaced by prediction models generated from data. Machine Learning Operations, or MLOps, is a discipline that combines people, processes, and technologies for continuous delivery and automation of ML models in production environments. Implementation enables the operationalization of prediction models or intelligent applications that guide decisions ranging from simple to complex—regardless of the sector. It encompasses concepts such as Data Engineering, Data Validation, Data Monitoring, Feature Engineering, Training, Testing, Ethical and Legal aspects, Deployment and Management of Artificial Intelligence in business environments. MLOps proposes a set of rules and routes to follow, aiming to bring business closer to the practical use of predictions, boosting the current and future advancements of both science and the community.

3.1. Introduction to MLOps

MLOps, a shortened compound of "machine learning operations," constitutes a higher discipline within artificial intelligence, specifically focused on the support, maintenance, deployment, and governance of models in productive operations [9,18-21]. Machine learning models require continuous monitoring and governance in productive use, necessitating the regular repetition of the entire process chain whenever there are changes. At a minimum, MLOps addresses discrete steps of machine learning. It can also be expanded to encompass cross-functional tasks. Model development and data incubation are supported by a suite of tools and stages.

Geographically, the interest and establishment of MLOps are predominantly concentrated in Europe and North America. Nearly all companies that employ machine learning in practical applications recognize the necessity of MLOps—or a similar configuration and structural approach—in ensuring that their models and data pipelines function reliably over years and decades. This support for durability and repeatability plays a significant role in addressing the ethical dimensions of AI. By implementing MLOps, considerations of digital sustainability can be safeguarded throughout the ALTAI Framework. Without operations and the workshop approach of MLOps, genuine progress in closing the GAP between the Ethical Framework and Ethical Use of AI remains elusive.

3.2. Key Components of MLOps

Machine learning operations, commonly referred to as MLOps, can be defined as the process of operating and maintaining a deployed AI model. MLOps is intended to valid and improve on DevOps principles. Every step of the lifecycle is distinctly set up in such a way that it avoids unknown or unexpected risks. MLOps ensures that machine learning technology will not cause any harm when released for public use [22,23]. Properly designed MLOps is expected to control AI ethics. Furthermore, everything is enabled in such a manner that it can operate during normal time and at disaster recovery moments. All operational and disaster recovery principles are established through MLOps. The main goal of MLOps is to make AI models accessible for use and to improve their efficiency.

The MLOps lifecycle consists of several stages, each focusing on different aspects of machine learning models. The development stage involves Teams building machine learning models [24-26]. In the continuous integration stage, the code and development models donated by the Team will be tested. The continuous delivery stage ensures that the models are ready for validation, deployment, and can be used by the public. Monitoring is conducted in the continuous monitoring stage. When any risks or issues occur in services that are using machine learning models, bug fixes and improvements will be arranged by the Team in the continuous training stage.

3.3. MLOps Lifecycle

AI fosters data-driven decision making in applications across healthcare, finance, retail, education, and more. MLOps represents a set of operational practices to simplify the deployment of AI applications to production [27,28]. The MLOps lifecycle encompasses data management, model development, continuous integration and delivery (CI/CD), as well as governance, enabling organizations to operate AI applications effectively at scale.

The AI/ML lifecycle comprises four broad stages—data management, model development, model deployment, and model operations—and is supported by CI/CD services at the center. Data Management involves collecting, validating, and preparing data. Model Development focuses on feature engineering, model training, and evaluation. Model Deployment covers processes for deploying models to production and serving predictions. Model Operations entails monitoring model performance and retraining when necessary. CI/CD practices automate building, testing, and delivery of AI models, integrating code and model pipelines to ensure reliable and reproducible deployments.

3.4. Best Practices for MLOps Implementation

The rapid growth and adoption of Artifical Intelligence through Machine Learning techniques have highlighted the need of deploying models in production. Through an AI model an organisation could potentially obtain competitive advantage against producers that do not rely on it for production and operational decisions [19,29-31]. There are numerous factors considered for an emergent market leader such as equitable and empathetic society, optimal production of goods, maintaining air and water quality, human-centric artificial intelligence, optimal infrastructure, smart health-care, education and protection of life. These factors are directly linked to the human life and need to be implemented optimally to build the market leader on the given parameters [32,33].

MLOps allow an organization to scale up its process, avoid model loss or model degradation, and ensure model governance, security and compliance. MLOps removes communication gaps between teams, saves monitoring and debugging time, and enables fast recovery in case of failure. It helps in delivering a positive customer experience, improved customer engagement, on-time delivery, and better resource planning. Embarking on the MLOps journey can be a challenging task but it pays off a lot in terms of long-run benefits. MLOps best practices help overcome the challenges during the journey and provide the desired results.

4. Ethical Considerations in AI

As artificial intelligence (AI) is deployed increasingly in high-stakes, real-world situations, a global discourse on AI ethics is emerging [34-36]. The dialogue revolves around biases and discrimination, AI transparency and explainability, privacy and data governance, robustness and accountability, among many other issues. Adhering to ethical guidelines mitigates the risks of AI system misuse and strengthens stakeholder trust in the technology.

The practical application of AI in regulated sectors (e.g., use of AI models in credit scoring in financial services) requires formal approval from regulatory authorities. The approval process considers the risks associated with the AI models and their applications. The risk assessment and approval of a model is dependent on where and how it is deployed. Risks arising due to the application of AI and AI model bias vary widely; for example, a model supporting a medical diagnosis will require significantly greater attention to detail regarding bias than a sentiment analysis model. AI model risk ratings classify models on a risk scale such as – high, medium, low [37-40]. The varying requirements for AI models in different sectors and the need to comply with regulations in the countries where models are deployed have led to the emergence of AI constitution frameworks.

4.1. Understanding AI Ethics

Ethical consideration is admittedly one of the big questions in the field of artificial intelligence. With its increasing adoption in daily life as well as in business, and with the colossal impact this implies, it has become a delicate topic, raising crucial questions such as, in Khurana, ‘‘Should machines be given the mandate to decide?” The main issues discussed in the literature are bias while training AI models, lack of transparency or unfair disadvantages to certain groups, and concerns regarding privacy and legal responsibility for decisions that AI makes.

The law currently does not cover questions such as responsibility or the right to privacy. The need for an ethical framework that can successfully guide the implementation of AI in business is now recognized; for instance, the guidelines of AI HLEG are based on ethics and are addressed to the various stakeholders participating in the business AI lifecycle. Practical frameworks for auditing business AI systems, applying the guidelines, are contained in the works of Karppinen. Business AI ethics is discussed also in Cardon, who accordingly propose a conceptual framework, summarizing the ethical issues, a process of ethical decision under AI, and a rating scale for ethical business AI.

4.2. Bias and Fairness in AI

Ensuring fairness requires addressing the issue of bias in Artificial Intelligence (AI). It is necessary to consider the ethical implications of using AI technology and take appropriate precautions. The type and amount of training data have a significant impact on model training; the issue is further complicated because of the complexity of the algorithms [41-43]. The training data could be biased if it represents a specific or limited part of the population. Any bias in the training data will persist in the model, and if it is implemented in real world applications, it will lead to unfair situation for other population groups.

The problem arises when a model trained with bias-laden data determines the outcome of the decision resulting in a serious consequence [28,44-47]. For example, if the human resource department is depending on a model for hiring, then the model might decide a suitable human resource candidate by analysing the previous hiring data. But, if the previous recruitment data possessed any bias, then the model will learn its pattern and as a result may lead to discrimination against certain parts of the population.

4.3. Transparency and Accountability

A significant development in AI systems is their growing complexity, which can make tracing the decision path of algorithms difficult, especially in automated decisions [48,49]. This complexity raises questions about how to provide transparency that allows affected persons to understand if their rights have been respected, enables authorities to assess risk or discrimination, and prepares enterprises for potential liability. The European Commission, for example, recommends an explainability approach clarifying the decisions made by an AI system with transparency for users of AI systems. Transparency alone does not remove or rule out bias and discrimination; discrimination should be eliminated, if feasible. Explainability entails making the sociodemographic data used in training AI models and the characteristics of the emerging model accessible and intelligible for specific use cases.

37 cases of AI-generated bias from a variety of sources were collected. If biases are systematically detected, developed, and used, they can make economies and societies inequitable, discriminatory, and unjust. There is a necessity for a monitoring system capable of supporting the incorporation of controls to societies that use AI. A population-wide response plan to AI bias is proposed. The system considers the phases of data input, data processing, and data output and operates on a dual scale: city and population [3,50-52]. The first proposes a mechanism for managing automated decisions made by algorithmic implementations of AI. The second is an IoT-based control system that monitors biases or discriminatory actions in populations.

4.4. Privacy Concerns

MLOps addresses profound concerns, such as the privacy of individuals whose data is used for training neural networks. Several strategies focus on protecting the data while the model learns: Before bringing the data into the organization, it is anonymized or pseudonymized. The training can, furthermore, be done differentially privately, that is, the learning is executed in such a manner that the model cannot reveal any information about the individuals in the training data [53-56].

Privacy and data protection laws govern the use of personal data for processing. Sensitive data (e.g., concerning health) is protected by stricter provisions, such as the GDPR. Individuals can request human intervention when decision-making processes have legal effects on them. When using or training large language models, not only is the training data a potential breach of privacy, but also the output can produce personal data, such as names, addresses, or even passwords.

4.5. Regulatory Frameworks

The division of AI applications in healthcare into bioinformatics and medical informatics highlights distinct domains of use. Privacy-by-Design (PbD) offers a strategic methodology to address data privacy concerns inherent in AI implementations. Ethical considerations—bias, accountability, transparency, honesty, safety, and privacy—emerge as core pillars in AI application, underscoring the necessity of a regulatory framework.

Regulatory frameworks for AI have become a major topic in recent years. The proposed use of the Explicit Ethical Machine Reasoning Architecture (EEMRA) aims to automate the process of vetting decisions made by ML models against ethical guidelines and constraints bases. The need for a legal framework that captures the vogue of AI in various domains is critical. Legislation is shifting from the sole protection of data privacy toward the ethical use of machine learning.

5. Use Cases of AI in Various Sectors

Artificial intelligence (AI) now plays a role in virtually every area of human existence, with ongoing innovations continually uncovering new potential uses. Specific examples from sectors serve to illustrate this reality.

In healthcare, AI algorithms detect patterns in X-ray images, facilitating early diagnosis of diseases such as tuberculosis and cancer. By enabling more rapid diagnoses, AI can make treatment more effective and accessible. In finance, AI detects fraud across an increasing number of activities, including identity theft, account takeover, and specific fraud types [2,4]. Retailers use AI-powered tools to develop personalized web pages for consumers, based on browsing and purchasing history. Logistics companies deploy AI-based optimization tools to reduce fuel consumption, improve routes, and enhance truck capacity utilization. Industrial companies apply AI techniques to predict damages and perform preventive maintenance on heavy machines. Educators employ AI systems to design more effective personalized curricula and automate the grading of essays and open-ended exams. In agriculture, AI permits automatic ripeness detection, thereby minimizing harvest losses.

5.1. Healthcare Applications

Artificial intelligence is often credited with revolutionizing numerous industries and tasks, and healthcare is an important one among them. With AI being integrated into multiple processes and activities, some of them also include the healthcare sector. Machine learning applications can be implemented for disease prediction, diagnosis, and prognosis. Clinical decision support systems, clinical service management, time and motion studies, medical image analysis, population management, public health surveillance, and remote patient telemetry are only a few examples of how AI can be utilized in healthcare.

Operations include disease identification, prognosis, treatment design, and drug creation. Diagnosis of diabetes mellitus, diabetic retinopathy detection, COVID-19 diagnosis and prognosis analysis, vaccine development, breast cancer tumor classification onto study, and so on are examples of healthcare applications. For illness prediction, algorithms are used to analyze a person's medical history and illness information. Patients who have a high risk of developing cardiac disease or diabetes are recognized, and suggestions are made for early detection. Based on the patient information, the medical help needed to cure each disease is analyzed, and an optimal treatment plan is proposed. Finally, deep learning algorithms are used in the development of new medications and vaccines devoted to specific disorders.

5.2. Finance and Banking

Financial and banking organizations have used AI for many years, such as algorithmic stock trading or credit scoring. Its applications in fraud detection are growing rapidly. By analysing historical transactions and external data, the model can identify fraud patterns. Compared with traditional approaches, intelligent models detect even unknown frauds and reduce false alerts. Another trend involves providing better quality services. Financial companies increasingly depend on NLP models, e.g., credit risk reports, financial consulting, and news analysis.

The launch of ChatGPT signifies a potentially large shift for the entire industry. The model generates more human-like conversation, provides financial knowledge, and executes trades. Companies embarking on the AI journey create unified data platforms. Using credit card transactions, marketing behaviour, customer complaints, and financial reports, organizations gain a 360-degree perspective of their customers. The assistance leads to improved personal finance management, efficient quick loan services, easier credit card payments, and very fast and accurate customer support. In the future, the combination of "knowledge based" and "memory based" solutions will reshape every Individual User Experience (UIX) within the financial and banking industry.

5.3. Retail and E-commerce

Although retail and e-commerce have a similar aim, the shopping experience is very different in each setting. In retail, shoppers get the benefit of touching, feeling, smelling, and trying products before making a purchase decision. Meanwhile, e-commerce shoppers usually have a wide variety of products to choose from and the convenience of shopping from their smartphones with fast delivery times and cheap prices.

Artificial intelligence makes shopping easier for retailers and their customers. One of the main factors for retailers' success is understanding customers' needs and preferences for different products or brands [2,4]. They can use AI to analyze the huge amount of data generated by customer interactions. AI helps businesses to make smarter decisions about when to restock warehouse products so that customer demands are always met.

5.4. Transportation and Logistics

The transportation and logistics sector has embraced AI and ML for more than two decades. The activities in this area are extremely diverse; however, there are important use cases in urban mobility, mobile applications for route planning, freight delivery services, airline services, self-driving vehicle development, optimizing urban transport, and vehicle routing. In addition, some of these applications have synergies, and a single algorithm or model can cover a wide range of use cases in all topics. For instance, a route determining model can be applied to airlines, freight delivery services, and urban mobility. Almost every use case depends on real-time data being collected from sensors monitoring traffic, weather, vehicle speed, location, distance traveled, remaining vehicle fuel, among others.

AI and ML play an inseparable and critical part in modern urban passenger transportation. Systems such as Uber, Lyft, Cabify, and others use ML models for scoring drivers and passengers, and such scores directly impact service quality and driver earnings. Surge pricing depends substantially on deep learning models developed based on historical data and trend analysis. Moreover, big mining tools, recommendation systems, and the billing forecasting associated with these companies are also assisted by AI and ML. In freight delivery services, ML models focus on route optimization, fuel consumption reduction, capacity maximization, driver scores, customer scores, shipment tracking prediction, and turn prediction. These areas have a significant impact on the company's business, shaping decisions that define operating procedures.

5.5. Education and Learning

Artificial intelligence (AI) is also advancing at an accelerated pace in the sector of Education and Learning, many of the emerging applications of AI provide a great promise of making modern education more effective and accessible to a broader community of students. However, while intelligent educational systems of the near future will be acting increasingly autonomously, their applications raise a number of ethical concerns. To address these concerns, these systems need to be designed in an ethically aware manner that also considers emotional aspects.

The ethical awareness of intelligent educational systems has to be developed over their entire lifecycle: starting with the conception phase in which the design team addresses ethical and emotional aspects and makes ethical design decisions, over the development/MLOps phase in which the actual implementation of ethics and stakeholders' values takes place by coding them into ethical educational-related algorithms and models, up to the operation phase when especially the autonomous acting of the system in a real-world environment raises ethical concerns and requires corresponding mitigation strategies. The following list of common Use Cases of AI in Education and Training should serve as an initial set and is expected to grow during AI research dedicated to education.

5.6. Agriculture and Food Production

Modern agriculture faces the daunting challenge of sustainably feeding more than 9 billion people by 2050 under the adverse conditions imposed by climate change. The fecundity of agricultural production relies largely on the quality of natural resources such as soil, fertilizer supply, water, sunlight, seasonality, and temperature. With a rapidly growing population and dwindling natural resources, it is imperative to cultivate these resources in a sustainable manner. To accomplish this, farms must be more efficient and resilient. In addition, food systems—as well as the wider agricultural supply chain—must be more resilient to major disruptions caused by extreme events such as droughts, fires, floods, and human conflicts.

In recent years, algorithms powered by big data have been able to understand agricultural landscapes and provide genuine early warnings of natural disasters and other global risks. Future advancements in generative models promise to improve the efficacy of Early Warning Systems (EWS) or recommend risk mitigation measures against the impact of climate change on agriculture and food systems. The various AI frameworks discussed earlier in this chapter—building blocks to train large models for diverse application domains like Computer Vision (CV), Natural Language Processing (NLP), Reinforcement Learning (RL), and Generative AI—can be integrated, deployed, and scaled through an

MLOps platform to operationalize timely and effective solutions for the agriculture and food production industry.

6. Challenges and Limitations of AI

Artificial intelligence has greatly improved in recent years and is no longer limited to research laboratories. AI is now becoming an important technology in many fields, including healthcare, finance, retail, logistics, industry, education and agriculture, thanks to the ability to train, test, deploy, monitor and maintain AI models efficiently. However, AI has several limitations and challenges, including the stigma that it is a "black box" and the increasing public demand for transparency, interpretability, explainability, trust, fairness, privacy and ethical aspects. To address these limitations and challenges, many regulations and laws are being imposed on AI applications and services. Machine learning operations can help to alleviate these issues and ensure successful AI implementation and automation in various fields.

Artificial intelligence (AI) is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans or animals. Leading AI textbooks define the field as the study of "intelligent agents": any system that perceives its environment and takes actions that maximize its chance of achieving its goals. The term "artificial intelligence" is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem-solving". As machines become increasingly capable, tasks considered to require "intelligence" are often removed from the definition of AI, a phenomenon known as the AI effect. For instance, optical character recognition is frequently excluded from things considered to be AI, having become a routine technology.

6.1. Technical Challenges

Machine Learning Operations (MLOps) is a concept that addresses the operational challenges of Artificial Intelligence (AI) systems with a particular focus on Machine Learning (ML) components. Its primary goal is the continuous and scalable functioning of AI-based software products. The increasing application of modern methods in expanding needs results in enormous and complex data, emphasizing the importance of AI systems. Realizing AI's benefits requires attention to deployment, execution, and management.

Integrating complex AI models into products is complex. Although Artificial Neural Network (ANN) models achieve high accuracy, the various steps from data acquisition to deployment play a crucial role in the final product. In practice, only a limited number of ANNs are implemented due to issues encountered during the product life cycle. These challenges underline the importance of life-cycle management in AI applications.

6.2. Ethical Dilemmas

The growing use of AI models in everyday life and in sectors such as healthcare, the legal industry, and logistics makes it imperative to develop them ethically. Ethics provide standards of behaviour. In everyday life, major moral values include respecting others, not harming them, upholding commitments, and helping others in need. Models should be developed integrating elements such as bias detection, transparency, certification of correctness, security, trust, privacy, explainability, and legal aspects. These elements relate to the phases of MLOps—such as data collection and cleansing, training, testing, prediction, review, and model correction—and must also consider the specific applications. Application use cases will determine whether acceptable ethical measures have been implemented, as there is scope for bias detection in algorithms, models, and data during a specific predictive task.

Healthcare and disease prediction use cases require algorithms and AI models to ensure privacy and security while providing trustworthy outcomes. In contrast, legal, financial, or retail use cases need models that are transparent and certified for correctness. In all cases, models older than the predefined shelf life must be reviewed and corrected before reinstatement, returning to the training lifecycle based on developer feedback. The societal context also plays a role in ethical AI use. There is an ongoing debate about the legality of using AI in autonomous vehicles or detecting the identity—or age and gender—of criminals using AI cameras.

6.3. Societal Impact

In addition to technical and engineering challenges, the ever-growing utilization of AI raises significant concerns in terms of its impact on society. These concerns contribute to a strong societal resistance against the broader introduction of AI-based technology. Social implications of AI include potential biases in datasets employed for AI training and differing opinions regarding the use of algorithms for risk analysis or routine decisions. The degree of human disclosure about AI applications in their environment is also pivotal, alongside the potential for informational opacity that diminishes the transparency surrounding AI decisions.

Although AI development projects hold considerable potential in advancing humanity, their implementation in real environments necessitates compliance with data protection regulations, such as the European General Data Protection Regulation (GDPR) or the Chinese Personal Information Protection Law (PIPL). The development of AI-related laws is vital to ascertain responsibilities, address liability issues, and define the applicability and limitations of autonomous systems to prevent damage or harm in critical applications.

7. Future Trends in AI

While the future of AI will bring significant changes at a technological level, the impact on the way we live and work will be even greater. Emerging computational technologies such as tangible interfaces, extended reality, ambient intelligence and sensory augmentation will create new ways of interaction and perception around and within the natural environment. The forthcoming AI era will transcend the traditional theory–practice/action dichotomy: AI will be closer to various fields, such as the humanities and social sciences.

Labor will undergo profound changes, redefining the role played by knowledge workers and their interaction with AI assistants, and eventually affecting also the patterns of reporting, coordination and organization. AI-assisted workers will be more productive and will be able to accomplish more comprehensive and complex tasks. The future of AI will also bring new perspectives for AI governance, the definition of control rules and the scope of regulation. Decision makers will be more AI literate, and governance strategies will be supported by AI tools. These tools will also help in planning the actions of first responders in the case of crises, in anticipating and controlling the impact of aggressive policies on the environment, and in anticipating and monitoring the actions of potentially dangerous adversaries.

7.1. Emerging Technologies

Rapid advances in artificial intelligence (AI) arise constantly. Cited developments include algorithms that approximate human commonsense reasoning, represent and learn causal relations, and provide interpretability and explainability. Progress is observed in areas such as conversational AI, object detection, speech recognition, and text to image and text to video generation. Research interests extend into the creation of non-player characters for interactive gaming environments. Emerging technologies are generally classified into helpers, transformers, or enablers. The smarter society of the future might well be fueled by AI-powered natural language processing that offers real-time intelligent interpretation and analysis of conversations and human intent. The synergy between emerging technologies and smart mainly technologies augurs a promising future.

7.2. AI in the Workforce

While Artificial Intelligence is inherently a tool conceived to enhance and augment human activity, cognitive tasks or services completed by AI can influence the workforce's structure. One such change includes the automation of specific jobs or job portions, such as the role of factory workers, by substituting them with AI-driven solutions. Depending on the sector, many different tasks exhibit a natural fit with automation, particularly for repeated tasks with minimal complexity. Still, AI has significantly contributed to creating new jobs and allowing the workforce to focus on other valuable tasks, allowing them to explore hobbies or spend more time with friends and families. Moreover, AI advances have improved a wide range of day-to-day tasks, reducing effort and increasing efficiency and productivity. Common examples include virtual assistants such as Siri or Alexa and multimodal content generation models such as ChatGPT or Midjourney.

Based on data from the McKinsey Global Institute, approximately 15% of the global workforce, equivalent to 400 million individuals, could be displaced by AI-driven automation. Furthermore, an additional 30% of workers, or 800 million individuals worldwide, may need to transition to different occupations. A remaining 55% fall within an intermediate group where AI's impact varies by task. Workforce preparation is a crucial discussion point, with experts divided between those who perceive AI as the end of work and those who consider it a tool facilitating a more fulfilling workforce. It appears certain that rethinking opposition to AI might be wise, as it seems AI is unlikely to disrupt in the coming years.

7.3. Global AI Governance

Artificial intelligence is changing the way people live and work, creating many benefits for society but also raising some new questions and challenges. Sustainable AI governance can help navigate the growing complexity of Advanced AI. Many jobs no longer require precise and repetitive human execution, but instead require information collection and the use of judgement. AI technology is expected to support humans in managing, making, and implementing decisions. It can assist in understanding and interpreting human needs and habits. With time, machine intelligence becomes more comprehensive and reacts faster, thereby enhancing human-AI interactive partnership.

The technology is rapidly maturing, but many of the legal, ethical, and philosophical questions remain open. Policymakers need to ensure that they govern AI in a way that accounts for unknowns, including the possibility of negative unintended consequences. International cooperation is needed to establish common standards and reduce perverse incentives, making the future of AI safer and more beneficial. AI risks should be managed similarly to other complex systems such as nuclear power plants and medical therapies, allowing society to reap the benefits of the technology without falling victim to the potential hazards.

8. Conclusion

The foundation has been laid for a discussion on practical applications of AI in society and for business: Academic basics in "Overview of Artificial Intelligence," operational implementation and control in "MLOps: Machine Learning Operations," ethical aspects in "Ethical Considerations in AI," exemplary use cases in "Use Cases of AI in Various Sectors," practical challenges posed by AI in "Challenges and Limitations of AI," and final future trends in "Future Trends in Artificial Intelligence." These interconnected concepts together provide a deeper understanding of the relevance of AI today.

The milestone from AI concept to practical use is MLOps, a set of management and development tasks applied throughout the AI lifecycle, which make AI usable for social or business purposes. The list of AI implementations in every-day live and business shows the impact of AI usage on society and business. But at the same time, the challenges and limitations of AI—and especially the ethical dimension—show that adequately dealing with AI is imperative to proceed with its use in society and business. Future trends—especially in the domains of AI-powered workforce automation and AI governance—indicate that the respective impact of AI on society and business will further increase.

References

[1] Ongsulee P. Artificial intelligence, machine learning and deep learning. In2017 15th international conference on ICT and knowledge engineering (ICT&KE) 2017 Nov 22 (pp. 1-6). IEEE.

[2] Panch T, Szolovits P, Atun R. Artificial intelligence, machine learning and health systems. Journal of global health. 2018 Oct 21;8(2):020303.

[3] Das S, Dey A, Pal A, Roy N. Applications of artificial intelligence in machine learning: review and prospect. International Journal of Computer Applications. 2015 Jan 1;115(9).

[4] Balyen L, Peto T. Promising artificial intelligence-machine learning-deep learning algorithms in ophthalmology. The Asia-Pacific Journal of Ophthalmology. 2019 May 1;8(3):264-72.

[5] Michalski RS, Carbonell JG, Mitchell TM, editors. Machine learning: An artificial intelligence approach. Springer Science & Business Media; 2013 Apr 17.

[6] Soori M, Arezoo B, Dastres R. Artificial intelligence, machine learning and deep learning in advanced robotics, a review. Cognitive Robotics. 2023 Jan 1;3:54-70.

[7] Ghahramani Z. Probabilistic machine learning and artificial intelligence. Nature. 2015 May 28;521(7553):452-9.

[8] Jakhar D, Kaur I. Artificial intelligence, machine learning and deep learning: definitions and differences. Clinical and experimental dermatology. 2020 Jan 1;45(1):131-2.

[9] Siau K, Wang W. Building trust in artificial intelligence, machine learning, and robotics. Cutter business technology journal. 2018;31(2):47.

[10] Panda SP. The Evolution and Defense Against Social Engineering and Phishing Attacks. International Journal of Science and Research (IJSR). 2025 Jan 1.

[11] Kühl N, Schemmer M, Goutier M, Satzger G. Artificial intelligence and machine learning. Electronic Markets. 2022 Dec;32(4):2235-44.

[12] Karthikeyan A, Priyakumar UD. Artificial intelligence: machine learning for chemical sciences. Journal of Chemical Sciences. 2022 Mar;134(1):2.

[13] Helm JM, Swiergosz AM, Haeberle HS, Karnuta JM, Schaffer JL, Krebs VE, Spitzer AI, Ramkumar PN. Machine learning and artificial intelligence: definitions, applications, and future directions. Current reviews in musculoskeletal medicine. 2020 Feb;13(1):69-76.

[14] Shivadekar S, Halem M, Yeah Y, Vibhute S. Edge AI cosmos blockchain distributed network for precise ablh detection. Multimedia tools and applications. 2024 Aug;83(27):69083-109.

[15] Helm JM, Swiergosz AM, Haeberle HS, Karnuta JM, Schaffer JL, Krebs VE, Spitzer AI, Ramkumar PN. Machine learning and artificial intelligence: definitions, applications, and future directions. Current reviews in musculoskeletal medicine. 2020 Feb;13(1):69-76.

[16] Panda SP. Augmented and Virtual Reality in Intelligent Systems. Available at SSRN. 2021 Apr 16.

[17] Bhat M, Rabindranath M, Chara BS, Simonetto DA. Artificial intelligence, machine learning, and deep learning in liver transplantation. Journal of hepatology. 2023 Jun 1;78(6):1216-33.

[18] Tyagi AK, Chahal P. Artificial intelligence and machine learning algorithms. InChallenges and applications for implementing machine learning in computer vision 2020 (pp. 188-219). IGI Global Scientific Publishing.

[19] Shivadekar S, Kataria DB, Hundekar S, Wanjale K, Balpande VP, Suryawanshi R. Deep learning based image classification of lungs radiography for detecting covid-19 using a deep cnn and resnet 50. International Journal of Intelligent Systems and Applications in Engineering. 2023;11:241-50.
[20] Kühl N, Goutier M, Hirt R, Satzger G. Machine learning in artificial intelligence: Towards a common understanding. arXiv preprint arXiv:2004.04686. 2020 Mar 27.
[21] Rane J, Chaudhari RA, Rane NL. Data Analysis and Information Processing Frameworks for Ethical Artificial Intelligence Implementation: Machine-Learning Algorithm Validation in Clinical Research Settings. Ethical Considerations and Bias Detection in Artificial Intelligence/Machine Learning Applications. 2025 Jul 10:192.
[22] Neapolitan RE, Jiang X. Artificial intelligence: With an introduction to machine learning. CRC press; 2018 Mar 12.
[23] Rane NL, Paramesha M, Choudhary SP, Rane J. Artificial intelligence, machine learning, and deep learning for advanced business strategies: a review. Partners Universal International Innovation Journal. 2024 Jun 25;2(3):147-71.
[24] Rubinger L, Gazendam A, Ekhtiari S, Bhandari M. Machine learning and artificial intelligence in research and healthcare. Injury. 2023 May 1;54:S69-73.
[25] Gupta R, Srivastava D, Sahu M, Tiwari S, Ambasta RK, Kumar P. Artificial intelligence to deep learning: machine intelligence approach for drug discovery. Molecular diversity. 2021 Aug;25(3):1315-60.
[26] Entezari A, Aslani A, Zahedi R, Noorollahi Y. Artificial intelligence and machine learning in energy systems: A bibliographic perspective. Energy Strategy Reviews. 2023 Jan 1;45:101017.
[27] Mohapatra PS. Artificial Intelligence and Machine Learning for Test Engineers: Concepts in Software Quality Assurance. Intelligent Assurance: Artificial Intelligence-Powered Software Testing in the Modern Development Lifecycle. 2025 Jul 27:17.
[28] Bini SA. Artificial intelligence, machine learning, deep learning, and cognitive computing: what do these terms mean and how will they impact health care?. The Journal of arthroplasty. 2018 Aug 1;33(8):2358-61.
[29] Wang W, Siau K. Artificial intelligence, machine learning, automation, robotics, future of work and future of humanity: A review and research agenda. Journal of Database Management (JDM). 2019 Jan 1;30(1):61-79.
[30] Nichols JA, Herbert Chan HW, Baker MA. Machine learning: applications of artificial intelligence to imaging and diagnosis. Biophysical reviews. 2019 Feb 7;11(1):111-8.
[31] Jones LD, Golan D, Hanna SA, Ramachandran M. Artificial intelligence, machine learning and the evolution of healthcare: A bright future or cause for concern?. Bone & joint research. 2018 Mar 1;7(3):223-5.
[32] Nuka ST. Next-Frontier Medical Devices and Embedded Systems: Harnessing Biomedical Engineering, Artificial Intelligence, and Cloud-Powered Big Data Analytics for Smarter Healthcare Solutions. Deep Science Publishing; 2025 Jun 6.
[33] Hyder Z, Siau K, Nah F. Artificial intelligence, machine learning, and autonomous technologies in mining industry. InResearch Anthology on Cross-Disciplinary Designs and Applications of Automation 2022 (pp. 478-492). IGI Global Scientific Publishing.

[34] Maguluri KK. Machine learning algorithms in personalized treatment planning. How Artificial Intelligence is Transforming Healthcare IT: Applications in Diagnostics, Treatment Planning, and Patient Monitoring. 2025 Jan 10:33.
[35] Mijwil MM, Aggarwal K, Sonia S, Al-Mistarehi AH, Alomari S, Gök M, Zein Alaabdin AM, Abdulrhman SH. Has the Future Started? The Current Growth of ArtificialIntelligence, Machine Learning, and Deep Learning. Iraqi Journal for Computer Science and Mathematics. 2022;3(1):13.
[36] Panda S. Observability in DevOps: Integrating AWS X-Ray, CloudWatch, and Open Telemetry. International Journal of Computer Application. 2025 Jan 1.
[37] Tapeh AT, Naser MZ. Artificial intelligence, machine learning, and deep learning in structural engineering: a scientometrics review of trends and best practices. Archives of Computational Methods in Engineering. 2023 Jan;30(1):115-59.
[38] Panda SP. Artificial Intelligence Across Borders: Transforming Industries Through Intelligent Innovation. Deep Science Publishing; 2025 Jun 6.
[39] Theodosiou AA, Read RC. Artificial intelligence, machine learning and deep learning: Potential resources for the infection clinician. Journal of Infection. 2023 Oct 1;87(4):287-94.
[40] Kersting K. Machine learning and artificial intelligence: two fellow travelers on the quest for intelligent behavior in machines. Frontiers in big Data. 2018 Nov 19;1:6.
[41] Panda SP, Muppala M, Koneti SB. The Contribution of AI in Climate Modeling and Sustainable Decision-Making. Available at SSRN 5283619. 2025 Jun 1.
[42] Goldenberg SL, Nir G, Salcudean SE. A new era: artificial intelligence and machine learning in prostate cancer. Nature Reviews Urology. 2019 Jul;16(7):391-403.
[43] Shivadekar S. Artificial Intelligence for Cognitive Systems: Deep Learning, Neuro-symbolic Integration, and Human-Centric Intelligence. Deep Science Publishing; 2025 Jun 30.
[44] Sultan AS, Elgharib MA, Tavares T, Jessri M, Basile JR. The use of artificial intelligence, machine learning and deep learning in oncologic histopathology. Journal of Oral Pathology & Medicine. 2020 Oct;49(9):849-56.
[45] Panda SP. Securing 5G Critical Interfaces: A Zero Trust Approach for Next-Generation Network Resilience. In2025 12th International Conference on Information Technology (ICIT) 2025 May 27 (pp. 141-146). IEEE.
[46] Rane J, Chaudhari RA, Rane NL. Data Privacy and Information Security in Deep Learning Applications: Risk Assessment and Patient Safety Protocols for Big Data Analytics. Ethical Considerations and Bias Detection in Artificial Intelligence/Machine Learning Applications. 2025 Jul 10:54.
[47] Mohapatra PS. Artificial Intelligence-Driven Test Case Generation in Software Development. Intelligent Assurance: Artificial Intelligence-Powered Software Testing in the Modern Development Lifecycle. 2025 Jul 27:38.
[48] Mich L. Artificial intelligence and machine learning. InHandbook of e-Tourism 2020 Sep 1 (pp. 1-21). Cham: Springer International Publishing.
[49] Mohapatra PS. Artificial Intelligence-Powered Software Testing: Challenges, Ethics, and Future Directions. Intelligent Assurance: Artificial Intelligence-Powered Software Testing in the Modern Development Lifecycle. 2025 Jul 27:163.

[50] Suura SR. Integrating Artificial Intelligence, Machine Learning, and Big Data with Genetic Testing and Genomic Medicine to Enable Earlier, Personalized Health Interventions. Deep Science Publishing; 2025 Apr 13.

[51] Panda SP. Relational, NoSQL, and Artificial Intelligence-Integrated Database Architectures: Foundations, Cloud Platforms, and Regulatory-Compliant Systems. Deep Science Publishing; 2025 Jun 22.

[52] Zhu S, Gilbert M, Chetty I, Siddiqui F. The 2021 landscape of FDA-approved artificial intelligence/machine learning-enabled medical devices: an analysis of the characteristics and intended use. International journal of medical informatics. 2022 Sep 1;165:104828.

[53] Mukhamediev RI, Popova Y, Kuchin Y, Zaitseva E, Kalimoldayev A, Symagulov A, Levashenko V, Abdoldina F, Gopejenko V, Yakunin K, Muhamedijeva E. Review of artificial intelligence and machine learning technologies: classification, restrictions, opportunities and challenges. Mathematics. 2022 Jul 22;10(15):2552.

[54] Gerke S, Babic B, Evgeniou T, Cohen IG. The need for a system view to regulate artificial intelligence/machine learning-based software as medical device. NPJ digital medicine. 2020 Apr 7;3(1):53.

[55] Paramesha M, Rane N, Rane J. Big data analytics, artificial intelligence, machine learning, internet of things, and blockchain for enhanced business intelligence. Artificial Intelligence, Machine Learning, Internet of Things, and Blockchain for Enhanced Business Intelligence (June 6, 2024). 2024 Jun 6.

[56] Arel I, Rose DC, Karnowski TP. Deep machine learning-a new frontier in artificial intelligence research [research frontier]. IEEE computational intelligence magazine. 2010 Oct 18;5(4):13-8.