**Artificial Intelligence and Machine Learning – The Future of Computing Domain with High Real World Prospective**

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**Abstract:**

The fourth industrial revolution has been sparked by emerging technologies including artificial intelligence (AI), the internet of things (IoT), Machine Learning, data analytics, block-chain technology, and robotics. This revolution encompasses many creative new solutions and is transforming daily life as we know it. This essay examines artificial intelligence (AI) and how it has advanced recently, opening up new, creative options and solutions. The AI and ML will shape the future of computing industry and will penetrate almost every facets of modern life including industrial automation, health care systems and agriculture. In this chapter, we have introduced Artificial Intelligence, ML, DL, etc. We also covered important application domains of AI & ML. The chapter is limited with introductory only.

**Keywords: Artificial Intelligence, Machine Learning, Smart Farming, Robotics, AI Algorithms, Automation, IOT.**

1. **Introduction to Artificial Intelligence**

Artificial intelligence (AI) refers to any task carried out by a computer or program or machine that would otherwise require a human to use intellect to complete. Making machines with intelligence—particularly those with visual perception, speech recognition, decision-making, and language translation—requires a combination of science and engineering. AI is the simulation of human intelligence processes by machines, specifically computer systems. This involves knowledge representation, self-correction, planning, reasoning, motion, manipulation, and creativity. It also includes learning.

It is a ‘super science’ and a collection of computational methods that draw inspiration from how humans use their bodies and neural systems to feel, remember, reason, and act. Deep learning and machine learning are related to AI, with machine learning using algorithms to find patterns and derive insights from the data it is working with. Deep learning is a branch of machine learning that moves AI one step closer to its objective of making it possible for robots to think and function as humanly as possible.

The topic of artificial intelligence (AI) is controversial and frequently portrayed negatively; some would consider it a disguised blessing for businesses, while others believe it to be a technology that threatens the very existence of humanity because it has the potential to subjugate and dominate humans. However, in reality, AI has already had an impact on our way of life, either directly or indirectly, and is helping to shape the world of tomorrow. Despite the indispensable uses of digital assistants for mobile phones, driver assistance systems, bots, texts and speech translators, and systems that help with product and service recommendations and personalized learning, AI has already become an integral part of our daily lives and has significantly impacted our way of life.

A vast volume of labeled training data is typically ingested by AI systems, which then examine the data for correlations and patterns before employing these patterns to forecast future states. By studying millions of instances, an image recognition tool can learn to recognize and describe objects in photographs, just as a chat-bot that is given examples of text chats can learn to make lifelike exchanges with people.

Three cognitive abilities—learning, reasoning, and self-correction—are the main topics of AI programming. processes for learning. This area of AI programming is concerned with gathering data and formulating the rules that will enable the data to be transformed into useful knowledge. The guidelines, also known as algorithms, give computing equipment detailed instructions on how to carry out a certain activity.

1. **History and Background of AI:** Since ancient times, the idea of giving intelligence to inanimate objects has been present. Myths describe the Greek god Hephaestus making robot-like servants out of gold. Ancient Egyptian engineers created statues of gods that priests could animate. Aristotle, Ramon Llull, a 13th-century Spanish priest, René Descartes, and Thomas Bayes all employed the methods and reasoning of their eras to characterize human thought processes as symbols, providing the groundwork for notions in artificial intelligence such general knowledge representation.

Artificially intelligent robots became well known in the first part of the 20th century because to science fiction. Both the "heartless" Tin Man from The Wizard of Oz and the humanoid robot who played Maria in Metropolis are examples of this. The idea of artificial intelligence (or AI) had become ingrained in the minds of scientists, mathematicians, and philosophers by the end of 1950s. One such individual was the young British polymath Alan Turing, who investigated the mathematical potential of artificial intelligence.

Turing argued that if people use accessible knowledge along with reason to solve issues and reach choices, why shouldn't robots be able to do the same? His 1950 study, Computing Machinery and Intelligence, which examined how to create intelligent machines and how to assess their intelligence, was organized along these logical lines.

1. **Types of Artificial Intelligence**

AI can be divided into four categories, starting with the task-specific intelligent systems that are currently in widespread use and moving on to sentient systems, which do not yet exist.

1. **Type – 1; Reactive Machines:** The most fundamental forms of AI are entirely reactive; they lack the capacity to remember past events or draw conclusions about the present from them. The ideal illustration of this kind of device is Deep Blue, IBM's chess-playing supercomputer that defeated world champion Garry Kasparov in late 1990s. Deep Blue can recognize the chess pieces and understand their individual manoeuvres. It is capable of predicting potential next steps for both it and its adversary. And it is capable of selecting the best possible moves from a range of options.

This form of intelligence entails the computer directly observing the outside world and responding accordingly. It is independent of any personal worldview. AI expert Rodney Brooks stated that we should only create machines like this in a major study. His fundamental argument was that, contrary to what is commonly believed in the field of artificial intelligence (AI), people are not very effective at creating realistic computer simulations of the real world.

1. **Type – 2; Limited Memory:** These tools have the ability to peer into the past. Some of this is already done by self-driving automobiles. For instance, they watch the direction and speed of other vehicles. That cannot be accomplished in a single instant; rather, it calls for the identification of certain things and continuous observation of them. These observations are added to the pre-programmed world models that the self-driving cars already have, which also include traffic signals, lane markings and other significant features, such as curves in the road. To prevent hitting another vehicle or being struck by one close, they are taken into consideration when the vehicle decides whether to change lanes. However, these basic tidbits of historical knowledge are just temporary. They aren't saved in the same way that human drivers accumulate experience over years of driving, so the automobile can't learn from them.
2. **Type – 3 ; Theory of Mind:** We may stop here and designate this as the crucial dividing line between the current generation of computers and those that will be created in the future. To discuss the kinds of representations machines must make and what those representations must be about, it is preferable to be more explicit. The following, more sophisticated class of machines creates representations not only of the world but also of other agents or things existing in it. The idea that people, animals, and inanimate objects in the world might have thoughts and emotions that influence their own behavior is known as the "theory of mind" in psychology.

Because they made it possible for us to interact socially, this is essential to understanding how humans created societies. Working together is at best challenging, at worst impossible without a knowledge of one another's intents and motivations, as well as without taking into consideration what someone else may know about me or the environment. AI systems must be able to comprehend that each of us has thoughts, feelings, and expectations for how we will be treated if they are to ever live among us. They will also need to change their behavior properly.

1. **Type – 4; Self Awareness:** The creation of systems that can create representations of themselves is the last stage in AI development. In the end, it will be up to AI researchers to create conscious machines in addition to understanding consciousness. In a way, this is an expansion of the "theory of mind" that Type 3 AI possess. For a good reason, consciousness is frequently referred to as "self-awareness." (Saying "I want that item" as opposed to "I know I want that item" is extremely different.) Conscious beings are self-conscious, aware of their internal states, and capable of anticipating the emotions of others. Given how we feel when we honk at other drivers, we automatically believe that someone honking at us in traffic is angry or frustrated. We could not draw those kinds of conclusions in the absence of a theory of mind.

We should concentrate our efforts on understanding memory, learning, and the capacity to draw conclusions from the past even though we are probably a long way from building robots that have self-awareness. To grasp human intellect on its own, this is a crucial step. And it is essential if we want to create or build machines that are exceptionally good at classifying the world around them.

1. **Strong and Weak Artificial Intelligence (AI)**
* **Weak AI:** An AI system that is created and educated to carry out a certain task is referred to as weak This type of AI is also known as narrow AI. Weak AI is used by a self driving car, industrial robots and virtual personal assistants like Apple's Siri. Weak AI depends on human intervention to specify the learning algorithm's parameters and to supply the necessary training data to assure correctness.
* **Strong AI:** Strong AI, commonly referred to as artificial general intelligence (AGI), is a term used to describe computer programming that can mimic human cognitive functions. A powerful AI system can employ fuzzy logic to transfer information from one area to another and discover a solution on its own when faced with an unexpected job. Theoretically, a powerful AI programme should be able to pass the Chinese room test as well as the Turing test.

Although powerful artificial intelligence has yet to be demonstrated, the field is innovating quickly. Artificial super-intelligence (ASI), often known as super intelligence or Super AI, is a new AI theory. Strong AI cannot compare to this form of AI in terms of intelligence or capabilities. Super AI, however, is still totally hypothetical since we haven't yet produced Strong AI examples.

1. **Use and examples of AI Technology**

There are numerous live examples of AI technology. . Some of the conspicuous technology are summarized below:

* 1. **Automation:** Automation tools can increase the number and variety of jobs carried out when used in conjunction with AI technologies. Robotic-Process-Automation ( RPA) , a form of software that automates repetitive, rule-based data processing operations often carried out by humans, is an example. RPA can automate larger portions of corporate jobs when paired with machine learning and new AI tools, allowing RPA's tactical bots to transmit intelligence from AI and react to process changes.
	2. **Machine learning.** This is the science of getting a computer to act without programming. Deep learning is a subset of machine learning that, in very simple terms, can be thought of as the automation of predictive analytics..

There are three types of machine learning algorithms

1. **Supervised ML:** An algorithm known as supervised machine learning learns from labeled training data to assist in making predictions about unanticipated data. In supervised learning, we teach the computer using appropriately "labeled" data. It indicates that some material has previously been appropriately tagged. It is comparable to learning while being observed by a manager or teacher. In machine learning, supervised learning enables us to gather data or generate data output from prior experiences. This assists us in resolving a variety of computation-related difficulties that arise in the real world. Some supervised ML algorithms are:
* **Regression:** Using training data, the regression technique forecasts a single output value. Regression can be used to forecast the price of a flat or home using training data. The input variables will include the neighborhoods, house size, location value, etc.

**Robustness:** This algorithm can be regularized to prevent over-fitting, and results can always be interpreted probabilistically.

**Weaknesse**s: When there are numerous or non-linear decision boundaries, logistic regression may perform poorly. Because of its rigidity, this approach is unable to capture interactions that are more complicated.

* **Logistic Regression**: To estimate distinct values based on a set of independent variables, the logistic regression method is utilized. By adjusting data to a logit function, you may anticipate the likelihood that an event will occur. It is also known as logistic regression as a result. Its output value, which represents the likelihood prediction, ranges from 0 to 1. Some of the Logistic Algorithms are summarized here:
* **Classification:** To classify something is to put the results into a group. Binary classification refers to an algorithm's attempt to categorize input into two different groups. Multiclass classification is the process of choosing between multiple classes. Choosing whether or not someone will default on a debt is an example.

**Robustness:** Classification tree performs admirably in actual use.

**Weaknesses:** Individual trees are much prone to over-fitting when unconstrained.

Some of the classification algorithms are:

**Naive Bayesian model:** The Naive Bayesian Model (NBN) is simple to construct and extremely effective for huge datasets. Direct acyclic graphs with one parent and multiple offspring make up this methodology. The independence of offspring nodes that have been cut off from their parent is assumed.

**Decision Tree:** By ordering instances according to the feature value, decision trees categorize instances. Each mode in this methodology represents a particular feature of an instance. Each and every branch represents a value that the node can adopt, and it should be categorized. It is a method of classification that is frequently employed. This approach uses a decision tree, a type of tree, for classification. It help us in the estimation of actual values, for example, cost to purchase a bike, number of inquiry, total monthly, quarterly or yearly sales, etc.

**Support Vector Machine (SVM):** The learning algorithm known as the support vector machine (SVM) was created in 1990. This approach is based on findings from Vap Nik's statistical learning theory. A key idea for the majority of learning problems, kernel functions, are closely related to SVM machines. SVM and the kernel framework are applied in many different disciplines. Bioinformatics, pattern recognition, and multimodal information retrieval are all included.

1. **Unsupervised ML:** Unsupervised learning frequently referred to as unsupervised ML, analyzes and groups unlabeled datasets using machine learning algorithms. These algorithms identify hidden patterns or data clusters without the assistance of a human. It is the best option for investigative data analysis, consumer segmentation, cross-selling tactics and picture identification because of its capacity to find similarities and differences in information.

**Some prominent unsupervised learning methods are described below:**

* **Clustering:** Unlabeled data are grouped using the data mining technique of clustering according to their similarities or differences. Algorithms called clustering are used to organize raw, unclassified data objects into groups that can be visualized as patterns or structures in the data. Several types of clustering algorithms, including probabilistic, exclusive, overlapping and hierarchical methods, can be distinguished.
* **Exclusive Clustering:** A data point may only be included in one cluster according to the grouping method known as exclusive clustering. Another name for this is "hard" clustering. Exclusive clustering is exemplified by the K-means algorithm.
* **Overlapping Clustering:** Data points can be members of many clusters with varying degrees of membership under overlapping clusters, which is different from exclusive clustering. Overlapping clustering is demonstrated by "soft" or fuzzy k-means clustering.
* **Hierarchical Clustering:** An unsupervised clustering approach known as hierarchical clustering, sometimes referred to as hierarchical cluster analysis (HCA), can be classified as either agglomerative or divisive. A "bottoms-up technique" is referred known as agglomerative clustering. Its data points are initially separated into distinct groupings, and once one cluster has been obtained, they are progressively combined based on similarity.
* **Divisive Clustering:** The antithesis of agglomerative clustering, referred to as divisive clustering, operates from the top down. In this instance, divisions between data points inside a single data cluster are made.
* **Probabilistic Clustering:** An unsupervised method known as a probabilistic model aids in the resolution of density estimates or "soft" clustering issues. Data points are grouped in probabilistic clustering according to how likely it is that they fall under a given distribution. The Gaussian Mixture Model (GMM), one of the most used probabilistic clustering techniques, was developed in the 1960s.
1. **Reinforcement Learning:** The study of decision-making is called reinforcement learning (RL). It involves understanding how to act in a situation to reap the most benefits. Similar to how children explore their environment and discover the behaviors that enable them to accomplish a task, this ideal behavior is taught through interactions with the surroundings (environment) and observations of how it responds.

The learner must autonomously determine the order of behaviors that maximizes the reward in the absence of a supervisor. This technique of discovery resembles a trial-and-error search. The quality of an activity is determined by both the immediate reward it brings in and any potential future rewards. Reinforcement learning is an extremely potent algorithm because it can learn the behaviors that lead to success in an unobserved environment without the assistance of a supervisor.

* 1. **Machine vision:** A machine can now sight thanks to this technology. With the use of a camera, analog-to-digital conversion, and digital signal processing, machine vision software can record and examine visual data. Machine vision is sometimes likened to human eyesight, however it is not constrained by biology and can be programmed to, for instance, see through walls. Applications for it span from medical picture analysis to signature identification. Machine vision and computer vision are frequently confused, with computer vision concentrating on automated image processing.

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* 1. **Natural Language Processing:** This is how a computer programme interprets human language. One of the first and most well-known applications of NLP is spam detection, which evaluates an email's subject line and body to determine whether it is spam. The methods used in NLP today are based on machine learning. Text translation, sentiment analysis, and speech recognition are examples of NLP tasks.
	2. **Robotics:** This area of engineering is devoted to the creation and design of robots. Robots are frequently utilized to complete jobs that are challenging for humans to complete or consistently complete. Robots, for instance, are employed by NASA to move heavy things in space or in auto assembly lines to produce cars. Machine learning is also being used by researchers to create socially intelligent robots.
	3. **Self Driving Cars:** A mix of computer vision, image recognition, and deep learning is used in autonomous vehicles to develop automatic ability at driving a vehicle while keeping in a set lane and avoiding unforeseen obstacles, such as pedestrians.

**Fig. 1. Companion of Artificial Intelligence**

1. **Applications Area of AI**

AI has penetrated various areas, such as, sales, marketing, industrial automation, healthcare, agriculture, farming and many more. The application areas of AI is still counting and increasing day by day. Some of the most conspicuous AI applications are briefly described below;

* 1. **HealthCare:** The biggest wagers are on decreasing costs and enhancing patient outcomes. Machine learning is being used by businesses to diagnose problems more quickly and accurately than humans. IBM Watson is one of the most well-known healthcare technologies. It can answer to inquiries and comprehends regular language. The system constructs a hypothesis using patient data as well as other available data sources, which it then provides with a confidence grading schema. Other AI uses include deploying chat-bots and online virtual health assistants to aid patients and healthcare consumers with administrative tasks like scheduling appointments, understanding billing, and finding medical information. Recently we have observed massive use of AI during Corona Pandemic.
	2. **Manufacturing:** Robot integration has been pioneered by the manufacturing industry. Cobots, which are smaller, multitasking robots that work alongside humans and assume more responsibility for the job in warehouses, factories, and other workspaces, are an example of industrial robots that were once programmed to execute single tasks and segregated from human workers.
	3. **Security:** Today, security vendors utilize a number of buzzwords to distinguish their products, with AI and machine learning at the top of the list. Additionally, such names refer to actual marketable technologies. Organizations utilize machine learning to detect anomalies and identify suspicious actions that point to threats in security information and event management (SIEM) software and related fields. AI can alert to new and developing assaults considerably earlier than human employees and prior technology iterations by analyzing data and utilizing logic to spot similarities to known harmful code. Organizations are benefiting greatly from the evolving technology as it aids in thwarting cyber-attacks.
	4. Banking and Finance: Chat-bots are being successfully used by banks to handle transactions that do not need human intervention and to inform clients of services and opportunities. Artificial intelligence (AI) virtual assistants are being utilized to streamline and lower the cost of adhering to banking standards. AI is also being used by banking institutions to better decide which loans to approve, as well as to set credit limits and find lucrative investment opportunities.

Financial institutions are being disrupted by artificial intelligence (AI) in personal finance software like Intuit Mint or TurboTax. Applications like this gather personal information and offer financial guidance. The process of purchasing a home has been used with other technologies, such as IBM Watson. Today, a large portion of Wall Street trading is carried out by artificial intelligence software.

* 1. **Transportation:** In addition to playing a crucial part in driving autonomous vehicles, AI and ML technologies are also employed in the transportation industry to control traffic, forecast airline delays, and improve the efficiency and safety of ocean shipping.
	2. **Education:** AI can fully automate grading, freeing up time for teachers. Students can be evaluated and their needs can be met, allowing them to work at their own swiftness. AI tools and techniques can provide pupils extra assistance to keep them on track. Additionally, it might alter where and how students learn, possibly even displacing some instructors.
	3. **Business:** In order to find out how to better serve clients, machine learning algorithms are being included into analytics and CRM platforms. In order to offer customers instant help, chat-bots have been integrated into websites. Academicians and IT analysts are now debating the topic of job automation.
	4. **Law Services:** For humans, the legal discovery process (which entails shifting through documents) is frequently overwhelming. AI is being used to speed up labor-intensive legal sector operations and enhance client service. Law companies use computer vision to identify and extract information from documents, machine learning to characterize data and forecast results, and natural language processing to comprehend information request.
	5. **Pattern Recognition:** Deep neural networks are used to enhance pattern recognition in a variety of applications. The AI can filter out extraneous data, create meaningful correlations, and increase the effectiveness of big data computation by identifying patterns of interesting data points that are often missed by humans.
	6. **Behavioral prediction: AI will become more powerful as a result of prediction algorithms, which will have uses ranging from forecasting the weather and the financial market to, even more intriguingly, predicting human behavior.**
1. **Related Challenges:**

Every new technology inspires both excitement and mistrust. In certain contexts, AI can be a source of benefits and drawbacks. Before we can fully appreciate the potential and enormous transformative power of this emerging technology, there are a few obstacles we must overcome. Major challenges related with AI applications are:

* 1. **AI-Human Interface:** Due to the fact that artificial intelligence is a new technology, there is a severe lack of working people with data science and analytics abilities who can be assigned to projects to maximize its potential. Businesses struggle to find qualified personnel who can handle the demand and work with AI as it advances. For their employees to fully profit from new technology, business owners must train them.
	2. **Trust Building:** People find it challenging to trust AI because it is based on science, technology, and algorithms, which most people aren't familiar with. A larger section of people do not rely on AI applications rather they have fear factor and reluctant to apply AI.
	3. **Cost Factor:** Not every business owner or management can afford to invest money in AI because it requires a lot of computational resources and occasionally hardware acceleration using GPU, FPGA, or ASIC is required to run machine learning models efficiently. Additionally, the businesses of those who have implemented AI are still in their infancy, which has slowed the use of AI technology at a large scale and prevented them from reaping the benefits of scale in terms of cost.
	4. **Non-invisible:** AI has its own limitations, just like any other technology, and it cannot completely replace all tasks. But it will lead to the emergence of a new job sector with a distinctive quality job profile.
	5. **Security of Data:** Huge volumes of classified data, frequently delicate and private in nature, form the foundation for machine learning and decision-making capabilities of AI and AI applications. This exposes it to major problems like identity theft and data breaches. The majority of the time, businesses and governments seeking profit and power, respectively, use AI-based tools that are typically internationally networked and hence challenging to control or rein in.
	6. **Malfunction of Software:** AI is controlled by machines and algorithms, which means that decision-making authority is automatically given to tools that run on code. Automation makes it challenging to pinpoint the root of errors and malfunctions. Furthermore, as automated systems proliferate and become more complex, humans have less and less control over the system due to their inability to grasp and comprehend how these tools function.
	7. **Algorithmic Bias:** Data and algorithms are the foundation of AI. AI's ability to make accurate decisions is solely dependent on how accurately it has been trained using real, unbiased facts. If data utilized for training is tainted with racial, gender, communal, or ethnic biases, unethical and unfair outcomes are inherent in crucial decision-making. Given that several AI systems will continue further to be taught using flawed data, such biases will probably become more pronounced.
	8. **Lack of Data:** The effectiveness and relevance of the supervised and labeled training and test datasets directly affect the power and capabilities of artificial intelligence (AI) and AI applications. Data with high quality labels are hard to come by. Although efforts are being made to develop methodology to enable AI models to learn despite the lack of high-quality labeled data, they will only make the issue worse. These approaches include active learning, transfer learning, unsupervised learning and deep learning.
	9. **High Degree of Expectations:** A large group of scientists and technologists working on artificial intelligence projects have different goals, motivations, and areas of interest. Research is primarily focused on figuring out the mechanisms that underlie cognition and intelligence, with a strong emphasis on solving the puzzles surrounding human thought and intellect. Not everyone is aware of how artificial intelligence works and may have unrealistic expectations of its performance.
1. **Conclusion**

Numerous potential and difficulties in the fascinating field of AI are covered in this chapter. In our society, AI is becoming more and more significant. Even after decades of study and learning, it continues to be the most esoteric topic in computer science and a popular catchphrase. The benefits of this happening phenomenon are widely acknowledged in a variety of fields, including medicine, security, consumer applications, and business. Until recently, it was primarily the subject of discussion and work among science fiction writers; it was restricted to university research labs. With the use of machine learning, highly responsive, sensitive, highly logical and working machines are being created.

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