Artificial Intelligence: Prospects and Challenges in Future Progression

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Abstract

Artificial intelligence (AI) is a branch of computer science that makes the computers to mimic the human behavior and assist humans for better performance in the field of science and technology. It refers to the ability of machines to perform cognitive tasks, such as thinking, perceiving, learning, problem solving, and decision making. The goal of it is to make a machine as smart as a human. Particular applications of AI are in advanced web search engines, internet, robotics, biometrics identification, speech recognition, natural language generation, virtual assistants, superhuman play, and to analysis in strategy games, autonomous vehicles, etc. At present many organizations are applying AI accurately and efficiently to provide security to their data and information systems. If AI system is not properly operated, it may face technical difficulties, data difficulties, security snags, etc. The purpose of this study is to discuss aspects of AI, and its present and future applications for the welfare of the global humanity.

Keywords: AI, ML, DL, speech recognition, biometrics, cyber-attacks, cyber-security

1. Introduction

Artificial intelligence (AI) is the capability of computational systems to perform tasks associated with human intelligence, such as learning, reasoning, problem-solving, perception, and decision-making (Agrawal et al., 2019). It is the study of how human brain thinks; and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of it as a basis of developing intelligent software and systems. The AI powered machine can perform many jobs at once with accurately and efficiently (Young et al., 2019). At present AI is impelling our daily lives, communities, and governmental structures more than ever before (Uzun et al., 2022).

The AI is a combination of science and technology that is based on **many subjects, such as** mathematics for developing algorithms, statistics for handling huge data, computer science to run the algorithm for implementing the concepts, neuroscience that studies human mind and its behavior, and some other subjects, such as philosophy, psychology, biology, engineering, and linguistics (Ghosh & Thirugnanam, 2021). It is an attempt to make a computer, a robot, and other piece of technology to think and process data in the same way as the humans do. It deals with bridging the gap of communication between the computer and human languages in a smart way. It can simulate human thought process, and can take actions based on these thoughts and even can draw conclusions (Aderibigbe et al., 2023).

Exponential growth of AI is observed globally. For example, in the USA the investment has increased by 20% in 2019 with $28.5 billion, and that of in The European Commission has reached to €20 billion in 2020 (Wirtz et al., 2019). It is expected that AI technological area will provide more than 2.5 million jobs by 2025. It is estimated that its economic size could generate to $13 trillion by 2030 (Bughin et al., 2018).

2. Literature Review

A literature review in research is a comprehensive analysis of existing published and unpublished academic works on a specific topic that provides an overview of the current state of knowledge that identifies key debates, and highlights gaps in the research (George et al., 2023). It synthesizes and evaluates previous research to provide context for a new study. It is often a part of a graduate and post-graduate requirement, such as in the preparation of a dissertation, or a journal article (Baglione, 2012). Sikender Mohsienuddin Mohammad has discussed different technologies in AI and how they apply to improve the performance of multiple sectors at present and future applications. He has observed that AI is the foundation of multiple concepts, such as computing, software creation, and data transmission (Mohammad, 2020). Parvinder Singh and Mandeep Singh have found that the fraud cases related to credit card, debit card, mobile banking and internet banking, online shopping, online bill payment, insurance premium, online recharges and online reservation of railways, bus, etc. are increasing, and it puts a great burden on the economy, affecting both customers and financial bodies (Singh & Singh, 2015). Cédric Beaulac and Fabrice Larribe have used Hidden Markov Models to build narrow AI that estimates the unknown position of a mobile target moving in a defined environment. They have used the Baum-Welch algorithm as a statistical learning tool to gain knowledge of the mobile target (Beaulac & Larribe, 2017).

Muhammet Damar and his coauthors have realized that the concepts of generative AI, super AI, and narrow AI have attracted considerable attention for the success of ChatGPT. They have estimated that AI could generate an economic size of $13 trillion by 2030 (Damar et al., 2024). Rebecca Marrone and her coworkers have set four underpinning propositions that will help to guide the integration of AI and human creativity. They have shown that these propositions explain not only why AI is not independently creative, but also how AI can support and augment human creativity in areas, such as education (Marrone et al., 2024). Shruti Joshi and her coworkers have explained various voice recognition systems that are used various techniques to decode human speech. They have shown that the voice recognition module VR3 that is speaker dependent is the best suited for use in projects of making automated systems (Joshi et al., 2017).

Zahid Akhtar and his coworkers have addressed that biometrics the issues, such as identity theft and security threats, a continuously evolving technology is presently being deployed in a wide range of personal, government, and commercial applications. They have presented an overview of biometric research and more importantly the significant progresses, such as spoofing, evasion, obfuscation, face reconstruction from DNA, Big data issues in biometrics, etc. that have been attained over the recent years (Akhtar et al., 2018). Krupal Joshi has studied that AGI represents a significant leap in the field of AI, defined by its ability to perform any intellectual task that a human can that is characterized by versatility, adaptability, autonomy, and reasoning capabilities. He explores the defining features of AGI, such as its cognitive flexibility and capacity for autonomous decision-making and problem-solving. He has emphasized on ethical frameworks and governance structures in AGI development among scientists, policymakers, and society for the benefit of humanity (Joshi, 2024).

Karamjit S. Gill has thought that the new wave of super AI raises a number of serious societal concerns, such as the crises and shocks of the AI machine that will trigger fundamental change and how should we cope with the resulting transformation; the implication be if AI machine takes over and transforms the way we live and work; technology do to work, employment, economy, governance, state, democracy and professions; the social and political implications of employment if people are replaced by the machine; the state disappears, and so do economy, professions, employment, politics disappear; digital economy be regulated, measured, and controlled; the AI machine with its embedded machine learning algorithms be monitored and controlled; new politics emerge as another digital game, and what would the rules of this game be; and how would these rules change the playing field of the game of politics itself (Gill, 2016). Bartosz Kopka has studied the advantages and disadvantages of AI-based chatbots. He has listed the advantages of it as; facilitating access to information for citizens, reducing costs in providing services to citizens in the public sector, and making the chatbot system more attractive to users, thereby encouraging more active use. He has noted disadvantages of it as the time-consuming nature of regularly processing new data and the inability to fully mimic human brains and behaviors in emulation (Kopka, 2011).

3. Research Methodology of the Study

Research is a creative and systematic investigation and study of materials and sources in order to establish facts, and reach new conclusions for increasing the stock of knowledge through the generation of new concepts, methodologies, and understandings (Adams et al., 2007). It describes the *techniques and procedures used to identify and analyze information* regarding a specific research topic (Mohajan, 2018b). Three main forms of research are i) exploratory research that helps to identify and define a problem, ii) constructive research that tests theories and proposes solutions to a problem, and iii) empirical research that tests the feasibility of a solution using empirical evidence, which has two major types; qualitative research and quantitative research (Muijs,

2010; Mohajan, 2017). Qualitative research aims to gather and analyze non-numerical data in order to gain an understanding of individuals' social reality, including understanding their attitudes, beliefs, and motivation (King et al., 2021). Quantitative research is a research strategy that focuses on quantifying the collection and analysis of data that is formed from a deductive approach where emphasis is placed on the testing of theory, shaped by empiricist and positivist philosophies (Bryman, 2012; Mohajan, 2020).

Methodology is the systematic approach or set of methods used to conduct research, gather information, and achieve a specific goal that is the backbone of any study, providing a structured path for researchers to follow. It is a fundamental concept that plays a crucial role in various fields of study, guiding researchers and practitioners in their quest for knowledge and problem-solving (Herrman, 2009). Research methodology is the specific procedures used to identify, select, process, and analyze information about a topic. It describes the techniques and procedures used to identify and analyze information regarding a specific research topic (Howell, 2013).

4. Objective of the Study

When machines are equipped with man-made intelligence to perform intelligent tasks similar to humans is known as artificial intelligence (AI). It encompasses a wide range of approaches, methodologies, and techniques aimed at mimicking human intelligence in machines (Damar et al., 2024). Therefore, the AI is a study how the human brain thinks, learns, and makes decisions when it tries to solve problems. The aim of AI is to improve technology by adding functionality related to the human acts of reasoning, learning, and problem-solving (Bermudez, 2017). The AI is one of the fastest-growing technologies that is making human life much easier by providing solutions for complex problems. It should also be able to correct itself, if it makes a mistake that is able to make a decision in a given situation like human beings and in some cases even better (Anderljung et al., 2023). Main objective of this article is to provide introductory ideas of AI and its usefulness and drawbacks. Other minor objectives of the study are as follows (Mohajan, 2018a):

1) to highlight on overview of AI,

2) to focus on types and domains of AI, and

3) to discuss application of AI.

5. An Overview of AI

The artificial intelligence (AI) has no universally agreed definition. It is the advancement of computer systems that can execute tasks typically requiring human intelligence, and can perform human-like cognitive functions, such as learning, logical reasoning, problem-solving, decision-making, and language comprehension (Miller, 2024). The AI technologies are used in various sectors, such as voice assistants, navigation, translations, e-services, autonomous vehicles, and smart home devices (Serçemeli, 2018). Machine learning (ML) and deep learning (DL) are two subsets of AI, where ML deals with high performance algorithms, and DL deals with multilayer neural networks (Şentürk, 2023).

The AI technical landscape has evolved significantly from 1950 when English mathematician, computer scientist, logician, cryptanalyst, philosopher and theoretical biologist Alan Mathison Turing (1912-1954) first posed the question of whether machines can think (Williams, 1985). The term artificial intelligence was first coined by **American computer scientist and cognitive scientist** John McCarthy **(1927-2011)** in 1956, who is often referred to as the father of AI (Huang et al., 2022). It is said that AI is the greatest thing humankind has ever worked on. On the other hand, computer hacking and loss of data are some of the cyber-attacks issues (Dilek et al., 2015).

6. Types of AI

At present there are a lot of AI developments, and most of them are divided into different types. In this section, we discuss seven main types of AI as, i) narrow AI, ii) general AI, iii) super AI, iv) reactive machine AI, v) limited memory AI, vi) theory of mind AI, and vii) self-aware AI. Among these, first three are of capability types, and the rest four are of functionality types (Aderibigbe et al., 2023).

6.1 Narrow AI

Narrow AI is also known as weak AI or specialized AI that refers to AI systems which undergoes training using machine learning (ML) algorithms like supervised learning or reinforcement learning which are meticulously designed and trained to carry out very specific actions or commands intelligently (Agrawal et al., 2019). It is focused on one narrow task that represents a significant milestone in the field of AI. As it is exclusively educated for one single narrow activity, and cannot perform outside its field or boundaries and is known as "weak AI". When narrow AI reaches its boundaries, it might fail in unexpected ways (Rathod & Mishra, 2023). The narrow AI is the most frequent and currently accessible AI. It operates a specific task or set of tasks under a pre-defined set of rules by the programmer and cannot exhibit the same level of understanding or adaptability as a human, and many of present popular applications fall under this category (Babu & Banana, 2024).

The weak AI is built to serve and excel in one cognitive capability, and cannot independently learn skills beyond their design, and lack the general intelligence and adaptability of humans (Edelman, 2020). It often utilizes machine learning, natural language processing and neural network algorithms to complete specified tasks (Liu, 2021). Some examples of narrow AI are AlphaGo, Alexa, Apple Siri, Google assistant, Google translate, playing chess, robot systems, buying suggestions on an e-commerce site, self-driving cars, AI virtual assistants, image and facial recognition systems, chatbots and conversational assistants, speech recognition, picture identification, recommendation engines, predictive maintenance models, and language translation tools (Damar et al., 2024).

Weak AI and strong AI are two terms coined by *American philosopher* John Searle in the "Chinese room argument" entitled "Minds, Brains, and Programs" (John, 1980). This system can perform single tasks very well, and sometimes it can be done better than humans. For example, it can be designed to identify cancer from X-ray or ultrasound images faster and more accurately than a trained radiologist (Bory et al., 2024). It can only do what it is designed to do and can only make decisions based on its training data. It is sometimes dangerous if unreliable, and the behavior that it follows can become inconsistent (Kuleshov & Prokhorov, 2019).

6.2 General AI

General AI (AGI) is also known as strong AI that refers to AI systems which possess human-like intelligence, and potentially surpass human intelligence; and are capable of understanding, learning, reasoning, decision making, problem-solving, and performing a wide range of tasks (Anderljung et al., 2023). It is an advanced form of AI that is capable of creating new content, such as text, images, and sounds based on patterns and data acquired from a body of training material. It promises to revolutionize industries, enhance productivity, and solve complex global challenges (Joshi, 2024). It can understand, generalize and apply knowledge, transfer skills between domains, and solve novel problems without task-specific reprogramming (Goertzel, 2014). It remains theoretical and unrealized, encompasses the defining characteristics of intelligence across a broad array of cognitive activities (Young et al., 2019).

Key characteristics of AGI are (Russell & Norvig, 2021) i) adaptability that can adapt to new tasks and environments without extensive retraining, which reflects human cognitive flexibility, where individuals can apply their knowledge and skills to unfamiliar situations; ii) learning and reasoning that encompasses learning from experience and reasoning about new information that includes inductive learning and deductive reasoning (Muro et al., 2019); iii) transferability that can transfer knowledge from one domain to another, demonstrating an understanding of basic principles that apply across contexts, which is similar to how people use their learning in one domain to solve problems in another; and iv) autonomy that operates autonomously, making decisions and taking actions without human intervention (Akpan, 2025).

The AGI can take the form of generic large language model programs, such as Chat-GPT, Claude, Grok, Llama, Google Bard, Co-Pilot, AI Media, and Read AI (Peng et al., 2024). The ultimate goal of it is to create machines that are capable of versatile, human-like intelligence, functioning as highly adaptable assistants in everyday life. It is quiet being researched and emerging, and such systems will take a portion of work and time. In near future, the groundwork technologies, such as supercomputers, quantum hardware and generative AI products like ChatGPT will develop (Damar et al., 2024).

6.3 Super AI

Super AI is *defined as a form of AI that is capable of surpassing human intelligence by manifesting cognitive skills and developing thinking skills of its own* (Baum & Tonn, 2015). It is considered as the most advanced, powerful, autonomous, and much smarter intelligent type of AI that may overcome human level intelligence and capabilities in various domains, and execute any job better than humans with cognitive abilities (Wogu et al., 2018). It is truly appears in science fiction, and it possess abilities, such as self-awareness, creativity, emotional intelligence, and problem solving skills far beyond what humans can achieve (Damar et al., 2024). Some essential properties of super AI are the capacity to understand reason, solve puzzles, make judgments and idea, and learn and communicate independently (Agrawal et al., 2019).

Super AI may overtake human life and may lead to destruction of society. For example, it could get out of control, either in peacetime or during a war, could intentionally end humanity by destroying the planet's atmosphere or biosphere with self-replicating nanotechnology, could fire all of our nuclear weapons, unleash a robot apocalypse, and unleash some powers of physics that we do not even know about (Bostrom, 2014). It may potentially dominate humanity, become uncontrollable to the point of endangering humanity, and restrict freedom. Therefore, better control mechanisms must be developed through the strong research collaboration among AI researchers to keep the society safe (Sharkey, 2018).

6.4 Reactive Machine AI

Reactive machines AI are the most fundamental type of AI that can respond to immediate requests and tasks, but they cannot capable of storing memory, learning from past experiences, improving their functionality through

experiences, or performing more complex tasks to make decisions in the future (Damar et al., 2024). These can perform a narrowed range of pre-defined tasks, such as operate solely based on the present data, taking into account only the current situation, and cannot form inferences from the data to evaluate their future actions. These rely on rules and heuristics to make real-time decisions and adjust to changing environmental conditions. These continuously interact with their environment, without maintaining an internal representation of it (Kumar et al., 2010). These are operated based on predefined rules and patterns, responding to immediate inputs without the need for internal memory or past experiences. These are characterized by their deterministic and non-learning nature, lack of memory-based functionality that does not learn from past actions or experiences (Demetrescu et al., 2011). These can only respond to a limited combination of inputs and answer in the best way feasible and highly reliable but with limited scope. For any input these produce the same output ensuring predictability and consistency in the operations. For example, Deep Blue of IBM was able to beat Russian chess grandmaster Garry Kasparov in a 1997 chess match (Aoki, 2020).

Their predictability, reliability, and efficiency make them indispensable in specific applications. The applications of them are paramount in various fields where consistency and reliability are very strong. These are used in combination with other machine learning approaches, such as reinforcement learning and supervised learning to improve their adaptive and decision-making capabilities (Zhang et al., 2021). For example, robot control systems and autonomous navigation systems, basic customer service chatbots, industrial automation systems, and certain types of gaming AIs are performed successfully. However, these are limited by their lack of memory, and cannot handle complex and unstructured tasks that require learning, adaptation, and understanding of context (Yamcharoen et al., 2021).

6.5 Limited Memory AI

Limited memory AI has a short-lived or a temporary memory that can store past data and use that to make predictions, and can make informed and improved decisions by studying the past data from its memory. It can look into the past and monitor specific objects or situations over time (Baranidharan et al., 2023). It can actively build its own limited and short-term knowledge base, and performs tasks based on that knowledge. It can be applied in a broad range of scenarios, from smaller-scale applications, such as chatbots to self-driving cars and other advanced use cases (Damar et al., 2024). This allows a machine to absorb data from experiences, learn from them, and help them for improving the accuracy of its actions over time. The majority of the usually used apps in our daily lives are limited memory AI. For example, deep learning imitates the function of neurons in the human brain, where self-driving cars use sensors to identify civilians crossing the road, steep roads, traffic signals, and so on to make better driving decisions that help to prevent any future accident (Agrawal et al., 2019).

6.6 Theory of Mind AI

The ability for tracking other people's mental states is known as theory of mind (ToM). It is an evolving ability that significantly impacts core function of human learning and cognition. It is a more advanced type of AI that plays a major role in psychology and philosophy, and has ability to recognize and interpret the emotions of others (Apperly, 2012). It comes from the idea that we develop an explicit theory as part of the underlying cognitive process for representing minds (Apperly & Butterfill, 2009). It is considered as a substantial milestone in AI development, and makes a lot of positive changes to the tech world. It has not yet been fully developed but rigorous research is happening in this area (Damar et al., 2024). The two dominant approaches to ToM are theory-theory and simulation-theory (Harris, 1992).

The ToM is central to human social interactions from communication to social decision-making, and has long been of interest to developmental, social, and clinical psychologists. It refers to the capacity to understand other individuals through beliefs, desires, intentions, needs, reactions, emotions, and thoughts by ascribing mental states to them (Strachan et al., 2024). It can focus mainly on emotional intelligence so that human believes and thoughts can be better comprehended. It was first conceptualized in 1978 by researchers evaluating the presence of theory of mind in animals (Davis, 2007).

6.7 Self-Aware AI

Awareness is related to unique environment, existence, sensations, feelings, memories, surroundings, and thoughts. Self-aware AI represents a speculative and futuristic vision of AI, where machines would possess consciousness, self-awareness, and even sentience (Abbo et al., 2024). It has a major contribution both in psychology and philosophy. Philosophers investigate how mental states interconnect with physical processes in the mind-body problem, whereas psychology finds it closely linked to consciousness and investigates into different levels of awareness, such as from conscious to the subconscious and unconscious (Fodor, 1981). It has maturity to the point where it is so similar to the human mind that it has gained self-awareness. It can recognize others emotions, plus has sense of self- and human-level intelligence (Agrawal et al., 2019). It represents a stage

beyond theory of mind and is one of the ultimate goals in AI development. It will not only be able to recognize and generate feelings in individuals with whom it cooperates, but will also have its own feelings, wants, beliefs, and possibly goals. It is thought that once self-aware AI is reached, AI machines will be beyond our control (Damar et al., 2024).

7. Domains of AI

The domains of AI are machine learning, deep learning, biometrics, natural language processing, speech recognition, natural language understanding, natural language generation, and generative pre-trained transformers. These domains work together to create intelligent systems capable of various tasks (Young et al., 2019).

7.1 Machine Learning (ML)

Machine learning (ML) is a branch of AI that focuses on enabling computers and machines to imitate the way that humans learn to perform the tasks autonomously, and to improve their performance and accuracy through experience and exposure to more data (Alpaydin, 2020). It is a subset of AI that enables machines to improve at tasks with experience that enables machines to learn by themselves using the provided data and makes accurate decisions (Hao, 2018). The term machine learning was first coined in 1959 by American pioneer in the field of computer gaming and artificial intelligence Arthur Lee Samuel (1901-1990) (Samuel, 1959). The ML is about designing algorithms that allow a computer to learn. There are three kinds of models used in ML: i) supervised learning, ii) unsupervised learning, and iii) reinforcement learning (Mohajan, 2025). The ML helps to identify fraud, security threats, personalization and recommendations, automated customer service through the chatbots, transcription and translation, data analysis, etc. It opens an entirely new realm of what humans can do with computers and other machines (Russell & Norvig, 2015). It is used in web search, drug design, spam filters, credit scoring, fraud detection, recommender systems, ad placement, stock trading, and many other applications (Domingos, 2012).

7.2 Deep Learning (DL)

Deep learning (DL) is considered as the subdomain of ML and thereby the subset of AI. It can be denoted as the next level of ML where the system is similar to human nervous system and mimic the working of the neurons (Schmidhuber, 2015). It is the most advanced form of AI that mimics human intelligence. It enables software to train itself for performing tasks with vast amounts of data. In recent times, DL models can not only analyze large volumes of text but can also come up with services, such as those providing a summarization of text, language translation, context modeling, and even sentiment analysis (MadyMantha, 2019).

There are two types of DL algorithms: deep neural networks (DNN) and deep belief network (DBN). The DL deals with many layers of computation, where "deep" refers to a "large" number of layers. It can be 20 to 1,000 layers, but at least more than 2 layers (Aoki, 2020). The initial layer is called input layer, the last layer is called the output layer, and the intermediate layers are termed as the hidden layer, and all the layers are interconnected (Reggia, 1993). The DL helps to gain massive amounts of unstructured data that makes it strenuous for humans to process and understand (Al-Asmari, 2022).

7.3 Biometrics

Identification of theft and security threats is growing concerns in our digital society. Biometrics is the automated measurement, statistical analysis, and biological characteristics of people, such as fingerprint, iris, face, veins, etc., and behavioral characteristics, such as voice, signature, walking, etc. that can be used to identify individuals (Li & Jain, 2015). It is used to identify, measure, and analyze the physical aspects of the body structure and form through the natural forms of interactions between humans and machines, including touch, fingerprints, gait, speech, eye, and body language recognition. Personal identification can be done using one or more of biometric traits (Agrawal et al., 2019).

Many organizations need security of data systems as a priority basis, and biometric identification, and the AI system can provide top security to data systems and digital devices (Alrahawe et al., 2019). Biometric technology uses body traits, such as face and voice recognition, iris scan, fingerprint scan, and DNA matching, and the AI system can easily understand these (Maltoni et al., 2009). The AI can transform these visible traits into specific codes that the operation can easily do the work (Akhtar et al. 2018). Although, biometrics has several advantages over tokens or passwords, it suffers from false matches. The logical process of biometric can be done through surveillance operations, where recognition is required to acquire their identity for store it, and then use the stored data to identify the person as it needed (Uludag et al., 2004).

7.4 Speech Recognition

Speech recognition is a technology that recognizes speech and the systems capture the natural conversations with a human, analyze said data, and convert the same into readable information (Joshi et al., 2017). The concept of

speech recognition started in the 1940s. The first speech recognition program appeared in 1952 at the Bell Labs by the three researchers, Stephen Balashek, R. Biddulph, and K. H. Davis through the built a system called "Audrey" for single-speaker digit recognition (Juang & Rabiner, 2005). Its popularity is increasing very rapidly. It is an interdisciplinary subfield of computer science and computational linguistics that develops methodologies and technologies, which enable the recognition and translation of spoken language into text by computers (Gales, 2009).

At present the speech recognition technology is using many organizations, such as Google, Amazon, Microsoft, and Facebook to improve the standards of their services and products (Jesus, 2019). It is applicable in phones, refrigerators, automobiles, and other vital devices in the form of smart speaker, smart home, and mobile device applications (Sarangi et al., 2020). The technology of recognizing speech is also used in the medical world, defense, home automation, gaming, and even in general robotics (Lifewire, 2019). Sometimes the speech recognition does not work properly. For example, when different people pronounce the same word in a totally different manner or when there is a great deal of background noise, the software will pick up the noise and may not be able to interpret it well (Suresh & Rao, 2015). Cortana is applied as a voice-activated virtual assistant released in 2017 by Microsoft to help online users to receive user reminders, store notes, and lists; and manage various applications (Agrawal et al., 2019).

7.5 Natural Language Processing (NLP)

The NLP is a subfield of computer science and AI that enables machines to both process and comprehends human language in the way it is written. It is closely related to information retrieval, knowledge representation, and computational linguistics (Aoki, 2020). It allows programs to read, write, and communicate in human languages through the processing of speech recognition, text classification, speech synthesis, machine translation, natural language understanding, information extraction, information retrieval, question answering, and natural language generation (NLG) (Russell & Norvig, 2021). English mathematician, computer scientist, logician, cryptanalyst, philosopher and theoretical biologist *Alan* Mathison *Turing* published an article titled "Computing Machinery and Intelligence" and it is called the "Turing Test" as a criterion of intelligence (Kurdi, 2016).

7.6 Natural Language Understanding (NLU)

The NLU is a branch of NLP that converts the natural language spoken by humans into structured data. It is used in computer software to understand input in the form of sentences using text or speech to automated reasoning, machine translation, question answering, news-gathering, text categorization, voice-activation, archiving, and large-scale content analysis (Hirschman & Gaizauskas, 2001). It can perform two tasks: intent classification and entity extraction. For example, when we read a sentence, we immediately understand the meaning or intent behind that sentence (Semaan, 2012).

The program "Student", written in 1964 by *American computer scientist* Daniel Bobrow (1935-2017) for his PhD dissertation at MIT, which is one of the earliest known attempts at NLU by a computer (Russell & Norvig, 2003). The NLU is considered as an umbrella term that can be applied to a diverse set of computer applications, ranging from small, relatively simple tasks, such as short commands issued to robots, to highly complex endeavors, such as the full comprehension of newspaper articles (Li et al., 2007).

7.7 Natural Language Generation (NLG)

The NLG is a sub-discipline function of AI that generates written or spoken speech from datasets in the text form, and converts it into a form which enables the computer system to communicate the data efficiently and accurately. It can mine numerical data, perform pattern identification, and share information for human understanding (Horacek, 2015). It is the process of constructing natural language outputs from nonlinguistic inputs. It is related to NLP, computational linguistics, and NLU. It is specifically used in the control of spam. Several email providers use similar NLG-based services to analyze the content of the emails to understand whether the mail is genuine or fake (Gatt & Krahmer, 2018).

The NLG can identify the message through the manually search data, comparing or scanning tables, analyze charts, metrics or maps, and then develop recurring status reports (Agrawal et al., 2019). The goal of NLG is to investigate how computer programs can be made to produce high-quality, expressive, uncomplicated, and natural language text from computer-internal sophisticated representations of information (Saliby, 2019). Common applications of NLG are production of various reports, such as weather and patient reports; image captions; and chatbots like ChatGPT (Portet et al., 2009).

7.8 Generative Pre-Trained Transformers (GPTs)

The GPTs are large language models (LLMs) that generate text based on the semantic relationships between words in sentences. Text-based GPT models are pre-trained on a large corpus of text that can be from the internet

(Smith, 2023). The GPT models accumulate knowledge about the world and can then generate human-like text by repeatedly predicting the next token (Metz & Weise, 2025). The subsequent training phase makes the model more truthful, useful, and harmless with reinforcement learning from human feedback (RLHF). Current GPT services are ChatGPT, Gemini, Grok, Claude, Copilot, and LLaMA (large language models (LLMs) released by Meta AI that can process different types of data, such as images, videos, sound, and text (Marmouyet, 2023).

8. AI Hardware and Software

Specialized computer hardware often used to execute AI programs faster with less energy are Lisp machines, neuromorphic engineering, event cameras, physical neural networks, central processing units (CPUs), system on a chip (SoC), and graphics processing units (GPUs) (Maxfield, 2020). Specialized programming languages, such as Prolog were used in early AI research; later general-purpose programming languages, such as R-language and Python have been using to run the AI activities (Damar et al., 2024). The R-language is a very prominent, free programming language that is used for statistical computing. Python is a platform-independent language that can work on different platforms, such as Windows, Mac, Linux, Raspberry Pi, etc. (Agrawal et al., 2019). It can be used for creating workflows, handling big data, connecting database systems, performing complex mathematical functions and rapid prototyping, reading and writing, and modifying files. Cloud computing is used in a robust network of remote servers to store, manage, and process data (Wodecki, 2023).

9. Application of AI

The AI can show human based skills, such as thinking, perceiving, learning, reasoning, solving logical problems, and decision making. It is trying to help humans with two types of technologies, such as manually in the form of robots, and digitally with chatbots that can perform risky, repetitive, and troublesome tasks (Aderibigbe et al., 2023). It has applications in all fields of human study, such as finance and economics, natural sciences, environmental engineering, chemistry, computer science, and so on. It is applied in many sectors, such as healthcare, assembling and manufacturing industries, business organizations, security, entertainment, and in the automotive industries (Mohammad, 2020).

The AI is widely used in machine learning (ML), deep learning (DL), advanced web search engines, recommendation systems, computer vision, internet, driving internet traffic, recommender systems, online advertisements, targeted advertising, biometrics identification, speech recognition, image labeling, virtual assistants, autonomous vehicles, reasoning, planning, knowledge representation, superhuman play and analysis in strategy games, facial recognition, perception, support for robotics, automatic language translation, and natural language generation (NLG) to improve human interaction with machines to facilitate most operations (Barfield & Pagallo, 2018; Russell & Norvig, 2021).

Virtual assistants of AI, such as Apple's Siri, Amazon's Alexa, Google Assistant, and Microsoft's Cortana are used to understand and respond voice commands, answer questions, perform tasks, and provide personalized recommendations (Agrawal et al., 2019). The AI can control self-driven vehicles and autonomous vehicles that can use commands from humans, can prevent cases of accidents, and can enable them to perceive their surroundings. It navigates safely, provides optimal routes, estimates arrival times, offers alternative routes to avoid congestion, makes real-time driving decisions based on sensor data and ML algorithms through the use of Google Maps and Waze leverage (Makridakis, 2017).

In healthcare, AI is used for medical imaging analysis, disease diagnosis, drug discovery, personalized treatment recommendations, and remote patient monitoring (Kakani et al., 2020). In online shopping and finance e-commerce platforms, such as Amazon and Alibaba are used in AI for product recommendations, dynamic pricing, fraud detection, credit scoring, risk assessment, algorithmic trading, inventory management, personalized financial advice, and customer service chatbots (Agrawal et al., 2019). The AI will contribute to an increase of up to 40% in the productivity of the industrial sector, reducing costs, and increasing the production of manufactures around the globe (Aderibigbe et al., 2023).

AI algorithms are used in social media platforms, such as Facebook, Instagram, and Twitter for content moderation, personalized content creation, targeted advertising, and sentiment analysis. AI-driven language translation services, such as Google Translate and Microsoft Translator use neural machine translation techniques to translate text and speech between multiple languages accurately (Aoki, 2020).

10. Advantages of AI

The AI is influencing daily lives, communities, and governmental structures more than ever before. For example, it may be personal assistant to schedule meetings, and other daily activities.

It plays a vital role in cyber-security. It enables the automation of repetitive and mundane tasks that focus on more creative and strategic activities, which leads to increased productivity and efficiency in both individual tasks and entire workflows (Uzun et al., 2022). It can process vast amounts of data with high accuracy and

precision, minimizing errors, and improving the quality of decision-making that is beneficial to data analysis, diagnostics, and quality control. It can operate continuously without the need for breaks. As a result, customer support, virtual assistants, and online transactions can enhance among users across different time zones (Aoki, 2020).

The AI fosters innovation by enabling the development of new products, services, and business models that were previously unfeasible. This includes applications, such as natural language processing, robotics, virtual reality, and augmented reality opening up new possibilities for creativity and exploration. For example, Chatbots use language to talk to people in a natural and pre-programmed way, recognize names and phone numbers and reproduce human behavior (Aderibigbe et al., 2023).

Use of AI in medical imaging analysis, disease diagnosis, drug discovery, personalized treatment planning, and remote patient monitoring can improve patient outcomes and reduce healthcare costs (Baranidharan et al., 2023). The AI can optimize resource allocation, scheduling, and logistics, leading to cost savings, reduced waste, and improved resource utilization in various sectors, such as transportation, manufacturing, and energy management. AI-powered systems enhance safety in various domains, such as autonomous vehicles, manufacturing, and cyber-security in internet banking by detecting anomalies, predicting potential hazards, and implementing preventive measures to mitigate risks (Ghosh & Thirugnanam, 2021).

11. Disadvantages and Risks of AI

Despite its many advantages, AI has some risk factors that may bring a negative impact on its use. The automation due to AI may cause job displacement; and consequently, the unemployment rate may increase that can affect routine tasks of the employees in some jobs, such as manufacturing, customer service, and administrative roles (Aderibigbe et al., 2023). For example, according to a Forbes article, it is predicted that by 2025 automation will cause a loss of 85 million jobs. Societal inequalities related to race, gender, ethnicity, and other factors may arise if not carefully monitored and mitigated when biases present in training data due to discriminatory decision-making processes. Vast amounts of personal data are used to function effectively that may raise concerns about privacy and data security. Therefore, unauthorized access, data breaches, and misuse of personal information may pose significant risks to privacy rights (Aoki, 2020).

The AI is prone to technical difficulties, security snags, data difficulties, and can cause accidents if users fail to understand the AI system (Cheatham et al., 2019). Data difficulties arise due to the increase in unstructured data, usually from various sources, such as social media and mobile devices, and sometimes security snags, such as fraud, loss of data, scamming, and hacking may happen due to carelessness (Singh & Singh, 2019). The use of virtual assistants and social robots may create social isolation and disconnection by reducing face-to-face interactions and interpersonal relationships. The use of autonomous weapons, surveillance technologies, and predictive policing algorithms may raise concerns about accountability, human rights violations, and the erosion of civil liberties (Anderljung et al., 2023).

12. Conclusions

The AI is a computing concept that helps a machine to think and solve complex problems as we do with our intelligence. It is the new way of living human with incredible and efficient impacts on almost every sector. It is a rapidly developing technology and it has made significant strides in recent years. But there are many unanswered questions about how it will evolve and impact society in near future. At present the AI has affected every branch of the society with digital revolution, such as security and defense, healthcare services, education, transportation and infrastructure, environmental and natural resource management, law and justice systems, etc. The policymakers should be aware of AI demerits, such as data difficulties, technological troubles, and security snags that may interfere with its performance. The AI technology is rapidly evolving, and we have to be ready to present successful accomplish and future potential applications for maximum benefit of global humanity.

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