

# Emerging Role of Artificial Intelligence

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## ABSTRACT

Artificial Intelligence (AI) is considered a branch of science that deals with the process of machine learning and intelligent behavior of machines. AI is increasingly becoming involved in our existence. Many see emergence of AI as a revolution that will impact every aspect of our lives. Some see it as an evolution based on the recent advances in hardware/software technologies, powerful computational platforms, and access to massive amount of data collected through pervasive communication networks such as Internet of Things (IoT). Irrespective of these opinions, AI is expected to profoundly impact many aspects of our existence including healthcare, transportation, agriculture, energy, social life, entertainment, fighting crime, and many more. How far AI will infiltrate in human existence is within our hands, at least, for now. We, human beings, design algorithms for AI, we restrict or relax the boundaries of their use, we benefit from the artificial intelligence, and we deal with the consequences of the decisions made by machines using AI. How far AI can go in improving our lives and how significant and deep its interference can be in our existence, remains to be seen. This paper captures the current state of AI and discusses its potential to make human existence better.

*Keywords: Artificial Intelligence (AI), Smart Systems, AI Opportunities and Challenges.*

## 1. INTRODUCTION

Traditionally intelligence has been attributed to humans. The term intelligence implies having ability to think, learn, analyze (reason), and apply these acquired skills to find solutions for problems and surrounding situations that we humans face [1,2]. We humans are born with an innate ability to observe, absorb information from our interactions/experiences, and learn as we follow our unique individual trajectory with our growth. Many known and unknown factors including emotions, perceptions, interests, social circles, cultural values, religious preferences etc. influence our intelligence growth. Scientists have been investigating and continue the subject of human intelligence (HI) leading to an impressive reservoir of knowledge [3].

Artificial intelligence (AI) on the other hand deals with non-human intelligence. It deals with intelligence in machines (such as computers) and attempts to make machines behave or act as humans. It is about studying how human brain functions and trying to mimic that in machines' cognitive process. This field of artificial intelligence has been an important field among researchers for a long time. The interest in this fields has witnessed a few hypes and winters. However, the current enhanced level of research interest and activity among researchers is expected to continue due to various factors including availability of massive processing power, access to massive amount of data (thanks to advances in information and communication technologies such as Internet of Things), and huge and relatively inexpensive data storage capacity. In addition, artificial intelligence is expected to have a significant and profound impact on our daily life.

The next section of this paper discusses a brief history of artificial intelligence. Section 3 discusses emerging role of artificial intelligence in some of the most common activities of our daily life. Some of the challenges associated with emerging role of artificial intelligence are discussed in section 4. Section 5 presents summary and conclusions of the paper.

## 2. BRIEF HISTORY OF ARTIFICIAL INTELLIGENCE

For centuries, humans have been interested in automation and doing things fast. Historically, such interests have been limited to casual discussions, fictions, and fantasies through 1600s. However, there was no tangible progress on this topic for decades. In early 1700s, the word "engine" was coined in the context of automation. The pace of progress was still slow. In 1872, computer scientists suggested that future machines may possess consciousness – a notion that is controversial and is still being debated. The interest in automation and intelligent machines grew rapidly in early 1900s. In 1921, a fictional concept of making artificial people (called robots) was created. The interest about this field started its rapid growth in the scientific community. In 1950, Alan Turing published, "Computing Machinery and Intelligence" [4].

The very first mention of the phrase “artificial intelligence” emerged when the first workshop was proposed on this topic by John McCarthy in 1956. That event coupled with other computing advancements, initiated many significant developments leading to the first use of industrial robot by General Motors in 1961. From 1960 to 2000, the field of artificial intelligence (AI) witnessed several promising developments including some of the AI-related programming languages e.g. LISP and ELIZA. These developments also included some of the early robots e.g. WABOT-1 and ASIMO [4,5].

From 2000 onward, based on serious research in the field of artificial intelligence, many other major developments have taken place. Some of the prominent ones include IBM’s Watson playing Jeopardy and winning big, humanoid Sophia and others, capable of intelligently interacting with humans, virtual assistants, autonomous vehicles, Amazon’s Alexa, visual recognition, and natural language processing [4,5].

Some experts label these AI-related developments as revolution. However, it will not be unreasonable to consider these developments as evolution because all the ingredients needed for these AI-related developments became available during the last two decades and are readily available now. These ingredients include availability of massive amount of data gathered through platforms such as Internet of Things (IoT), massive processing power made available through impressive advances in semiconductors technologies, and efficient and huge data storage mechanisms. These developments are expected to continue their rapid growth and are bound to impact our daily lives in a very transformational manner.

### 3. EMERGING ROLE OF AI

Artificial intelligence (AI), by definition, converts common devices to smart devices. These smart devices can be trained using machine learning techniques and algorithms. These devices can process large volumes of information quickly, suggest possible solutions to problems, and possibly make autonomous decisions. These devices can make local decisions using edge computing or can utilize cloud computing resources, or a combination of both.

Artificial intelligence can play an effective role in many common applications. In this paper, however, we will use a few areas and applications of common interest and discuss how AI can be applied in these areas to make applications smart and efficient. Specifically, we will discuss application of AI in healthcare, energy, agriculture, transportation, and smart cities and public service.

There are several factors and trends that are fueling the growth of smart devices using artificial intelligence. The

world population is growing and is expected to reach 10 billion by 2050. That is a 7.5 billion increase in 100 years (world population was 2.5 billion in 1950). Such a growth demands smart and efficient food production mechanisms, smart infrastructure to sustain and serve the population, smart healthcare, and smart energy use. In parallel, information and communications technologies (ICTs) are providing unprecedented connectivity among world citizens. Number of connected devices are expected to be 50 billion by 2050. That will imply 5 devices per capita by 2050. Rise of quantum computing will represent a manifold increase in processing power. A \$1000 laptop by 2050 is expected to have processing power exceeding that of a human brain. All these factors and trends are expected to transform every aspect of our daily living and daily activities.

#### Role of AI in healthcare

Healthcare is a field that is important to all of us. A healthcare ecosystem involves patients, doctors, nurses, pharmaceuticals, healthcare facilities, healthcare tools, healthcare infrastructure, and, of course, prevailing technologies. Latest technologies have always been desired and deployed for delivering the best possible healthcare. For it to be at its best, every aspect of the healthcare ecosystem must be adaptive and ready to integrate the latest and the greatest technologies available. At the same time, the healthcare systems must adapt to the shifting demographics. These two aspects (technological advances and varying population demographics) must be addressed on an ongoing and regular basis for healthcare to stay current and be beneficial to citizens [6].

There has never been more pressing need for healthcare professionals and technology professionals to work together, exchange ideas and opportunities for using emerging technologies to improve healthcare, and to find practical and effective solutions for healthcare challenges. This approach leads to collective wisdom and has resulted in many significant improvements in healthcare including medical imaging, diagnostic tools, robotic surgeries, telemedicine, focused and personalized healthcare treatments, drug development, tools for monitoring patients inside hospitals and/or at their homes, and tracking progression of diseases including pandemics such as COVID. Emerging technologies have also improved access to healthcare in urban as well in rural areas. Emerging communication technologies have created widespread awareness about healthcare issues among citizens. These aspects, along with other developments, are creating a fundamental shift in healthcare model. This transformational shift is about focusing more on keeping people healthy rather than treating the sick individuals. In other words, healthcare model is moving towards becoming proactive (preventive) rather than reactive [7].

Artificial intelligence (AI) is playing a very important role in this transformational shift in healthcare. With the

growing deployment of Internet of Things (IoT), an ideal platform is being created to collect healthcare information about individuals, groups, cities, countries, and the world. The information collected on such a wider scale, can be analyzed using Artificial algorithms for observing the patterns about all the desired aspects of healthcare, and making informed decisions about diagnostics, selection of treatments options, and selections of drugs to be used. Use of AI in healthcare is never expected to replace the judgement of healthcare professionals. It is, however, expected to immensely improve the decision-making process of healthcare professionals. In other words, when human intelligence is augmented with artificial intelligence, the results are expected to offer healthcare with higher quality, less cost, and more efficiency. These aspects will lead to a healthier world. Use of artificial intelligence in healthcare is expected to have tremendous benefits, including the following [8]:

- Faster diagnosis of medical conditions, and identification of well-informed and better treatments options based on much larger health informatics datasets.
- Availability of personalized treatments options based on genetic dispositions of individuals.
- Availability of better, faster, reliable, efficient, and effective healthcare processes and operations within healthcare facilities.
- Availability of better and well-informed coordination among healthcare facilities and healthcare professionals.
- Leading to a healthcare model that is focused on keeping people healthy rather than treating the sickness.

The use of artificial intelligence in healthcare is a win-win situation for the entire healthcare ecosystem. It will lead to tremendous benefits (including cost savings) for patients as well as healthcare providers and improve overall confidence in the healthcare system.

### **Role of AI in energy**

As mentioned earlier, the world population is expected to reach 10 billion by year 2050, according to the current trends. The percentage of population living in urban areas is also expected to increase. An increase in the demand for energy will certainly follow. Experts estimate that energy consumption during the next 25 years will jump by 40%. It is also important to know that the energy sector is going through a transformational shift. In early days, energy was generated or harvested at some big, centralized energy plants (or sources) and distributed to the consumers through an elaborate distribution system often called a power grid. Over the past few decades, there has been a dramatic shift towards a variety of energy sources such as windmills, and solar panels. This has created a distributed system of energy sources connected to the energy grid. To

minimize the energy losses during the process of energy distribution (which could be as high as 10%), it is important to keep the consumption of energy as close to the generating points as possible. This problem needs a management strategy that keeps track of consumers' energy demands and the energy being generated at various locations.

To meet that challenge, it is essential to develop and maintain an intelligent energy infrastructure. It is also important to realize that, because of the increased demand for energy, evolving environmental policies, emerging technologies, and shifting demographics, the energy sector is expected to continue going through transformational changes. Use of windmills, solar panels, and natural gas are on the rise and this trend is expected to continue and grow. It is important to consider automating the energy management processes and to focus on operational efficiencies. As the energy sources become geographically distributed, development of microgrids is expected to emerge and their integration with the national energy grid is a necessity. Remote monitoring and management of assets will be an integral part of the energy operations. This requires a use of a connected system that can regularly collect information about the status of energy sources, energy consumers, and the energy distribution system [9].

A pervasive communication network such as Internet of Things (IoT) can serve as an ideal platform to collect information about all the entities that are part of the energy infrastructure. The amount of information collected using such an elaborate process, could be massive. This information can be analyzed using data analytics to extract information about patterns of energy flow. Such information can, in turn, be used to train machines and implement smart and automatic decisions using artificial intelligence algorithms. This approach of collecting information, training machines, using artificial intelligence for making smart decisions, may lead to big benefits including the following [10]:

- Making energy distribution decisions based on the consumer demands and availability of energy for a distributed set of energy sources.
- Keeping track of the health of energy sources and energy distribution system and suggesting a preventive maintenance schedule to minimize the outages.
- Automatically conducting inspections of all components of the energy infrastructure (possibly with the help of autonomous aerial vehicles or drones) and possibly mitigating some or all the problems detected.
- In case of unfortunate situations such as disasters, automatically reroute the flow of energy to minimize the outages and provide fast, reliable, and efficient restoration mechanism.

The use of Artificial intelligence in managing the processes related to the energy sector will be beneficial to the energy companies as well as provide cost-savings and stability to consumers.

### **Role of AI in agriculture**

With the growing world population, shifting demographics, and shrinking agricultural land, there is a pressing need for the agricultural processes to become more efficient and have adequate food production. It is anticipated that about 70% of the world population will choose to live in urban settings in the next few decades and agricultural workforce will shrink further. Emerging technologies can certainly help address these challenges [11]. Significant automation, such as use of drones, has already been introduced to improve the agricultural processes [12] and more automation is expected to be deployed as additional new technologies emerge.

It is anticipated that use of artificial intelligence in agricultural process will increase rapidly. For that to materialize, an elaborate platform will be needed for collection of relevant agricultural data. Wireless sensor networks and/or Internet of Things (IoT) are ideal candidates for that. Sensor networks and IoT can monitor agricultural processes and collect data about all aspects including soil condition, irrigation needs, crops' health, need for fertilizer/pesticide etc. to make sure their health and optimal conditions. The collected data can be analyzed using data analytics, artificial intelligence algorithms can be applied, and appropriate decisions can be made and implemented leading to optimal conditions for the best possible outcomes [13,14]. The use of artificial intelligence and automation in agriculture will not only address the shortage of agricultural workforce, but it is also expected to have the following outcomes [15,16]:

- With the better use of agricultural resources, we can expect higher yield and healthier crops. Fertilizer and pesticide can be applied only as needed. Irrigation can be controlled precisely and used only if needed, resulting in tremendous conservation of assets including water.
- Greenhouses with controlled climate using artificial intelligence, can grow the same crop multiple times and year.
- The entire agriculture process can be automated. One can remotely manage the entire agricultural cycle including soil preparation, cultivation, monitoring, harvesting, packing, and shipping without visiting the farm.
- Image processing combined with artificial intelligence can be used to monitor and mitigate weeds for healthier growth of crops. The same approach can be used to harvest fruits when ready.

There are many other applications of artificial intelligence that can improve the agricultural process from the moment a crop is cultivated to the moment it is ready to be consumed at the dining table. This includes monitoring the crop health during transportation and making sure the food items are not exposed to any contamination while in transition.

### **Role of AI in transportation**

Transportation industry has always been significantly dependent on emerging technologies. From the use of engine technologies, and now being connected and being autonomous, are just some of the recent developments in this field. The latest use of information and communication technologies, and artificial intelligence in the field of transportation, is bringing transformational changes to this industrial sector. With demographical shifts leaning towards growing urban population, transportation companies are revising their future plans. Recent trends indicate that car ownership is declining, and the trend is expected to continue. There are also indications that transportation will become more as a service rather than as ownership. With autonomous self-driving vehicles becoming common, and with impressive developments in information and communication technologies, transportation as a service makes a lot of sense. Transportation companies are already investing heavily in autonomous self-driving cars, to stay competitive. Use of artificial intelligence is expected to take a central role in the transportation industry.

In the future, all vehicles (land, sea, and air) are expected to be pervasively connected and become a part of pervasive communication networks such as Internet of Things (IoT). They will be able to communicate with each other (vehicle-to-vehicle or V2V, vehicle-to-infrastructure or V2I, and vehicle-to-everything or V2E). The infrastructure will need to keep its pace with technical advances and not become a bottleneck. We also know that air transportation such as airplanes can provide travel but only between the airports, sea transportation such as cargo ships and cruise ships can provide travel but only between the seaports, and land vehicles can go as far as the infrastructure goes [17]. That leaves a transportation gap to areas where there is a no transportation infrastructure. Small autonomous aerial vehicles (e.g. drones) can fill that gap. Coordination among all these modes of transportation is necessary for smooth and effective operations. Artificial intelligence can play an effective role in making autonomous decisions for efficient transportation environment.

Use of artificial intelligence in transportation, as in other applications, also requires collection of relevant information and communication infrastructure can help with that. Collected data can be analyzed and AI algorithms can be applied to identify possible decision options or make smart decisions. Among many other

applications, self-driving vehicles can make use of artificial intelligence the most. Relevant information can be collected, AI algorithms can be used, autonomous vehicle can be trained and be ready to go. In this approach, it is important that AI algorithms use all the information available to be prepared for any situation that they may come across or face. These situations may include other vehicles, traffic lights, construction sites, emergency vehicles, pedestrians, cyclists, road signs, speed limits, cops directing traffic, accidents, obstructions, and many more. Onboard computing power should be adequate to process the available information and make almost real-time decisions so that the autonomous vehicles may keep up with the speed limits and not impact the other traffic adversely. The operations of autonomous vehicles have been very promising so far. The major factors leading to the satisfactory performance of autonomous vehicles include availability of more information than that a human driver can possibly collect and the faster processing power to analyze that information than a human can possibly do. In addition, with the use of data collection devices such as sensors, autonomous vehicles can gather information from blind spots and blind corners which are not in the direct line-of-sight. The use of artificial intelligence and automation in transportation is transformational and is expected to provide many beneficial outcomes including the following [18,19]:

- Traffic accidents are expected to reduce leading to saving many precious lives.
- Many individuals with physical challenges may be able to enjoy the benefits of transportation without the need of driving.
- Deployment of transportation as a service will become easy.
- Cities will be able to manage traffic and deal with parking challenges much more effectively.
- With pervasive connectivity features, vehicles will be able to keep current with the latest information about traffic conditions and make appropriate routing adjustments as necessary.
- Consumers will have choice to put their travel time to some better use.

Consumers will have many more benefits with the use of artificial intelligence in the field of transportation. These benefits include cost savings, reliability, and safety of the vehicles.

### **AI in smart cities and public service**

A smart city acquires and implements all available technologies. The main objective of smart cities is to improve quality of life of their citizens, encourage and enable connected and cohesive communities, provide efficient public services, and to raise the level of happiness among their citizens. Public services include law enforcement, reliable utilities, fighting fires, healthcare,

transportation, search-and-rescue missions, and managing disaster situations. Use of artificial intelligence can significantly improve all these aspects of smart cities and public service [20]. Some of these aspects have been discussed in detail in the earlier sections of this paper. This section will focus on use of artificial intelligence in public services [21].

Artificial intelligence can be very effectively used in almost all aspects of public service including government office operations, urban planning, water management, security services etc. Connectivity and innovative use of available technologies such as drones, can augment the effectiveness of law enforcement in tracking individuals and managing suspicious activities. They can effectively mark the boundaries of a crime area, document the suspicious activities, track suspects, and guide the police until the suspects are apprehended. During the process, a live video feed from drone(s) can also be sent to the law enforcement agencies [22]. These services can be further enhanced with the use of artificial intelligence incorporating image recognitions and identifications. In addition, AI can be used in parallel to parse through all relevant databases to extract and analyze any relevant information to the situation being pursued.

Artificial intelligence, combined with other available tools can serve as a very powerful platform for saving lives in disaster situations such as accidents, tornados, flooding, earthquakes, and hurricanes etc. This is commonly referred to as search-and-rescue missions. Due to their small sizes, drones can stay connected and collect critical information for AI algorithms to analyze and make decisions. Connected drones can also serve as remote ambulances with limited but effective healthcare tools to deploy and serve [23,24].

Artificial intelligence can also be used in other sectors such as human resources, legal matters, insurance claims etc. Its use can introduce automation and speed in serving citizens which should be music to the ears of the citizens. So, the use of artificial intelligence in smart cities and public sectors provides many benefits including the following [25,26]:

- Use of artificial intelligence (AI) in smart cities and public services, makes the government's job effective and easier.
- AI can very effectively help the law enforcement agencies in solving crimes.
- AI can effectively support an environment in which a wide range of services can be coordinated to improve the efficiency of delivering these services.
- City architecture can be planned after analyzing all relevant data and applying AI algorithms, to better serve the citizens. Such planning may lead to lower stress levels, better airflow patterns,

comfortable range of average temperatures in the city, higher level of happiness, and lower crime rates.

- Artificial intelligence can also be used in human resources to improve hiring practices, and better marketing of its services [27,28].

There are many other aspects where artificial intelligence can be used to achieve better performance and optimized use of resources [29,30].

#### 4. CHALLENGES AND OPPORTUNITIES

While integration of artificial intelligence is beneficial for the society and offers tremendous opportunities, the idea also poses some concerns and faces some challenges. To begin with, the biggest concern that people have is the “fear of unknown”. This has always been the case with the introduction of new technologies. With time such fears tend to fade away. Another fear is about all the information that is being collected about us and our surroundings. This includes information about our whereabouts, our finances, our healthcare records, and many more. No one wants their personal and private information fall in the hands of unauthorized individuals and/or corporations. Another longstanding concern that is very often associated with the introduction of new technologies and that is the future of workforce. Whenever a new technology is introduced, it is feared that technology and automation will eliminate the jobs that humans used to do and now machines will be doing. When robots were introduced in assembly lines, it was feared that human workers will lose their jobs. That is true to some extent. After all, mechanization of agricultural process did lead to a drastic reduction in the percentage of people who worked at the farms. Similar fears emerge as we see proliferation of automation with the integration of artificial intelligence in most of the applications around us including healthcare, energy, transportation, agriculture and more. Looking at this from another perspective, this challenge can also be viewed as a mother of many opportunities. Introduction of new technologies will indeed result in elimination of some jobs and loss of some workforce. At the same time, an equal or higher number of jobs will be created to maintain the new technologies being introduced. For example, the jobs at Google, Amazon, Facebook, or Twitter did not exist a few decades ago. They were created as the new technologies were deployed in these giant companies. It should be expected that each disruption caused by new technologies, will result in a slightly adjusted ecosystem of jobs where new skillsets will be required.

The biggest challenges associated with the introduction of artificial intelligence may be different than the one associated with previous technologies. AI challenges should be viewed through the context of emerging AI trends. As the world population grows so does the

connectivity and processing power of machines. Rise of quantum computing will give a massive boost to the processing speed and processing power. It is anticipated that by 2050, a \$1000 laptop will have processing power exceeding that of a human brain. With that context, people are asking the following questions:

- Can computing machines think?
- Can computing machines have awareness?
- Can computing machines have consciousness?

While these questions are legitimate and at this stage the answer to these questions in negative. What will future bring, remains unknown and the fears of unknown are not easy to overcome. It is anticipated that with the rapid pace of AI developments and supporting technologies, mapping entire human brain will be possible. Such brain maps can then be integrated with one’s life history. That may lead to the scenarios that one can interact with and have conversations with a digital version of an individual who has already left this mortal world. This possibility is being referred to as digital immortality of fellow human beings.

The best we can do at this stage and in the near future is to put artificial intelligence to a good use to serve humanity and find ways to coexist with AI developments. At the same time, let us hope that with all the impressive leaps and bounds in artificial intelligence, we humans can stay in control and avoid any potential pitfalls.

#### 5. SUMMARY AND CONCLUSIONS

This paper has discussed emerging role of artificial intelligence in various aspects of our lives. Artificial Intelligence (AI) is considered a branch of science that deals with the process of machine learning and intelligent behavior of machines. AI is increasingly becoming involved in our existence. Some researchers see AI developments as an evolution based on the recent advances in hardware/software technologies, powerful computational platforms, and access to massive amount of data collected through pervasive communication networks such as Internet of Things (IoT). AI is expected to profoundly impact many aspects of our existence including healthcare, transportation, agriculture, energy, social life, entertainment, fighting crime, and many more. How far AI will infiltrate in human existence is within our hands, at least, for now. We, human beings, design algorithms for AI, we restrict or relax the boundaries of their use, we benefit from the artificial intelligence, and we deal with the consequences of the decisions made by machines using AI. This paper captures the current state of AI and discusses its potential to make human existence better. The paper has discussed roles of AI in some prominent areas such as healthcare, energy, agriculture, transportation, and smart cities/public service. The paper has also discussed some of the challenges and opportunities as artificial intelligence makes its way into all aspects of our lives.

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