Chapter

Introductory Chapter: Artificial Intelligence - Challenges and Applications

Dinesh G. Harkut, Kashmira Kasat and Vaishnavi D. Harkut

1. What is artificial intelligence (AI)?

Artificial intelligence (AI) is any task performed by program or machine, which otherwise human needs to apply intelligence to accomplish it. It is the science and engineering of making machines to demonstrate intelligence especially visual perception, speech recognition, decision-making, and translation between languages like human beings. AI is the simulation of human intelligence processes by machines, especially computer systems. This includes learning, reasoning, planning, self-correction, problem solving, knowledge representation, perception, motion, manipulation, and creativity. It is a science and a set of computational techniques that are inspired by the way in which human beings use their nervous system and their body to feel, learn, reason, and act. AI is related to machine learning and deep learning wherein machine learning makes use of algorithms to discover patterns and generate insights from the data they are working on. Deep learning is a subset of machine learning, one that brings AI closer to the goal of enabling machines to think and work as human as possible.

AI is a debatable topic and is often represented in a negative way; some would call it a blessing in disguise for businesses, while for some it is a technology that endangers the mere existence of humankind as it is potentially capable of taking over and dominating human being, but in reality artificial intelligence has affected our lifestyle either directly or indirectly and shaping the future of tomorrow. AI has already become an intrinsic part of our daily life and has greatly impacted our lifestyle despite the imperative uses of digital assistants of mobile phones, driver-assistance systems, the bots, texts and speech translators, and systems that assist in recommending products and services and customized learning.

Every emerging technology is a source of both enthusiasm and skepticism. AI is a source of both advantages and disadvantages in different perspectives. However, we need to overcome certain challenges before we can realize the true potential and immense transformational capabilities of this emerging technology. Some of the challenges related to artificial intelligence are:

2. Challenges

Building trust: The AI is all about science, technology, and algorithms which mostly people are unaware of, which makes it difficult for them to trust it.

AI human interface: Being a new technology, there is a huge shortage of working manpower having data analytics and data science skills; those in turn can be deputed to get maximum output from artificial intelligence. As the advancement of

AI rising, businesses lack a skilled professional who can match the requirement and work with this technology. Business owners need to train their professionals to be able to leverage the benefits of this technology.

Investment: AI is an expensive technology that not every business owner or manager can invest money into as large amount of computing power will be necessary and sometimes hardware acceleration with GPU, FPGA, or ASIC must be in place to run machine learning models effectively. Though adoptability of AI is surging high, it has not been integrated fully in business's value chain at the scale which it should have. Moreover, enterprises of those who have incorporated are still in nascent stage which have resulted in the slowdown in the lifting of the AI technology at scale and thus been deprived of cost benefit of scale. After decades of speculation and justifiable anxiety about the social implications of intensifying & potentially de-stabilizing AI technology for humankind and Black box problem, AI investors are bit skeptical from parking their money in potential startups.

Software malfunction: With machines and algorithms controlling AI, decision-making ability is automatically ceded to code-driven Black Box tools. Automation makes it difficult to identify the cause of mistakes and malfunctions. Moreover, due to the lack of ability of human beings to learn and understand how these tools work, they have little or no control over the system which is further complicated as automated systems become more prevalent and complex.

Non-invincible: (Can replace only certain tasks) Like any other technology, AI also has its own limitations; it simply cannot replace all tasks. However, it will result in emerging new job domain with different quality job profile.

High expectations: Research in artificial intelligence is conducted by large pool of technologist and scientists with varying objectives, motivation perspectives, and interests. Main focus of research is confined in understanding the underlying basis of cognition and intelligence with heavy emphasis on unraveling the mysteries of human intelligence and thought process. Not everyone understands the functioning of AI and might also have very high expectation of functioning.

Data security: Machine learning and decision-making capability of AI and AI application are based on huge volumes of classified data, often sensitive and personal in nature. This makes it vulnerable to serious issues like data breach and identity theft. Mostly, companies and government striving for profits and power, respectively, exploit the AI-based tools which are generally globally networked which make them difficult to regulate or rein in.

Algorithm bias: AI is all about data and algorithms. Accuracy of decision-making capability of AI is purely based on how accurately it has been trained and by using authentic and unbiased data. Unethical and unfair consequences are inherent in vital decision-making if data used for training is laced with racial, gender, communal, or ethnic biases. Such biases will probably be more accentuated, as many AI systems will continue to be trained using bad data.

Data scarcity: Power and capabilities of AI and AI applications depend directly on the accuracy and relevancy of supervised and labeled datasets being used for training and learning. There is scarcity of quality-labeled data. Though efforts are underway by means of transfer learning, active learning, deep learning, and unsupervised learning, to devise methodologies to make AI models learn despite the scarcity of quality-labeled data, it will only aggravate the problem.

3. Application domain

Artificial neural networks allow modeling of nonlinear processes and become a useful tool for solving many problems such as classification,

clustering, dimension reduction, regression, structured prediction, machine translation, anomaly detection, pattern recognition, decision-making, computer vision, visualization, and others. This wide range of abilities makes it possible to use artificial neural networks in many areas. Recent developments in AI techniques complimented by the availability of high computational capacity at increasingly accessible costs, wide availability of labeled data, and improvement in learning techniques result in exploring the wide application domain for AI. Anticipated progress of AI is shown in **Figure 1**.

AI improves lives of human beings by assisting in driving, taking personal care of aged /handicap people, executing arduous and dangerous tasks, assisting in making informed decisions, rationally managing huge amounts of data that would otherwise be difficult to interpret, assisting in translating, and communicating multilingually while not knowing the language of our interlocutors and many more.

Artificial intelligence is already everywhere and is widely used in ways that are quite obvious. Some of the areas currently on the priority list include but not limited to:

Collaborative systems: Research on collaborative systems investigates models and algorithms to support the development of autonomous systems that can collaborate with each other and with human beings.

Computer vision: Till the advent of computer vision, support-vector machines were considered the most used method for visual classification activities and were the most relevant form of machine perception. Further, deep learning has deep impact on computer vision which is complimented by the evolution and low-cost availability of large-scale computing and the availability of large amounts of data. Moreover, the fine-tuning of networks of neural network algorithms has allowed the AI to perform visual classification tasks better than human beings.

Crowd sourcing and human computation: It is focused on the creation of innovative ways to exploit human intelligence.

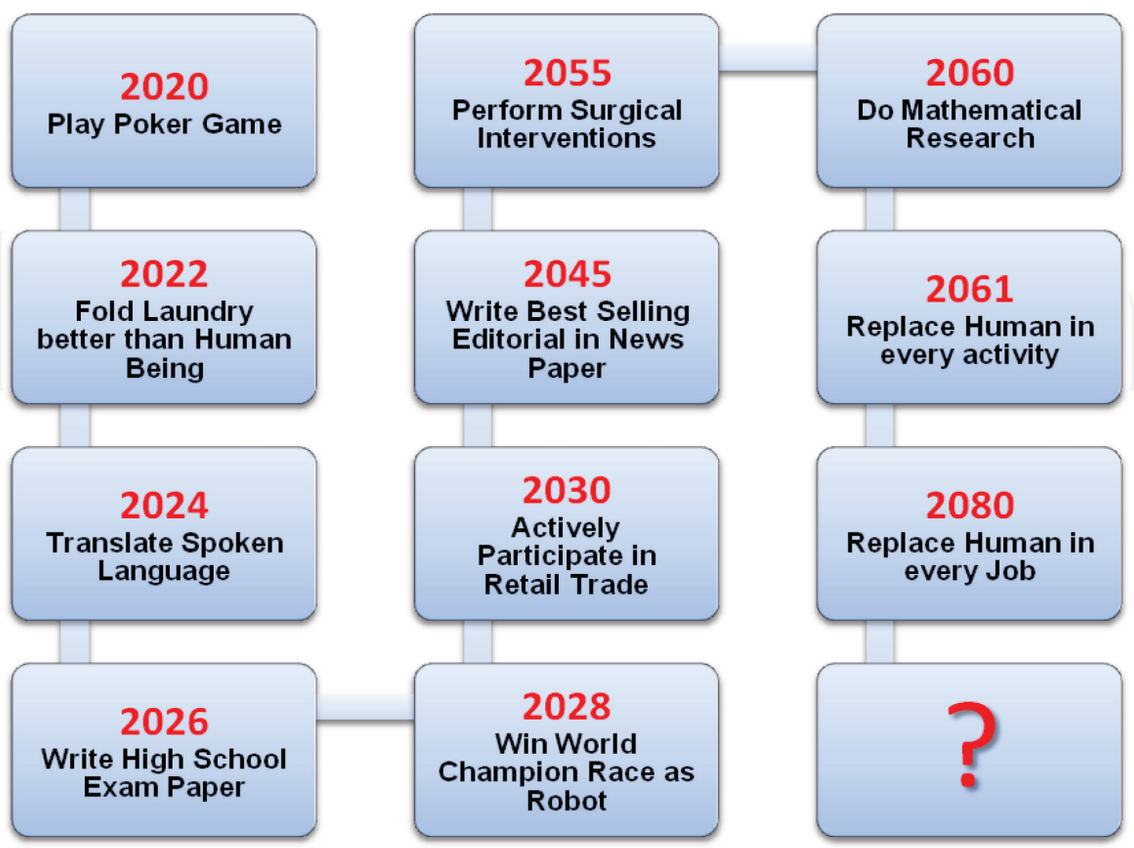

Figure 1.
Anticipated progress of artificial intelligence.

Deep learning (DL): The ability to learn convolutional neural networks has brought many benefits to the computer vision sector, with applications such as object recognition, video labeling, and other variants.

Internet of things (IoT): Artificial intelligence plays a growing role in IoT applications and deployments. The value of AI in this context is its ability to quickly wring insights from data. Moreover, machine learning brings the ability to automatically identify patterns and detect anomalies in the data that smart sensors and devices generate. Other AI technologies such as speech recognition and computer vision can help extract insight from data that used to require human review. AI plays a growing role in IoT applications and deployments and is making a big splash in the Internet of things.

Machine learning (ML): Many basic problems in machine learning (such as supervised and non-supervised learning) are well known. A central focus in current studies concerns the chance of increasing the ability of algorithms to work on extremely large datasets.

Natural language processing (NLP): It is a very dynamic sector in the area of machine perception which is majorly associated with automatic speech recognition. It is nothing but imparting the ability to understand human language as it is spoken to computer program. Research in this area is basically focused on the ability to develop systems capable of interacting with people through dialog and not with simple standard reactions which find application in enterprise search which involves organized retrieval of structured and unstructured data within an organization.

Neuromorphic computing: Traditional computers use von Neumann's architecture model. With the success of the deep neural networks, alternative models are being developed, many of which are inspired by neural biological networks.

Reinforcement learning: Through rule extraction, pattern matching, and mining, machine learning become one of the important tools which is further complimented by motivational decision-making capability implemented via reinforcement learning. Advent of reinforcement learning sharpens the ability of AI to address the real-world dynamic problem of complex nature.

Robotics: Navigation of robots in static environments is widely addressed and resolved. Now studies are revolving around exploring their ability to interact with the surrounding reality in a predictable way in dynamic environment in real time.

This is just a partial list of exhaustive application domain area of artificial intelligence where it can be used extensively. One area which was explored during PhD thesis, illustrated next, is the design of fuzzy inference system (FIS)-based adaptive hardware task scheduler for multiprocessor systems.

4. Conclusion

This chapter encompasses many challenges and opportunities in the fascinating area of AI. AI is playing an increasingly important role in our society. Though it has been learnt and studied for decades, it still remains a strong buzzword and the most abstract subject in computer science. Until recently, it has been mostly the topic of discussion among science fiction writers and worked on; it was confined to university research labs, but remarkable progress has recently been made in this domain, and the benefits of this happening phenomenon are widely recognized in diversified areas ranging from medicine to security to consumer applications and business.

The impact of adaptive neuro-fuzzy inference system (ANFIS) has emerged as a dominant technique for addressing highly nonlinear, complex, and dynamic research problems which required cognitive skills. The ability of machines to demonstrate the application of this advanced cognitive skills in predicting

behavior, decision-making, language processing (written or spoken), and learning (supervised or unsupervised) makes this domain of paramount importance in today's world which is highly influenced by massive volume of unsupervised data. Exponential growth of data generation, sophisticated storage capabilities, steady increases of computing power, and advancement in research machine self-learning have greatly enhanced the capabilities of AI.

There are pros and cons of every new disruptive technology, and AI is no exception to this rule. AI has implications for privacy, data protection, and the rights of individuals which pose social and ethical challenges which are further exaggerated by self-learning algorithms gaining controls of societies and people. Many people are expressing their anxiety and predicting that the havoc which AI could wreak may be in terms of growing deluge of unemployment and disenchantments. However, AI revolution will create plenty of new data science, machine learning, engineering, and IT job positions to develop and maintain the systems and software that will be running those AI algorithms and enhance the quality of life of mankind.

Author details

Dinesh G. Harkut[1]*, Kashmira Kasat[2] and Vaishnavi D. Harkut[1]

1 Department of Computer Science and Engineering, Prof Ram Meghe College of Engineering and Management, Amravati, India

2 Department of Electronics and Telecommunication Engineering, Prof Ram Meghe College of Engineering and Management, Amravati, India

*Address all correspondence to: dg.harkut@gmail.com