International Journal of Engineering Research and Advanced Technology (IJERAT)

DOI: 10.31695/IJERAT.2020.3670

E-ISSN : 2454-6135

Volume.6, Issue 12
December -2020

Artificial Intelligence in Healthcare: An Overview

Matthew N. O. Sadiku, Omobayode I. Fagbohungbe, and Sarhan M. Musa

Roy G. Perry College of Engineering

Prairie View A&M University

Prairie View, TX, USA

ABSTRACT

Artificial intelligence (AI) is the use of computer science to develop machine that can be trained to learn, reason, communicate, and make human-like decisions. It is a technology that is rapidly being adopted in many industries to improve performance, precision, time efficiency, and cost reduction. The use of artificial intelligence in healthcare is an emerging scientific area that aims to generate healthcare intelligence by analyzing health data. AIis becoming increasingly attractive in healthcare industry and changing the landscape of healthcare and biomedical research. This paper provides an overview of a broad range of applications of AI in healthcare.

Key Words: Artificial Intelligence, Healthcare.

1. INTRODUCTION

Recently, we have witnessed a wave of emerging technologies, from Internet of things and blockchain to artificial intelligence (AI), demonstrate significant potential to transform and disrupt multiple sectors, including healthcare. Healthcare is shifting from traditional hospital-centric care to a more virtual care that leverages the latest technologies around artificial intelligence, deep learning, big data genomics, robotics, increased access to data, additive manufacturing, and wearable and implanted devices [1].

Today, artificial intelligence (AI) is shorthand for any task a machine can perform just as well as, if not better than, humans. AI represents the hopes and fears of an industry seeking more intelligent solutions. AI is an interdisciplinary field covering numerous areas such as computer science, psychology, linguistics, philosophy, and neurosciences. The central objectives of AI research include reasoning, knowledge, planning, learning, natural language processing, perception, and the ability to move and manipulate objects [2].

Although AI is a branch of computer science, there is hardly any field which is unaffected by this technology. Common areas of applications include agriculture, business, law enforcement, oil and gas, banking and finance, education, transportation, healthcare, automobiles, entertainment, manufacturing, speech and text recognition, facial analysis, and telecommunications [3]. In healthcare, AI can help manage and analyze data. AI can have a significant impact in making healthcare more accessible, especially in developing countries, where shortages of healthcare practitioners are most severe. There are many cases in which AI can perform healthcare tasks as well or better than humans.

2. OVERVIEW ON ARTIFICIAL INTELLIGENCE

The term "artificial intelligence" (AI) was coined in 1956 by John McCarthy during a conference held on this subject. AI is the branch of computer science that deals with designing intelligent computer systems that mimic human intelligence. The ability of machines to process natural language, to learn, to plan makes it possible for new tasks to be performed by intelligent systems. The main purpose of AI is to mimic the cognitive function of human beings and perform activities that would typically be performed by a human being. AI is stand-alone independent electronic entity that functions much like human healthcare expert. Today, AI is integrated into our daily lives in several forms, such as personal assistants, automated mass transportation, aviation, computer gaming, facial recognition at passport control, voice recognition on virtual assistants, driverless cars, companion robots, etc. [4].

AI technologies are performing better and better at analyzing health data, thereby helping doctors better understand the future needs of their patients.

. An important feature of AI technology is that is can be added to existing technologies. AI has benefited many areas such chemistry and medicine, where routine diagnoses can initiated by AI-aided computers. It embraces a wide range of disciplines such as computer science, engineering, machine learning, chemistry, biology, physics, astronomy, neuroscience, and social sciences.

AI is not a single technology but a range of computational models and algorithms. The major disciplines in AI include expert systems, fuzzy logic, and artificial neural networks (ANNs), machine learning, deep learning, natural language processing, computer vision, and robotics. The various computer-based tools or technologies that have been used to achieve AI's goals are the following [5,6]:

- ***Expert Systems*:** An expert system (ES) (or knowledge-based system) enables computers to make decisions by interpreting data and selecting between alternatives just as a human expert would do. It uses a technique known as rule-based inference in which rules are used to process data.
- ***Neural Networks***: These computer programs identify objects or recognize patterns after having been trained. Artificial neural networks (ANNs) are parallel distributed systems consisting of processing units (neurons) that calculate some mathematical functions. The ANN model represents nonlinear relationships which are directly learned from the data being modeled. Neural networks are being explored for healthcare applications in imaging and diagnoses, risk analysis, lifestyle management and monitoring, health information management, and virtual health assistance.
- ***Natural Language Processors*:** Computer programs that translate or interpret language as it is spoken by normal people. NLP techniques extract information from unstructured data such as clinical notes to supplement and enrich structured medical data. NLP targets at extracting useful information from the narrative text to assist clinical decision making. NLP includes applications such as speech recognition, text analysis, translation and other goals related to language. There are two basic approaches to NLP: statistical and semantic. Healthcare is the biggest user of the NLP tools. NLP has been used in the clinical setting for capturing, representing, and utilizing clinical information [7].
- ***Robots*:** Computer-based programmable machines that have physical manipulators and sensors. The introduction of intelligent robots in the healthcare domain enhances patients' satisfaction, accuracy of diagnosis, and operational efficiency of hospitals. Medical robots can help with surgical operations, rehabilitation, social interaction, assisted living, etc. Robotic-guidance is becoming common in spine surgery. Figure 1 shows AI and robotics [8].
- ***Fuzzy Logic***: Reasoning based on imprecise or incomplete information in terms of a range of values rather than point estimates. Fuzzy logic deals with uncertainty in knowledge that simulates human reasoning in incomplete or fuzzy data. The fuzzy model is robust to parameter changes and tolerant to impression.
- ***Machine Learning:*** Algorithms to make predictions and interpret data and "learn", without static program instructions. ML is a statistical technique for fitting models to data and training models with data. ML extracts features from input data by constructing analytical data algorithms and examines the features to create predictive models. The most common ML algorithms are supervised learning, unsupervised learning, reinforcement learning, and deep learning. The most common application of ML is precision medicine. Many hospitals have started using ML for predictive analytics for hospital management purposes. ML algorithms are capable of identifying suicide risk factors.
- ***Deep Learning*:** A subset of machine learning built on a deep hierarchy of layers, with each layer solving different pieces of a complex problem. It aims at increasing the capacity of supervised and unsupervised learning algorithms for solving complex real-world problems by adding multiple processing layers. An illustration of deep learning with two hidden layers is in Figure 2 [9].
- ***Data Mining:*** This deals with the discovery of hidden patterns and new knowledge from large databases. Data mining exhibits a variety of algorithmic tools such as statistics, regression models, neural networks, fuzzy sets, and evolutionary models.

Each AI tool has its own advantages. Using a combination of these models, rather than a single model, is recommended. AI technologies are drastically influencing the retail industry and customer experience.

DOI : 10.31695/IJERAT.2020.3670

3. APPLICATIONS IN HEALTHCARE

AI techniques are now actively being applied in healthcare, as shown in Figure 3 [10]. The primary aim of AI applications in the health domain is to analyze relationships between prevention or treatment techniques and patient outcomes. Various AI applications have been developed to solve some of the most pressing problems that currently face healthcare industry. The following specialties in medicine have shown an increase in research regarding AI [5, 9,11,12].

- ***Radiology*:** The ability to interpret imaging results with radiology may aid clinicians in detecting a minute change in an image that a clinician might not notice otherwise. This is the widest application of AI in medicine, but providers are just beginning to tap into the potential of what AI technology has to offer. The practice of radiology relies primarily on imaging for diagnosis and is very amenable to deep-learning techniques. As AI continues to expand in its ability to interpret radiology, it may be able to diagnose more people with the need for less doctors as there is a shortage in many nations. The emergence of AI technology in radiology is perceived as a threat by some specialists.

- ***Oncology/Cancer*:** In breast cancer diagnosis and the detection of lung cancer, AI algorithms have been shown to be better and more effective than a human. It has been demonstrated that the IBM Watson for oncology would be a reliable AI system for assisting the diagnosis of cancer.

- ***Telemedicine:*** Telemedicine (also known as telehealth or ehealth) may be regarded as the transmission of medical images between healthcare centers for diagnosis across distance. It allows healthcare practitioners to diagnose, treat, and monitor patients at a distance using telecommunications technology. Telemedicine is used in a variety of specialties including radiology, neurology, and pathology. The ability to monitor patients using AI may allow for the communication of information to physicians if possible disease activity may have occurred [13,14].

- ***Electronic Health Records:*** Electronic health records are crucial to the digitalization and information spread of the healthcare industry. They contain the clinical history of patients and could be used to identify the individual risk of developing cardiovascular diseases, diabetes, and other chronic conditions. Using an AI tool to scan EHR data can accurately predict the course of disease in a patient.

- ***Mobile Health:*** Mobile health (or mHealth) refers to the practice of medicine via mobile devices such as mobile phones, tablet computers, personal digital assistants (PDAs), and wearable devices. It has emerged as the creative use of emerging mobile devices to deliver and improve healthcare practices. It integrates mobile technology with the health delivery with the premise of promoting a better health and improving efficiency. mHealth benefits immensely from AI. AI algorithms, sensor technology, and advanced data are helping transform smartphones into full health-management platforms. The evolution of mHealth can be seen in the improved availability of healthcare services, increased efficiency in the treatment process, reduced costs, and the creation unprecedented opportunities for preventive care. mHealth assistants will become a popular alternative in developed countries, where doctors are very busy [15,16].

- ***Medical Research*:** AI can be used to analyze and identify patterns in large and complex datasets. It can also be used to search the scientific literature for relevant articles. AI systems used in healthcare could also be valuable for medical research by helping to match suitable patients to clinical studies. AI can aid early detection of infectious disease outbreaks and sources of epidemics. AI has also been used to predict adverse drug reactions [17].

AI can also be used in neurology, cardiology, stroke, aging, health surveillance health, health monitoring, hospital inpatient care, healthcare management, urban healthcare system, suicide risk prediction, emergence medicine, detection of disease, management of chronic conditions, delivery of health services, and drug discovery. The scope of possible applications of AI in healthcare is almost limitless. Future uses for AI include Brain-computer Interfaces (BCI) which will help those with trouble moving or speaking.

Medical institutions, such as The Mayo Clinic, Massachusetts General Hospital, Memorial Sloan Kettering Cancer Center, and National Health Service, have developed AI algorithms for their departments. Major technology companies such as IBM, Intel, Microsoft, and Google have also developed AI algorithms for healthcare [11].

DOI : 10.31695/IJERAT.2020.3670

4. INTERNATIONAL TRENDS

Artificial Intelligence has arrived in healthcare. The AI technology now moves towards globalization and it becomes necessary to track both government initiatives as well as regulatory changes around the world. There is global policy developments and investments in AI. AI has been a strategic priority for governments around the world. The following are typical examples of international trends [18].

- ***Canada:*** Canada has a unique and time-limited opportunity to be world leaders in system design using AI technology. It has established itself as a world leader in AI technology-related research. Its main cities, Montreal, Toronto, and Vancouver, have become hubs for AI research and development, attracting companies like Google, Facebook, Uber, Microsoft, and Samsung. Canada aims at establishing responsible development of human-centric AI and facilitate international scientific collaboration [19].
- ***United Kingdom****:* The British Government has announced its ambition to make the UK a world leader in AI and data technologies. The UK government has launched the *Centre for Data Ethics and Innovation*, as part of the UK's initiative to lead global governance on AI ethics.
- ***France:*** The government plans to establish France as leader in AI research. Its key initiatives include: (1) developing an open data policy to drive the adoption and application of AI in sectors like healthcare, (2) establishing a regulatory and financial framework to support the development of domestic "AI champions," and (3) putting in place regulation to ensure that AI developments remain transparent, explainable, and non-discriminatory.
- ***China:*** The government plans to develop intelligent and networked products such as vehicles, service robots, and identification systems. It announces investment in industry training resources, standard testing, and cybersecurity.
- ***India*****:** India's AI strategy aims at promoting AI inclusion, an approach called "*AIforAll."* India is also attempting to establish itself as an "AI Garage", which allows the AI technology developed in India to be useable to the rest of world. India is rich in data due to the volume of patients. Artificial intelligence (AI) and machine learning (ML) are witnessing increasing adoption in the Indian healthcare setting. However, India is fraught with several problems like aging population, lack of adequate infrastructure, limited access to healthcare facilities, adherence to treatment, and availability of care providers [20].

AI solutions could improve access, quality, and efficacy of global health systems. A common trend is the international focus on the development of transparent and responsible AI policy.

5. BENEFITS AND CHALLENGES

AI has unimaginable potential, and its benefits are enormous when implemented strategically.
The use of AI will deliver major improvements in quality and safety of patient care. It will decrease medical costs as there will be more accuracy in diagnosis and better predictions in the treatment plan. AI is destined to drastically change clinicians' roles and everyday practices. While a healthcare practitioner can treat one patient at a time, automated AI-powered health assistants can serve millions of patients simultaneously, thereby multiplying productivity. AI has already begun making progress in healthcare by simplifying tedious and expensive procedures, guarding against human error, and promising to usher in a new era of patient care [21].

There are challenges hindering the successful AI technology adoption. While AI has achieved widespread adoption in certain sectors, the complexities of healthcare have resulted in slower adoption. Healthcare providers must recognize that patient privacy and security must remain paramount. Therefore, AI companies should utilize valuable medical data while remaining compliant with laws governing the protection of patient information and data ownership. There is a misconception that AI will replace human clinicians. As technology is increasingly implemented in workplaces, some fear that their jobs will be replaced by machines. Doctors and nurses still have a number of unique and important advantages over AI. They can do a lot if things (touching, sensing, take a blood test, compassion, anxiety, memory, communication, learning, etc.) that an AI assistant cannot do because they are human traits that are difficult to model mathematically. The social and ethical use of AI in healthcare presents significant challenges as some question about the ethical appropriateness of the use of AI. There is lack of regulations specifically for the use of AI in healthcare. Medical costs are skyrocketing at an unsustainable rate. Failure of hospitals to use AI prevents both the use of potentially life-saving technology and potential cost savings. Other significant challenges and issues include data preprocessing, consolidation, ubiquitous information, knowledge extraction, interpretability, and the need to ensure that the way AI is developed and used is transparent, accountable, and compatible with public interest [17].

DOI : 10.31695/IJERAT.2020.3670

6. CONCLUSION

The use of artificial intelligence in healthcare is evolving at a rapid rate. AI is penetrating into every aspect of global healthcare. It has the potential to disrupt the healthcare industry. AI presents unprecedented opportunities in healthcare and major challenges for the patients, developers, providers, and regulators. Through our collective effort, AI can achieve all its lofty expectations to improve healthcare for patients across the world.

However, AI-based technologies are still quite controversial because they are not yet commonly used. In the near future, healthcare will be delivered as a seamless continuum of care and with a greater focus on prevention and early intervention. For more information about AI in healthcare, one should consult books in [22-28] and the related journals: *Artificial Intelligence in Medicine* and *Journal of Medical Artificial Intelligence*.

REFERENCES

[1] M. Wehde, "Healthcare 4.0," *IEEE Engineering Management Review*, vol. 47, no. 3, Third Quarter, September 2019, pp. 24-28.

[2] I. Sniecinskia and J. Seghatchianb, "Artificial intelligence: A joint narrative on potential use in pediatric stem and immune cell therapies and regenerative medicine," *Transfusion and Apheresis Science*, vol. 57, 2018, pp. 422-424.

[3] M. N. O. Sadiku, "Artificial intelligence", *IEEE Potentials*, May 1989, pp. 35- 39.

[4] Y. Mintz and R. Brodie, "Introduction to artificial intelligence in medicine," *Minimally Invasive Therapy & Allied Technologies*, vol. 28, no. 2, 2019, pp. 73-81.

[5] R. O. Mason, "Ethical issues in artificial intelligence," *Encyclopedia of Information Systems*, vol 2, 2003, pp. 239-258.

[6] A. N. Rames et al., "Artificial intelligence in medicine," *Annals of the Royal College of Surgeons of England*, vol. 86, 2004, pp. 334–338.

[7] M. N. O. Sadiku, Y. Zhou, and S. M. Musa, "Natural language processing in healthcare," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 8, no. 5, May 2018, pp. 39-42.

[8] "No longer science fiction, AI and robotics are transforming healthcare,"
https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/transforming-healthcare.html

[9] F. Jiang et al., "Artificial intelligence in healthcare: Past, present and future," *Stroke and Vascular Neurology*, 2017.

[10] D. Naik, "AI in the healthcare world," August 2017,

https://medium.com/@humansforai/ai-in-the-healthcare-world-88d13a815f35

[11] "Artificial intelligence in healthcare," *Wikipedia*, the free encyclopedia

https://en.wikipedia.org/wiki/Artificial_intelligence_in_healthcare

[12] M. N. O. Sadiku, T. J. Ashaolu, and S. M. Musa, "Artificial intelligence in medicine: A primer," *International Journal of Trend in Research and Development*, vol. 6, no. 1, Jan.-Feb. 2019, pp. 270-272.

[13] M. N. O. Sadiku, M. Tembely, and S.M. Musa, "Telemedicine:: A primer (Part 1)," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 9, no. 6, June 2019, pp.43-46.

[14] M. N. O. Sadiku, M. Tembely, and S.M. Musa, "Telemedicine:: Teleeverything phenomena (Part 2)," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 9, no. 6, June 2019, pp.35-38.

[15] M. N. O. Sadiku, A. E. Shadare, and S.M. Musa, "Mobile health," *International Journal of Engineering Research*, vol. 6, no. 11, Oct. 2017, pp. 450-452.

[16] B. Dickson, "How artificial intelligence is revolutionizing the mhealth industry,"
https://www.magzter.com/articles/1642/241037/59c9590a889f7

[17] Nuffield Council on Bioethics, "Artificial intelligence (AI) in healthcare and research"
http://nuffieldbioethics.org/wp-content/uploads/Artificial-Intelligence-AI-in-healthcare-and-research.pdf

[18] S. E. Davies, "Artificial intelligence in global health," *Ethics & International Affairs*, vol. 33, no. 2, Summer 2019.

[19] A. Kassam and N. Kassam, " Artificial intelligence in healthcare: A Canadian context,"
Healthcare Management Forum, 2019, pp. 1-5.

[20] R. Mabiyan, "How artificial intelligence can help transform Indian healthcare," ETHealthWorld, May 2018,

DOI : 10.31695/IJERAT.2020.3670

https://health.economictimes.indiatimes.com/news/health-it/how-artificial-intelligence-can-help-transform-indian-healthcare/64285489
[21] "AI in healthcare: Keys to a smarter future," https://www.gehealthcare.com/-/media/b3a5e32538454cf4a61a4c58bd775415.pdf
[22] P. Vasant (ed.), *Handbook of Research on Artificial Intelligence Techniques and Algorithms.* Information Science Reference, 2015.

[23] D. D. Luxton, *Artificial Intelligence in Behavioral and Mental Health Care.* San Diego, CA: Elsevier, 2016.

[24] A. Panesar, *Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes*. Apress, 2019.
[25] C., Gunnar and, F. X Campion, *Machine Intelligence for Healthcare*. CreateSpace Independent Publishing, 2017.

[26]A. Agah, *Medical Applications of Artificial Intelligence*. Boca Raton, FL: CRC Press, 2017.

[27] S. M. Richins, *Emerging Technologies in Healthcare.* Boca Raton, FL: CRC Press, 2015.

[28] S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*. Upper Saddle River, NJ: Prentice Hall, 3rd edition, 2009.

ABOUT THE AUTHORS

Matthew N.O. Sadiku, is a professor emeritus in the Department of Electrical and Computer Engineering at Prairie View A&M University, Prairie View, Texas. He is the author of several books and papers. His areas of research interests include computational electromagnetics and computer networks. He is a fellow of IEEE.

Omobayode I. Fagbohungbe, is a Doctoral student at Prairie View A&M University, Prairie View Texas. He holds a masters of science degree in control engineering from the University of Manchester, UK and a bachelor degree in electrical and electronics engineering from Obafemi Awolowo University, Nigeria. He is a graduate member of the IEEE. His current research interests are in data science, machine learning, and deep learning.

Sarhan M. Musa, is a professor in the Department of Electrical and Computer Engineering at Prairie View A&M University, Texas. He has been the director of Prairie View Networking Academy, Texas, since 2004. He is an LTD Sprint and Boeing Welliver Fellow. His research interests include computer networks and computational electromagnetics.

DOI : 10.31695/IJERAT.2020.3670

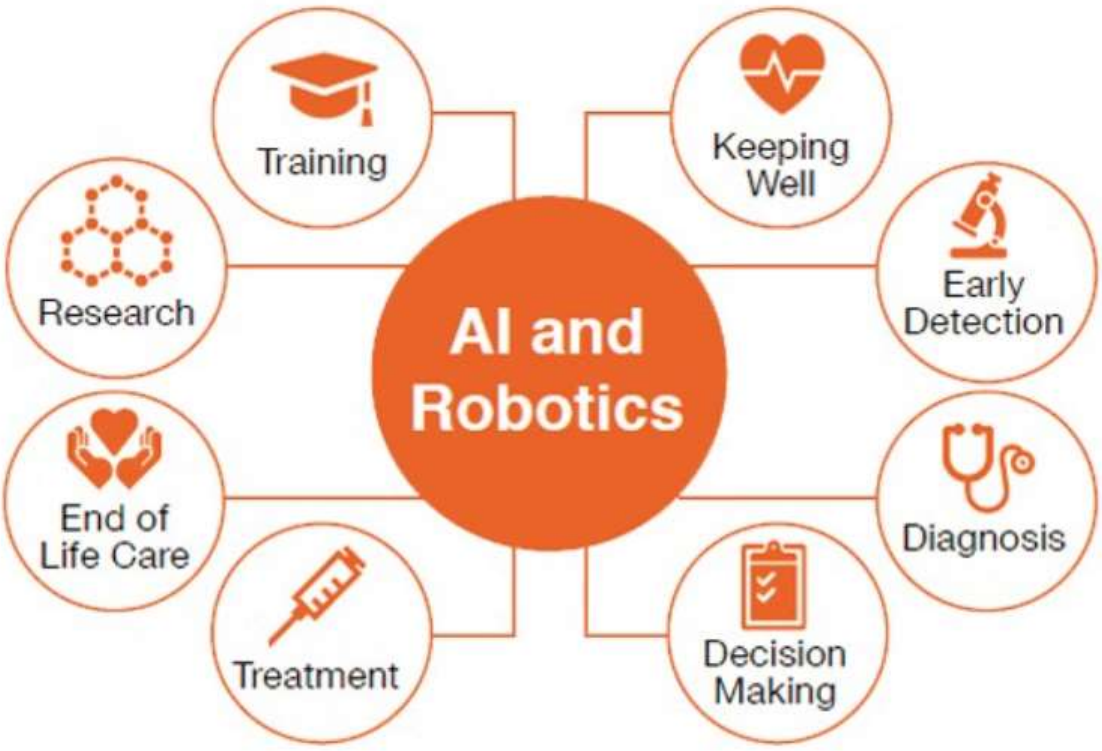

Figure 1 AI and robotics [8].

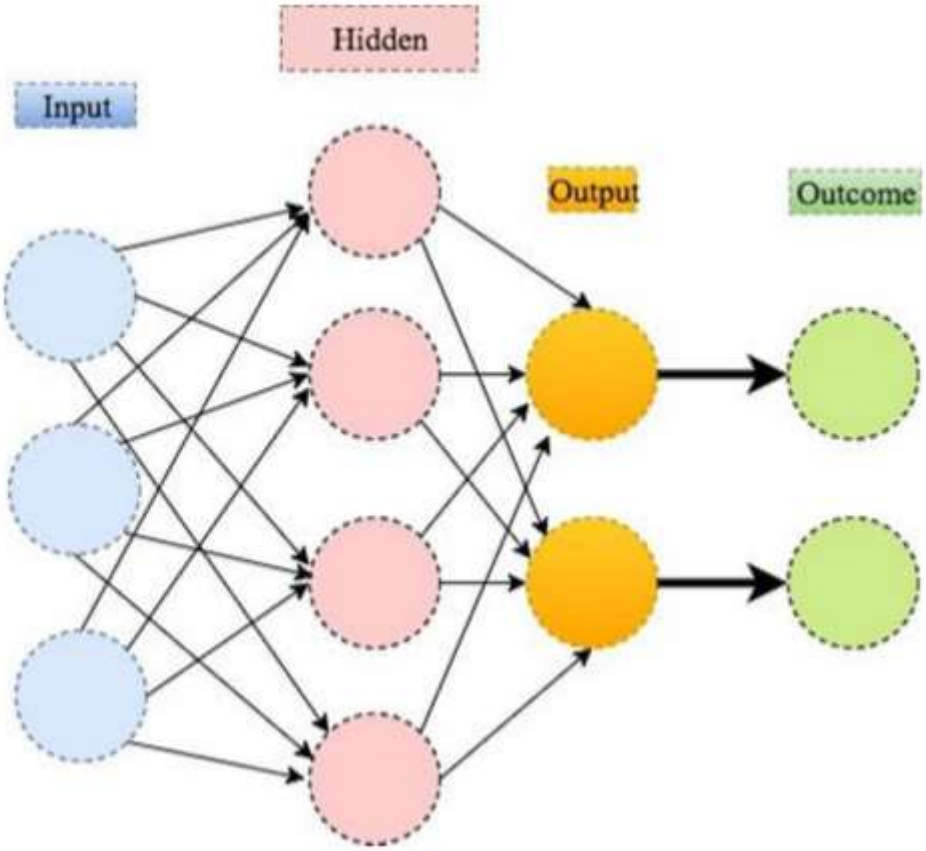

Figure 2 An illustration of deep learning with two hidden layers [9].

DOI : 10.31695/IJERAT.2020.3670

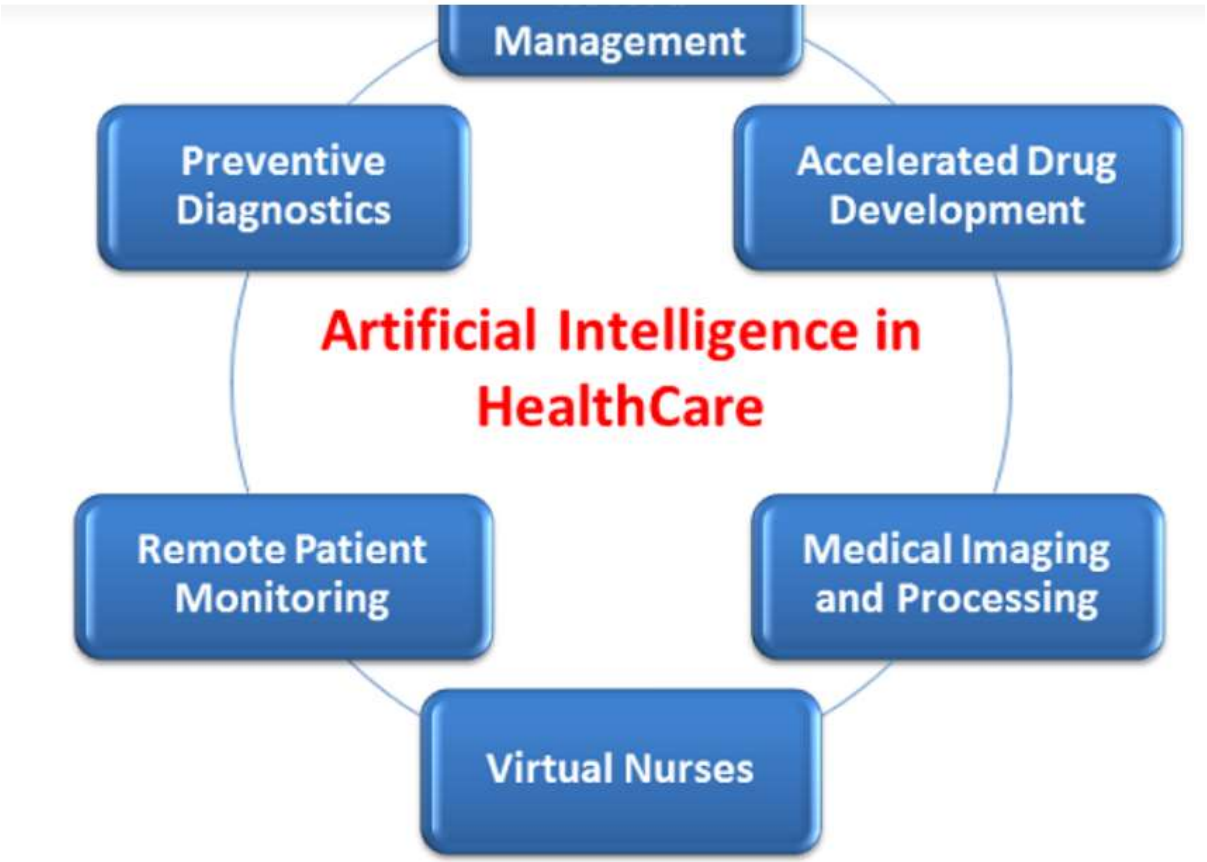

Figure 3 AI in healthcare [10].

DOI : 10.31695/IJERAT.2020.3670