Impact of Artificial Intelligence in Health care: A Study

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Abstract The acceptance of AI in health care relates to the analysis of the huge amount of information that is generated each day and the limitation of physicians to address these needs. The growth of data complexity in the medical domain refers to the increasing usage of artificial intelligence in that sector. Some vital functionaries include care providers, diagnostic recommendation systems, and adherence of patients among others. Likewise, there exist several applications where AI can be successfully deployed in clinical applications. In this study, the role of AI in this critical healthcare sector is highlighted. Some popular existing research works in the healthcare domain are discussed. Software projects involving AI in this sector are summarized. Finally, a real-time implementation of medical imaging using different computational methods is demonstrated. Maximum accuracy of 94.2% was noted for prostate cancer. It is also found that it takes maximum time for the analysis of lung cancer (2.43 s) and minimum for brain cancer (1.12 s)**.**

Keywords Artificial intelligence (AI) · Health care · Machine learning · Medical imaging · Classification accuracy

1 Introduction

Artificial intelligence is the study and design of intelligent models and programs that mimic the human mind, that is, to think, reason, and perform tasks that are similar to the human brain. From Cortana and Siri to drones and driverless cars, artificial

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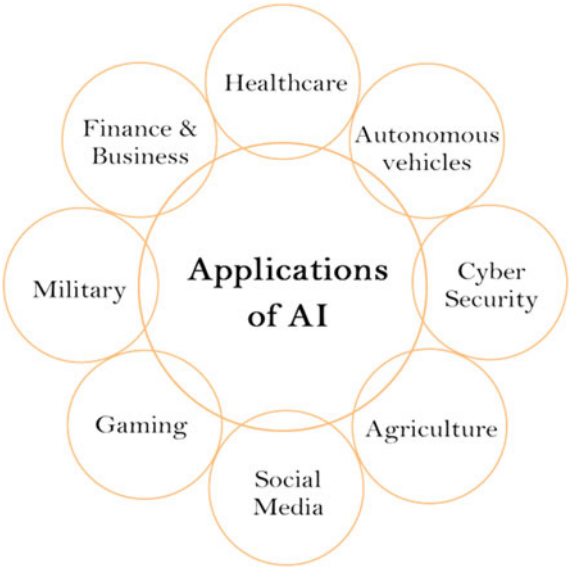

Fig. 1 Few applications of AI

intelligence (AI) has been advancing rapidly. AI includes everything from Bing and Google to the autonomous military. AI is an extremely broad field that consists of several sub-fields [1]. In today's fast-paced world, much of the world's information is produced by individuals and machines. This transcends our ability to understand, interpret, and make sound decisions. AI is the future of all decision making processes as AI-powered algorithms are highly efficient at calculating combinations and going through multiple decisions to arrive at the best conclusion [2, 3]. AI utilizes repetitive learning and discovery through data and also incorporates intelligence into existing machines. It performs frequent computerized tasks reliably and without weariness. For example, Siri was an added feature to a new set of Apple products. AI adapts by finding structure and regularities in data through learning algorithms. So, just as it can teach itself how to play games like chess or tic-tac-toe, it can teach itself what product should be recommended, just like in Amazon or Netflix. The algorithm adapts when new data is provided. It analyzes data using neural networks that have many hidden layers. It also achieves tasks with commendable accuracy. Figure 1 shows a few domains where artificial intelligence is widely used. Apart from these, there are various other sectors where AI is used with outstanding brilliancy.

1.1 Autonomous Vehicles

Information collected by the sensors in self-driving cars is useless unless it is processed. This is where AI comes up and can be matched up to the human brain. Companies like Waymo carried out numerous test drives before applying their

first AI-based public ride-hailing service [4]. This technique gathers data from the cameras, radar, and GPS of the vehicle to produce instructions that can operate it. Another great example of an autonomous vehicle is the Tesla self-driving car. AI executes computer vision and image detection with DL to build cars that can recognize objects and drive without human instructions.

1.2 Cybersecurity

AI is being used in this sector as it faces significant challenges like large-scale hacking that harm organizations and create huge business damage. AI combines understanding and uses its techniques to create relationships between threats, such as destructive files, suspicious addresses and so on [5]. This investigation eliminates time-consuming research activities and provides systematic risk analysis, allowing security analysts to respond to threats almost 50 times faster and initiate a response to mitigate the threat. It helps to focus on the attacks that can be a real hazard and keeps data safe and secure, thus enabling organizations to not become victims of cyber-attacks.

1.3 Agriculture

AI provides innovative approaches to improve crop yield and also provides efficient ways to protect crops from weeds. "PEAT," a Berlin-based agricultural start-up, has developed "Plantix" that distinguishes prospective defects and nutrient deficiencies in the soil by a series of images with a calculated accuracy of up to 93%. Precision cultivation uses AI technology to identify diseases, pests, and inadequate nutrition in crops. Its sensors can detect and identify weeds and then determine which herbicides will be used [6]. This process helps to combat the overuse of herbicides and toxins that damage plants and ultimately end up in our food supply.

1.4 Social Media and Gaming

Nowadays, a tremendous amount of data posts, chats, etc., lead to a huge amount of data. Here, AI and machine learning (ML) are involved. For example, on Facebook, AI is used for facial recognition that receives facial features and is also used for tagging people. ML concepts are used to design our feeds based on our specific interests and to filter offensive content. AI algorithms can also play systematic and interactive games where the machine needs to think and analyze a large number of moves and possible scenarios. For a better game experience, AI is increasingly transferring control to the player.

1.5 Military

Nations are developing AI technologies for better analysis, asset performance, cyber performance, command, and control, as well as a variety of private and independent weapons and vehicles. This is also used to enable sensor coordination, threat detection and detection, detection of signals, enemy positions, and drones capable of independent operation. The most prominent example of AI on the battlefield is the Project Maven, which used ML algorithms to filter through hours of motion videos, tracking suspected terrorists, and insurgents. However, it was publicly said that this project only looks for tanks and other targets of interest in a war.

1.6 Finance and Business

AI systems can respond when a business is slowing down and reduce financial crime by monitoring unusual or negative changes. AI-based e-commerce platforms have made it easy to balance demand and turnover. Customer relationship management (CRM) platforms are used to get more information on how to better serve customers. Also, interview chats have already been installed for immediate action. AI algorithms are great for trading because they can analyze large amounts of data in a short period of time and can be trained to store patterns and predict how this can happen again.

AI is a vast domain with a huge number of applications, with even more projects under development. Few other areas of it include its application in Law, Hospitality, Advertising, Education, Art, Travel, etc. The list is never-ending!

2 AI in Health care

AI in health care is used to automate several tasks like the evaluation of diseases, performing surgeries, administrative work, and to identify high-risk patients [7]. It is also applied to dosage issues which is a high-cost problem where it could save more than $15 billion. It receives patient data to form a hypothesis, which it then displays with a confidence score. Artificial intelligence can also assist doctors. Microsoft has a "Hanover" project that will memorize all the papers, articles, and information needed for cancer and predict which drug combinations will work best for all patients. There is also a project which is working on fighting myeloid leukaemia. An algorithm also conducted a diagnosis with more than 94% accuracy and produced a result within 40 s which was a decision as to whether or not whether not, the patient should be undergoing treatment.

It is used to automatically perform initial CT scans or ECG scans or to identify high-risk patients. It is already being used for the most expensive volume problem where it can save about $16 billion. Cambio health care has established a stroke

support system that provides a warning when a patient is at risk of having a stroke. Coala life has a device that can monitor heart disease. Artificial intelligence can also assist doctors.

Artificial intelligence has been playing a significant role in society and has only been expanding its domain for the past few decades [8]. What we do not realize is that it presents itself in almost everything we use which directly or indirectly impacts our daily life. Using e-mail, social media, e-commerce platforms, and app-cab services, all involve AI algorithms to improve our experience and to make life easier. A leading domain for AI in the healthcare sector and it is already serving major roles here. AI in health care includes treatment methods, their outcomes, automating routine tasks in medical practice, survival rates, increasing recovery rate, managing patients and medical resources, and interconnected health conditions. Here, the data mining and pattern recognition ability of AI-powered systems come in handy. It uses statistical techniques to give machines the ability to learn and get trained with new data. It then identifies patterns to finally make decisions without human instructions. It can detect and examine trends in data and even make predictions that could identify potential health hazards. It can help doctors personalize care for patients. Diagnostic AI applications gather and process data to compare it with predefined categories to help with treatment. This helps the work of doctors as AI carries out tasks in lesser time and reduces the cost. This even allows patients to track their glucose monitors, ultrasounds, electrocardiograms, thermometers, and so on.

Machine learning techniques can extract specific patient traits via their algorithms, which includes the data collected when a patient visits a doctor [9]. These traits, for example, symptoms, physical exam reports, medications, disease-related data, images of diagnoses, and laboratory tests all contribute to structured data. ML uses the physical features of the patient, along with its huge database of gathered information to provide a targeted and accurate diagnosis. In deep learning, the same inputs are fed into a programmed neural network which has hidden layers that merge the provided information and close into a curated output. This is beneficial when multiple possible outcomes can then be narrowed down to one or two results, thus, allowing the doctor to come to a concrete decision [10].

In natural language processing, the information is documented from notes and speech to text processing when a doctor sees a patient. This includes reports from physical examinations, previous exposure to diseases, laboratory tests, and so on. NLP does this by using databases that have disease-relevant keywords which aid the final decision procedure for a correct diagnosis. This improves diagnoses as it provides an efficient output which saves time and can also speed up the treatment process so the patient can recover faster. AI-based platforms allow physicians to gain a better grasp on significant patterns from data which saves time, effort, and expenditure. This incorporation of AI tools and techniques results in efficiently improving patient care.

AI can also pinpoint any risk a patient might have, thereby helping in the early detection of a health hazard. One study involving high-risk stroke patients was conducted which used AI programs including their present and past symptoms, and genetic information. Here, if any unusual physical movement in the patient was

recorded, an alert would be triggered. This enabled doctors to send patients to an MRI or CT scan earlier due to which they were able to arrange for treatment sooner and predict whether the patient had a possibility of future stroke. This early detection had an accuracy of 85% in a diagnostic evaluation.

Quite often, a patient could have several symptoms that point to different conditions which delay the diagnosis. AI improves accuracy in early detection, diagnosis, and treatment. It can also be used to help newer physicians, who do not have that much experience, to be able to make the right decisions. Ophthalmology and radiology are popular fields because of the AI process of image analysis. It uses images of the human eye to provide a diagnosis that would otherwise involve an ophthalmologist. Using these methods, professionals, therapists, and even patients can come to conclusions. Physicians can share HD 3D images and consult with other physicians locally and internationally to improve the efficiency of the procedure.

AI can perform tasks that are tedious in their operation. Too much time is spent working on records, bills, study screens, laboratory testing rooms, and more. AI systems can handle these tasks efficiently and filter the results which could save a significant amount of time, manage patients, and maximize the quality for diagnosis. AI also manages medical resources. For example, it can predict which patients could benefit the most from rare medical resources, which departments are likely to need additional staff, which practitioner is most required in which department, and so on.

AI-powered robots are also quite well known by now as there are over 200,000 robots that are installed every year, all over the world. These robots can perform several tasks from lifting or assembling objects to the delivery of supplies in healthcare units. These days, robots are more cooperative with humans and can be trained easily to carry out specific tasks. With other capabilities being embedded in their operating systems, they are also becoming more intelligent. There are surgical robots as well which help surgeons by enhancing their ability to explore, create precise incisions, perform tests, stitch wounds, and so on. Gynaecologic surgery, prostate surgery, and head and neck surgery are a few common surgeries that employ robots.

Wearable technologies like FitBits and smartwatches use AI to track data and alert users about potential health issues and hazards. Being able to analyze one's health eases professionals and prevents unnecessary hospital visits. It is important to guide new trainees on the capabilities of AI and also train them to function efficiently alongside new technology. The ultimate aim should be to achieve a proper balance between the productive use of automated procedures and the judgment of trained doctors. This is a necessity as the thought of AI completely replacing humans in the realm of medicine is a concern as this could end up hindering the privileges which are obtained from it.

3 Existing Applications Integrating AI in the Healthcare Sector

Artificial intelligence in health care has a wide scope and is regularly developing. Many existing AI-powered services are already implemented in the healthcare domain. Figure 2 shows a few application of AI in health care. AI applications are not only limited to healthcare but a far more vast and constantly increasing the usability in different sectors.

3.1 Virtual Nurses and Digital Consultation

AI-powered virtual assistants are good for nursing. They can keep doctors and patients in touch with each other all the time thus lowering sudden hospital visits and load on medical professionals. The start-up Sense.ly had developed "Molly," a digital nurse to observe the patient's health and follow up for treatments. ML is used to support patients with chronic illnesses.

Fig. 2 AI in health care

3.2 Robots

Robots use actual surgical encounter information to upgrade existing surgical approaches and techniques and can also assist surgeons since their accuracy, flexibility, and control go well beyond human potential. This reduces treatment time and error. Analyzing tests, X-Rays, lab reports, CT and MRI scans, billing, data entry, and so on can all be done faster and precisely by robots.

3.3 Cybersecurity

It is the responsibility of a hospital to keep the data of their patients safe and secure.

Instinctive and prudent, AI cybersecurity applications provide that extra layer of safety. Advanced protection protects the LAN and responds in nano-seconds to anomalous behavior patterns. Biomedical security tools use artificial intelligence to handle and secure the increasing number of devices as they connect and disconnect from hospital networks.

3.4 Administration and Workflow

This technique helps to maximize the time given by nurses, doctors to their jobs and make their everyday tasks easier. It merges AI algorithms with existing technological infrastructure. AI can keep a record of all treatments and patients to recommend predictive diagnosis and also assemble, store, re-format, and detect data to provide swift and accurate results.

3.5 Dosage and Treatment Design

The dosage of a patient is important as even a little drop of medicine can make a huge difference. The applications are designed to lessen the margin of errors that may occur when giving medicines to patients. There are elaborate artificial intelligence systems that are designed to load and analyze data. From records and reports to expertise or external research, these applications will help converge to the correct and individualized treatment for every patient.

3.6 Fraud Detection

Both patients and healthcare providers can face damage due to frauds. Fraud detection with AI can analyze data within seconds and detect complex patterns in the best way possible. AI also automates time-consuming tasks which enable the fraud analysts to focus on high-risk, critical cases. The work quality and efficiency of the analysts also increase due to these automated AI algorithms. This also helps to steer through elaborate payment and service fraud endeavors.

3.7 Health Monitoring

Wearable well-being trackers like FitBit, Garmin, and others monitor the heart rate and activity levels of the body to make sure that the person is healthy and fit. It sends alerts and notifications about improvements and can share this information with doctors as well.

3.8 Drug Creation and Clinical Trial Participation

AI-powered applications can make the procedure of drug creation faster and inexpensive. By examining existing medicines, they can remodel them to counter disease. AI-based trials collect data and assemble them to get the right theory and facilitate its outcome.

3.9 Treatment Design and Precision Medicine

Correct diagnosis is the pillar of the healthcare domain. The sooner it is, the better the treatment will be. AI uses data architecture to refine the precision of the initial diagnosis. It analyzes data and reports of the patient, conducts external research, involves clinical expertise, and helps to choose the accurate customized treatment. Also, with the help of AI, full-body scans can spot cancerous cells and vascular diseases early and predict health issues that patients might face based on their genetics. Table 1 highlights the working principle, merits, and applications of some popular products implementing AI in health care.

Table 1 Comparative analysis of projects implementing AI

Product	Working principle	Applications
PathAI	• Minimizing error in cancer diagnosis • Designing methods for precision treatment	• Cancer diagnosis • Precision medicine
Enlitic	• DL to facilitate radiology diagnostics	• Radiology
Freenome	• Merges deep expertise in molecular biology with advanced computational techniques • Routine blood draw	• Radiology
XtalPi	• Predicts the chemical composition and pharmaceutical features of micro molecules by integrating AI, the cloud, and quantum physics	• Drug design and development
Olive	• AI-powered algorithms to automate and optimize workflow	• Administration and workflow for fast and stable operations
Qventus	• AI-based algorithm to solve operational issues	• Simplifying healthcare operations
IBM Watson	• Infusing AI into applications to make more precise predictions, automate decisions and procedures, and optimize staff time	• Individualized health plans • Early detection of diseases
ICarbonX	• Uses AI and big data to better analyze aspects of human life to digitize and understand life	• All aspects of health care

4 Popular AI Products in Health care

There are hundreds of other healthcare companies and hospitals that benefit from the services AI provides. Here are a few of them.

4.1 PathAI

PathAI has developed a technology to aid pathologists to enhance accurate diagnoses. Its current goal is to reduce the risk of cancer diagnosis and innovative treatment options. PathAI has partnered with drug developers such as Bristol-Myers Squibb, clinical networks such as LabCorp, and organizations such as the Bill & Melinda Gates Foundation to expand its technology.

4.2 Enlitic

Enlitic uses DL to forge ahead in radiology. It examines medical data (radiology imaging, blood tests, medical history of the patient, and more) to allow doctors to better assess the patient's real-time needs and allow them to get more precision, efficiency, and quality.

4.3 Freenome

It focuses on diagnosing cancer in its early stages and over time, developing new therapies using AI for tests, diagnostic tests, and blood pressure. By combining cellular biology with advanced computer techniques to detect and interpret disease-related patterns among billions of circulating biomarkers, it improves simple and accurate blood tests for the early detection of cancer.

4.4 Bioxcel Therapeutics

It is a clinical biopharmaceutical company that uses AI to identify and develop new drugs in the field of immuno-oncology and neuroscience and approaches to drug development. Additionally, the company's drug rehabilitation program uses AI to find new uses for existing drugs. It was called "Most Innovative Healthcare AI Development of 2019."

4.5 XtalPi

Combining AI, cloud, and quantum physics, XtalPi's ID4 system predicts chemical and pharmaceutical properties of micro-chemical in the development and development of drugs. Besides, it claims that its crystal structure forecasting technology envisions intricate cell formation in a matter of days. XtalPi investors include Google, Tencent, and Sequoia Capital.

4.6 BenevolentAI

BenevolentAI's main goal is to find the right treatment for patients promptly by using artificial intelligence to produce better choices and to provide previously unpublished

information about DL. BenevolentAI has partnered with major pharmaceutical organizations to issue licenses for drugs and organizations that help the community to develop drugs that are more susceptible to rare diseases.

4.7 Olive

The Olive AI platform is designed to perform very repetitive tasks thus freeing executives to operate at a higher level. It makes everything automated from qualification testing to data migration so doctors can focus on providing the best patient service. Olive AI-as-a-Service integrates easily within existing hospital software thus eliminating the need for costly integration.

4.8 Qventus

Qventus supports former teams and develops genes using AI and behavioral science that solves operational issues including those linked to emergency rooms and patient safety. It prioritizes the patient's illness or injury, follows waiting times and can even map the immediate ambulance routes. CB insights named Qventus as one of the 100 most starting AI startups for 2019.

4.9 IBM Watson

Watson's IBM experts help use their data to increase hospital productivity, better engagement with patients, and improve treatment by combining human experts and artificial intelligence. Watson currently uses his skills in everything from designing personal health programs to interpreting genetic testing results and capturing early signs of disease.

4.10 ICarbonX

ICarbonX uses AI and big data to carefully study aspects of human life in a way they describe as "digital life." By examining people's health and actions in the "carbon cloud," they hope it will be strong enough to handle all aspects of life. ICarbonX expects that when it will eventually collect enough data, it will better diagnose symptoms, change treatments, and find healthy people.

4.11 Vicarious Surgical

Vicarious surgical integrates VR with AI-enabled robots so that surgeons can perform less invasive tasks. Surgeons almost shrink and examine the inside of the patient's body in detail. With these new technologies, they seek to improve the lives of patients, improve the efficiency of surgeons, and increase global access to quality care.

In addition to the existing establishment, there are some advances in various stages of development, which help physicians to become better physicians.

Apart from the inventions which already exist, there are certain advances in various phases of development, which help physicians be better doctors.

5 Background Study

In [11], Mohammad Shafenoor Amin et al. targets critical features and data mining skills for the accurate prediction of heart disorders. Here Naïve Bayes and logistic regression are used. The number of attributes for this proposed method is nine, and the accuracy for the vote is 86%. Sarath Babu et al. in [12] focused on the prediction of heart disorders by the effective use of data mining and sequencing of characteristics. This approach uses genetic algorithm, k-means algorithm, maximal frequent itemset algorithm (MAFIA), and decision trees. Meenal saini et al. in [13] used nine classifiers and some modern procedures to predict heart diseases. This hybrid classifier gave an accuracy of 82%. Purushottam et al. [14] has helped untrained physicians to make an informed choice in matters involving the heart. KEEL tool was used for its implementation, and the generated classification decision rule gave an accuracy of 86% [15]. Bandarage shehsni et al. presented a comparative analysis of the strategies for distinguishing the prediction of cardiovascular disease. This method used Naïve Bayes, neural networks, and decision trees. Naïve Bayes had an accuracy of 86%, neural networks of 89%, and decision trees of 85% [16]. The analysis by Dandıl, (2018) set out a unique automated channel of computed tomography (CT) diagnostic test for the diagnosis of lung cancer in early stages by the division of benign and malignant nodes [17]. The research work by Naresh and Shettar (2014) proposed a method for the identification of the presence of lung cancer during the preliminary stages itself by utilizing CT screening images taken from patients [18]. The research by Wu et al. (2017) proposed the use of computational histomorphometry image classifier that works on nuclear sequencing, texture, composition, and tumor structure to anticipate the possibility of recurrence of lung cancer [19]. The study by Win et al. (2014) unfolds one of the most advanced ML strategies, termed averaged one-dependence estimators with subsumption resolution that forecasts the reappearance of the tumor by using DNA microarray gene expression data [20]. The study by Teramoto et al. (2017) introduced a computer-aided program to identify lung cancer, found in microimages using deep convolutional neural network.

6 Deep Learning in Radiographic Imaging

The fundamental advancements and enhancements of AI in health care are mostly in medical imaging. Medical imaging involves the identification of the image of interest and the important areas of the image [21]. The image is then segregated and interpreted as required. Recent advancements in ML and deep learning have further heightened computational strategies that can refine image quality and boost accuracy to optimize clinical decisions [22–25]. These methods begin with the gathering of data in huge amounts. This data is curated and integrated to facilitate automated analysis which provides a better view of the collected data, which then proceeds for screening. The application of information collected from datasets, continuous monitoring along with screening reports result in automated detection of potential tumors. The application then proceeds with specific treatments optimized for each patient by the categorization of different types of tumors. Table 2 highlights the number of articles and datasets which were taken to demonstrate the feasibility of radiographic imaging.

Figure 3 illustrates the result of the model discussed above. It is seen that it classifies brain cancer with an accuracy of 93.8%, prostrate cancer with an accuracy

Table 2 Datasets and articles taken for reference

Type of cancer	Number of datasets	Number of articles
Brain cancer	03	10
Prostrate cancer	02	12
Skin cancer	03	14
Lung cancer	04	15
Breast cancer	04	12

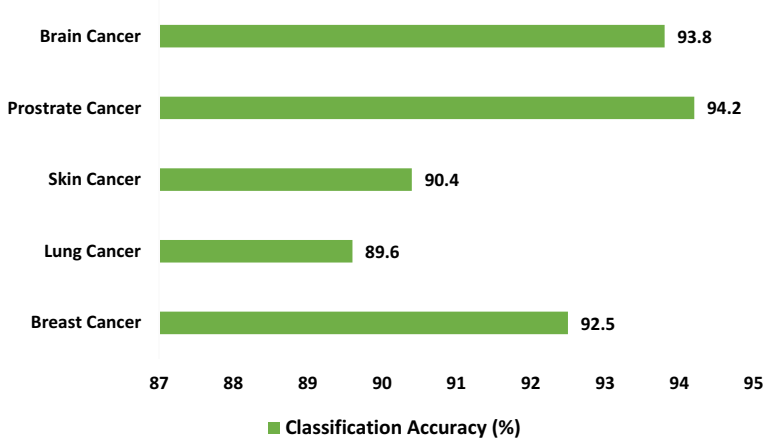

Fig. 3 Classification accuracy for various types of cancer

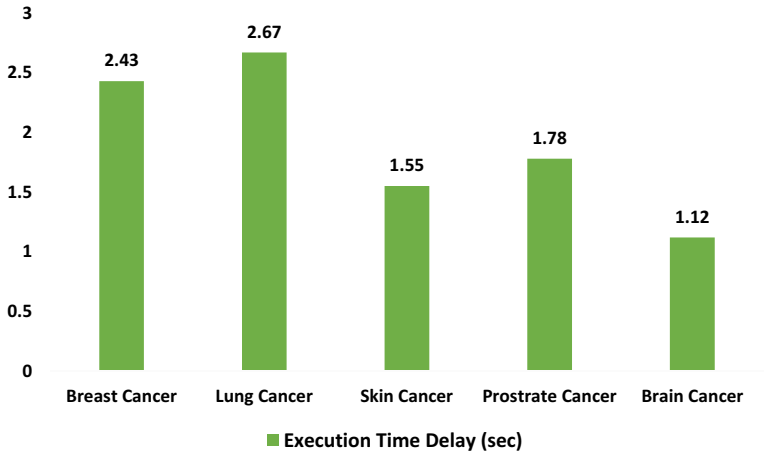

Fig. 4 Execution time delay in seconds for various types of cancer

of 94.2%, and so on. This process provides maximum accuracy for prostrate cancer and minimum for lung cancer.

Figure 4 illustrates the execution time day for the five types of cancer that we have referred to. It is found that it takes maximum time for the analysis of lung cancer (2.43 s) and minimum for brain cancer (1.12 s).

Recently, an automated detection system for radiography utilizing deep learning algorithms was developed to distinguish between common diseases for diagnosis. This particular algorithm integrated data from various streams into an integrated diagnosis to come up with a specified treatment plan by mining data to find links. This system also learnt and improved from previous patterns and images. The outcome of this method proved that this AI-powered process has superior image recognition abilities than when done manually. This brings forward the vast potential of AI in this field for finer quality, boosted accuracy, and greater efficiency. Medical imaging is a helpful and essential model for the detection of cancer, progression monitoring, and prediction prognosis of the disease. Early detection of disease with this is vital for lowering mortality rates.

Figure 5 shows how AI algorithms in health care begin with the gathering of large amounts of data. The curation and integration of this data are done to facilitate automated analysis which provides a better view of the collected data, which then proceeds for screening. Medical imaging involves the identification of the image of interest and the important areas of the image. The image is then segregated and interpreted as required. The application of information from datasets, continuous monitoring along with the results of patient screening results in automated detection of potential tumors. Through the categorization of different types of tumors, the application then proceeds with the specific treatments optimized for each patient.

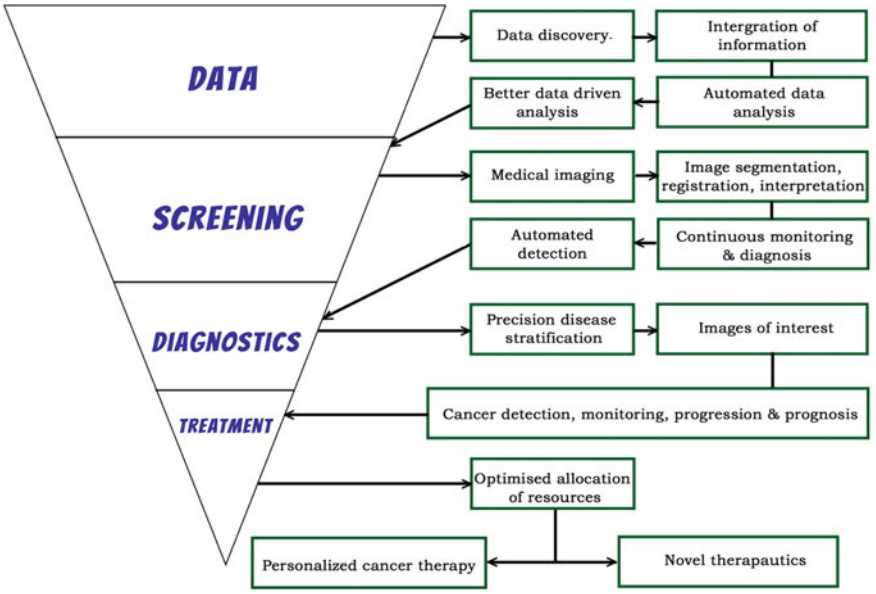

Fig. 5 Artificial intelligence in cancer medical imaging

7 Conclusion

The acceptance of AI in health care relates to the analysis of the huge amount of information that is generated each day and the limitation of physicians to address these needs. With advanced computing ability, medical AI programs are overcoming these limitations to a large extent. Hardly a week goes by without research claiming that it has come up with a new approach to using AI for diagnosis or treatment with greater accuracy than humans. However, the most prominent challenge to AI in this domain is ensuring its application in daily practice. For extensive adoption, AI programs must be approved by regulators, standardized to a degree such that similar products work similarly, taught to physicians, paid for by organizations, and updated regularly. These challenges will be overcome, but that will take a substantial amount of time. As a result, we can expect to see wider and more extensive use of AI in the health care sector within 10–15 years.

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