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Artificial Intelligence in Healthcare: A Survey

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Abstract— The sole goal of artificial intelligence (AI) is to mimic human cognitive processes. It is starting a paradigm shift in the healthcare industry, driven by the expansion of healthcare data availability and the quick development of analytics tools. In this article, we've covered a study of the state of AI applications in healthcare and a discussion of their potential. AI can easily be used to analyze many sorts of healthcare and Medicare data (structured and unstructured). Various machine learning approaches for structured data, such as support vector machines and neural networks, as well as contemporary deep learning algorithms and natural language processing for unstructured data, are well-known AI techniques. Therefore, the three main illness fields that employ AI-based techniques are cardiology, neurology, and cancer. Then we went over the review of AI applications in stroke in more depth, covering the three main areas of early detection, diagnosis, problem resolution, and treatment, as well as using it to anticipate outcomes and predict evaluation. We conducted a poll on each component and its related characteristics of early AI systems, like IBM Watson, but also issues with the use of AI in the real world.

***Keywords* — Artificial Intelligence; Deep Learning; Neural Networks; Machine Learning Algorithms.**

I. INTRODUCTION

Artificial intelligence approaches have lately had a significant impact on the healthcare industry, sparking an ongoing debate on whether AI doctors may someday take the place of human doctors. In general, we all agree that artificial intelligence (AI) won't be able to completely replace human doctors in the near future, but it can help them make better clinical judgments or perhaps take the role of human judgment in some areas of healthcare [1].

In the mainstream, experts define AI as a field of computing that prioritizes the development of intelligent systems that simply function and respond like humans. Some of the artificial intelligence-enhanced computer programs and activities are intended to be used with the approaches listed below.

- Speech recognition
- Learning
- Planning
- Problem solving

Some academics provide general definitions. The goal of the computer science subfield known as artificial intelligence is to build intelligent machines. It has allegedly grown to be a crucial component of the technological sector. Some of the primary artificial intelligence research is quite sophisticated and specialized in the same field. The fundamental difficulty with artificial intelligence is teaching computer systems to exhibit the features listed below:

Reasoning, Knowledge, Problem solving, Perception, Learning, Planning, Ability to manipulate and move objects with certain parameters.

Regarding these crucial elements, knowledge engineering is a crucial area of AI research. Simply put, machines may frequently behave and respond like people only if they have specialised knowledge about their surrounding world. To apply knowledge-based engineering, artificial intelligence needs access to control over all of its objects, categories, attributes, and relationships between them. It is challenging and tough to start generalised knowledge, common sense, reasoning, and problem-solving abilities in machines.

Another fundamental component of artificial intelligence is machine learning. In fact, learning without any supervision necessitates the capacity to spot and comprehend patterns in input streams, whereas learning with proper supervision entails classification and numerically based regressions. Simply put, classification establishes an object's category within the context of regression, which deals with obtaining a series of examples of numerical input or output. Therefore, functions are found, making it possible to generate appropriate outputs from appropriate inputs of the same difficulties. A well-defined area of theoretical computer science known as computational learning theory is concerned with the mathematical analysis of generalised machine learning algorithms and their performance.

In the same stream of intellectual system, machine perception deals with the ability to use sensory inputs to reduce the various aspects of the world, while computer vision is the capacity to analyse visual inputs with a few sub-problems like posture,

facial, object and gesture recognition and analysis with particular methodology.

Overview:

In general, AI is being used extensively for a variety of healthcare, Medicare, and research applications, involving disease diagnosis and prevention, illness management, the delivery of high-quality health services, and medication development with advancement in preview. The quality of the healthcare data that is currently available and the fact that artificial intelligence is currently unable to exhibit some human qualities limit and constrain its ability to handle significant health concerns.

Applications of AI raise some ethical questions, such as the possibility that AI will make wrong decisions; the question of who is responsible when and how AI is used to support decision-making things; challenges in cross-checking the outputs of AI-based systems; inherent changes in the data used to train AI systems; ensuring and validating the protection of potentially sensitive data used; and securing the public's trust and responsibilities in the development and use of AI-based technologies, implications on individuals feeling of dignity and social isolation while receiving medical treatment, affects on the duties and skill needs of medical workers, and the potential for AI to be misused.

A significant concern will be ensuring that AI is created and deployed in a way that is highly transparent, compatible with the public interest and applications, and that also encourages and drives positive discoveries in the industry.

Neural Networks:

An Artificial Neural network, or ANN, is a method of processing information that takes its cues from how human organic nerve systems, like the human brain, do so. The generalized new structure of the Information Processing System (IPS) serves as the fundamental component of this paradigm. Simply put, it is made up of a sizeable number of highly interconnected processing units (neurons) that collaborate to address particular problems that frequently arise. Similar to people, Artificial Neural Networks only learn from examples. Through a straightforward learning process, an Artificial Neural Network can be set up for particular use in the field of AI, such as pattern recognition or data classification in numerous processes. In human biological systems, learning entails modifications to the neuronal connections that are already there. The same holds true for Artificial Neural Networks.

AI Robotics in Healthcare:

In the field of AI and intelligent systems another important area that connects to AI is robotics. Robots need intelligence to manage a variety of activities, including navigating and manipulating objects, as well as the related issues of general localization, tracking, motion planning, and mapping.

Figure 1: AI aspects in healthcare [7]

II. RELATED WORK

Disease focus:

Despite the continuously expanding and extensive AI literature in healthcare, the research has been primarily focused on three disease types: Cancer, Nervous System disease, and Cardiovascular disease. Here, we have been focused on the generalized disease been focused through the AI-based systems to get solved. Below, we discuss some instances [1].

1. Cancer: Through a technique of double-blinded validation study in the patients' systems, Somashekhar analyzed and showed that the IBM Watson for oncology would be a trustworthy and very good AI system for assisting and referencing the diagnosis of cancer. Esteva used a set of characteristics to analyze various clinical photos to pinpoint different subtypes of skin cancer.

2. Neurology: To provide patients with quadriplegia control over their movement and activities, Bouton created an AI-based system for this condition. With the use of this, Farina assessed the effectiveness of an offline man-machine interface that operates upper-limb prosthetics by timing the discharge of spinal motor neurons.

3. Cardiology: Dilsizian and Siegel proposed the potential use of an AI system in cardiology to screen for and diagnose heart disease using cardiac images as input. The US Food and Drug Administration (FDA) recently granted Arterys permission to market its Arterys Cardio DL-based program, which employs AI to generate automated and customizable ventricular segmentation based on conventional cardiac MRI-based input pictures [1].

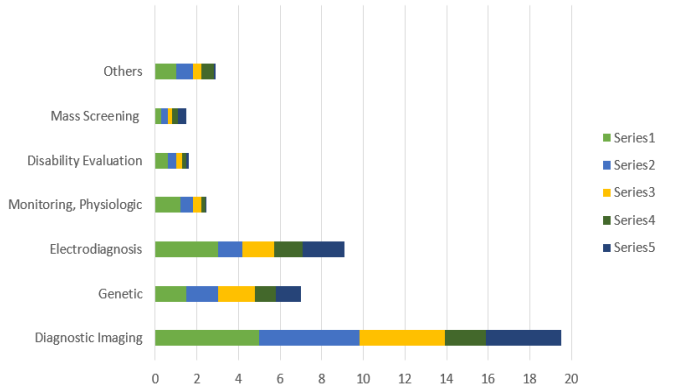

Figure 2: The data types are all taken into account in the literature on Artificial Intelligence[1]. The comparison is made using healthcare data from the US.

Here in Fig 2 as it shows that bar graph of the type of data which is been considered in Healthcare based literature which simply represents the different types if disease like Diagnosis, Imaging, Genetic, Monitoring Physiologic, Disability evaluation, Mass Screening and so many other categories been considered.

Convolutional Neural Network (CNN):

The Convolutional Neural Network is created by performing convolution on Artificial Neural Networks. A CNN is made up of neurons that have biases and weights that can be learned. Convolutional, pooling, and fully connected layers are the three basic layers that make up the convolutional neural network architecture. Because it has one or more convolutional layers, a convolutional neural network (CNN) gets its name. Through convolutional layers, certain local features in the input images are found [2]. Each node of a convolutional layer connects to a group of neurons that are spatially interconnected.

This assists in finding local forms (structures) in the supplied image's channels. To look for a comparable local attribute in the input channels, the nodes of the convolution layer share the weights on the connections. Each kernel is a set of shared weights (convolution kernel). Local features (whose intensity is evident in the feature map) that need to be

recognized are learned across the input images by convolutional layers with kernels. The goal of a pooling layer, which comes after a convolution layer in a CNN, is to reduce the spatial size of the representation, which also assists in lowering the number of parameters and the computational complexity of the network and controls over-fitting [2].

In India, the burden of numerous lifestyle disorders like diabetes has exploded in the previous few decades. By 2025, it is projected that 75 million people in India will have diabetes. However, the current healthcare system and infrastructure cannot handle the needs and demands of this enormous, rapidly growing population. The provision of an online patient support system that aids in patient-centered decision-making and physician-centered health monitoring would significantly contribute to lowering treatment costs and enhancing patient quality of life. Even if it's quite challenging, it's essential in this field to be able to extract meaningful information from quite massive web-based medical databases and simply provide some scientific decision-making. This issue might be resolved by using tools and approaches based on artificial intelligence for heterogeneous and massive databases. The potential of artificial intelligence approaches is examined in this article, in particular for web-based medical and healthcare applications. A model for web-based medical diagnosis and prediction is additionally put forward [3].

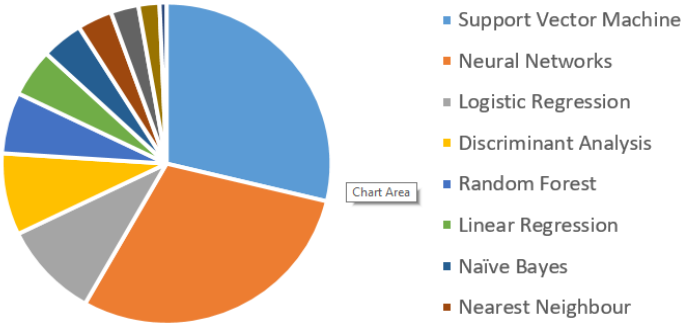

Figure 3. Several popular machine learning techniques are mentioned in the medical literature. The information is produced by looking through healthcare-related machine learning algorithms [1].

Support Vector Machine (SVM):

SVM is a popular machine learning technique that may be applied to classification or regression problems on many planes with various input data that is either structured or semi-structured. When the outcome, Yi, is a classifier (as indicated above), Yi = 1 or 1 denotes whether the ith patient belongs to group 1 or 2, respectively. (The approach may be extended to situations involving more than two groups operating simultaneously.) The fundamental premise for the same thing is that the subjects can be divided into two groups by a decision boundary established based on the characteristics Xij, which can be stated as:

$$ai = \Sigma p\ j=1\ wjXij + b,$$

Whereas, wj is only the weight given to the jth trait to show how important it is in comparison to the other traits in influencing the outcome. Similar to the decision rule, the ith patient is assigned to group 1 if ai > 0, which means labelling Yi = 1, and group 2 if ai 0, which means labelling Yi = 1. For the places where ai=0, the class memberships of the same group are uncertain. For an example with p = 2, b = 0, a1 = 1, and a2 = 1.

Medical Artificial Intelligence:

Artificial intelligence is a field of study that aims to imitate human intelligence using some pre-existing constraints in information technology. Numerous scholars have discussed the fundamental potential of AI in medicine. The following are some potential applications of AI in medicine:

- It offers a space where medical knowledge can be examined, arranged, represented, and cataloged.
- To enhance medical teaching, research, and decision-making, it creates new tools and technology.
- It merely merges activity in the fields of medicine, computing, cognition, and others.
- Finally, it provides a discipline with plenty of information for a future scientific medical specialty.

All areas of the healthcare ecosystem, including drug research, diagnostics, care management, physician tools, and medication management, have been impacted by AI [8].

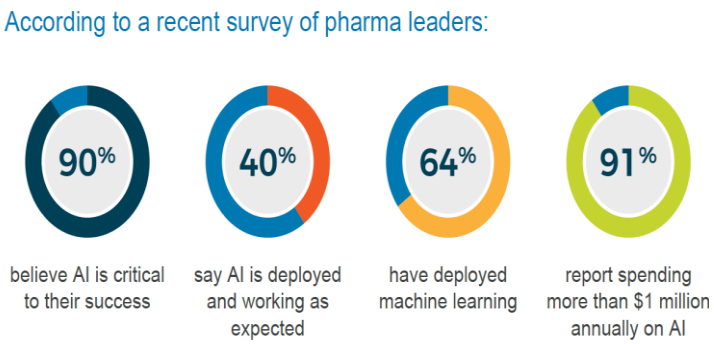

Figure 4. Survey of pharmacy leaders

III. APPLICATIONS

- HEALTHCARE ORGANISATION

Artificial Intelligence has the ability to be used in planning and resource allocation in health and social care services. For example, the IBM Watson Care Manager system is being run and piloted by Harrow Council to improve the cost efficiency of the AI-based system. Simply it matches individuals with a care provider that meets their needs, within their allocated care budget of resources. It also designs individual specified care plans and claims to offer insights for more effective use of care management resources with the same considered data.

The goal of using artificial intelligence is to enhance the patient experience. In order to establish a "cognitive hospital" Alder Hey Children's Hospital in Liverpool, UK, is collaborating with IBM Watson. This hospital will have an app that will enable direct patient contacts. The app attempts to uncover patient worries and issues prior to a visit, offer information on demand, and gather data from clinicians to assist them in providing suitable therapies [14].

- MEDICAL RESEARCH

Utilizing artificial intelligence, it is now feasible to investigate and find patterns in enormous, complicated datasets more quickly and accurately than before. It can also be used to merge many types of data, such as fundamental to help with drug discovery, and to search the scientific literature for pertinent studies. The Institute of Cancer Research's cancer database combines genetic and clinical data based on certain patient reference data with data from academic research and use artificial intelligence to forecast novel targets for cancer therapy development.

- CLINICAL CARE

In some UK hospitals, artificial intelligence is currently being tested for its ability to perform and assist in disease detection. Treatment choices may be aided by using AI to analyze clinical data, academic articles and professional guidelines.

• Medical imaging – Simply put, medical scans have been methodically gathered and stored for a while and are easily accessible to train AI-based systems. Artificial intelligence may make scan analysis inexpensive and less time-consuming, perhaps enabling the use of more scans to better target therapy. Artificial intelligence has demonstrated encouraging outcomes in the early detection of diseases like pneumonia, skin, breast, and eye malignancies.

• Echocardiography – The Ultromics technology, which is now being tested at John Radcliffe Hospital in Oxford, analyses echocardiogram scans to quickly diagnose coronary heart disease by identifying patterns in heartbeats.

• Screening for neurological conditions – Tools based on artificial intelligence are being created to analyze speech patterns to forecast psychotic episodes and to diagnose and track the signs of neurological diseases like Parkinson's disease.

• Surgery – In research, robotic instruments powered by AI have been utilized to do specialized keyhole surgery tasks, like tying knots to close wounds.

- CONSUMERS & PATIENT-FACING APPLICATIONS

There are already a number of apps available that give individualized health assessments, help, and home care recommendations. The intelligent chatbot in the smart app Ada Health Companion utilizes artificial intelligence to blend the user's symptoms with other data to suggest a diagnosis. A selection of NHS practices in London are currently testing GP at Hand, a related app that Babylon Health has created to help in the same field [14].

Artificial intelligence-powered informational systems, or chatbots, are employed to support the management of chronic medical disorders. For instance, the IBM-created Arthritis Virtual Assistant for Arthritis Research UK is learning from patient interactions to offer individualized information and advice about medications, food, and exercise, among other topics. For the same price, government-funded and private initiatives are looking into how AI may power robotic equipment and apps to support individuals living at home with illnesses like early-stage dementia, potentially easing the burden on family caregivers and professional caregivers.

- SOCIAL AND ETHICAL CONCERNS:

Basically many ethical and social issues raised by Artificial Intelligence overlap with those raised by data use, automation, the reliance on technologies more broadly, and issues that arise with the use of assistive technologies and Telehealth.

- DEPENDABILITY & SAFETY

When artificial intelligence is utilized in healthcare to operate devices, administer treatments, or make choices, reliability and safety are often the two main concerns taken into account. Artificial intelligence is susceptible to mistakes, which could have major repercussions if they are hard to spot or have a domino effect. A 2015 clinical experiment, for instance, employed artificial intelligence to identify which patients were most likely to experience complications from pneumonia and needed to be hospitalized. This system's inability to take contextual information into account led clinicians to incorrectly advise sending patients home who had asthma symptoms. The artificial intelligence-based symptoms checker app's effectiveness has been called into question. For instance, it's been discovered that app recommendations may be unduly

cautious, thereby boosting demand for pointless procedures and diagnostics [14].

- ACCOUNTABILITY & TRANSPARENCY

Simply put, figuring out the underlying logic that produces the outputs provided by artificial intelligence may be challenging or unattainable for a while. Some forms of artificial intelligence are proprietary and kept a secret on purpose, but others are just too sophisticated for a person to comprehend. Because machine learning techniques and technologies constantly modify their own data-based parameters and rules as they learn, they can be particularly opaque. This merely makes it more difficult to detect faults or biases in the data and validate the outputs of AI systems.

- FAIRNESS, EQUITY AND DATA BIAS

Applications of AI may reduce human error and prejudice, but they also have the ability to reflect and reinforce biases present in the training data. 50 Artificial intelligence has generated concerns about the possibility of hidden or non-aligned forms of discrimination against individuals based on factors including age, gender, ethnicity, and other legally protected qualities. The House of Lords Select Committee on Artificial Intelligence has issued a warning that because the datasets used to train these systems are frequently not representative of the general population, they may make decisions that are unfair and, as a result, reflect significant societal prejudices.

The Committee also discovered that biases could be ingrained in the algorithms themselves, reflecting the convictions and prejudices of those who work in the field of artificial intelligence development. To help with this issue, some observers have asked for more diversity among coders.

- SECURITY AND PRIVACY FOR DATA

Applications of artificial intelligence in the healthcare industry make use of information that many people would deem private and sensitive. Some of these are governed by laws. However, other types of data, such as social media activity and internet search history, which are not related to patients' health status, may be utilized to provide details about the user's and people around them present health status. The Nuffield Council on Bioethics has recommended that when privacy is a problem, projects employing data that raise privacy concerns go beyond compliance with the law to take into account people's expectations about how their data would be used [14].

- MALEVOLENT USE OF AI

Even if artificial intelligence has the potential to be utilized for good, it can frequently be mishandled. For instance, there are concerns that AI may be utilized for covert health system monitoring or screening. Artificial intelligence techniques and technology could inadvertently reveal information about a person's health by analyzing motor behavior (such as the way someone taps on a keyboard) and mobility patterns found by tracking smartphones. Cyberattacks could be carried out more widely and at lesser cost using artificial intelligence.

Governments, researchers, and engineers have been urged as a result to consider the dual-use nature of artificial intelligence and to get ready for potentially nefarious applications of AI technologies.

- FUTURE SCOPE

However, it is expected that artificial intelligence systems will progress and eventually be able to complete a greater variety of jobs without human supervision or input. If this happens, some people have urged that AI systems should have the ability to "be ethical" and make moral choices. This is the topic of intense philosophical discussion, addressing the issue of whether and how moral principles or values can ever be encoded or learned by a machine. If someone were to decide on these fundamental moral principles and whether or not the same obligations that apply to people also apply to robots, new ethical standards may be required.

IV. CONCLUSION

All and all, we may draw the conclusion that recent effective applications of artificial intelligence in healthcare have been made possible by the growing availability of healthcare data of some good quality and the quick development of big data analytic methods and technology. Strong artificial intelligence approaches can uncover clinically pertinent information hidden in the vast amount of data with the help of some pertinent clinical queries, which in turn can help with clinical decision-making.

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