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Review On: Artificial Intelligence [AI] In Healthcare System

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Abstract

The healthcare industry is changing thanks to AI, that is improving drug research, patient management and disease diagnostics. This paper explores the various uses of AI in important fields such as natural language processing (NLP), predictive analytics, medical imaging and personalized medicine. By analysing vast quantities of medical data, AI systems exhibited amazing efficacy within diagnosing diseases like cancer, interpreting medical imaging and forecasting patient outcomes. AI has greatly reduced both time and expense in the drug development process by optimizing the process of finding new medicinal molecules and repurposing current medications. Furthermore, AI is improving personalized medicine by evaluating patient and genomic data to develop individualized therapy regimens that improve patient outcomes. Healthcare workers' workloads are lessened by AI, which also aids clinical decision-making and automates administrative duties. Nonetheless, issues like algorithmic bias, data privacy and the requirement for transparent, comprehensible AI models continue to exist. This paper tackles these challenges while examining how AI might spur innovation, improve patient care and help healthcare professionals negotiate the intricacies of contemporary healthcare systems.

Keywords - AI in Healthcare, Machine Learning [ML], Medical Imaging, Predictive Analytics, Algorithmic Bias, Deep Learning

INTRODUCTION

Artificial Intelligence (AI) is progressing quickly alongside the growing adoption of big data, expanding its applications into numerous sectors such as security, environmental science, education, healthcare and commerce. [1,2]

AI-based technologies in healthcare are unlocking new possibilities, particularly in decision-support systems (DSSs) for diagnosis and treatment. Many hospitals are now adopting AI-driven solutions to aid medical staff in making more informed decisions. In addition to clinical support, AI is revolutionizing the organizational aspects of healthcare by enhancing the efficiency of various roles, including nursing and hospital management, ultimately enhancing the overall effectiveness of healthcare operations [3,4]

In recent years, artificial intelligence (AI) technologies have dramatically reshaped the healthcare landscape, sparking ongoing debates about whether AI could eventually replace human physicians.[5,6] While it seems improbable that AI will eventually completely replace physicians, making clinical decisions with it could be much improved & may take over certain aspects of human judgment, especially in fields like radiology.[7,8,9] The growing availability of healthcare data,c ombined with quick advancements in analytics for big data, has paved the way for successful AI applications in healthcare.[10]

By focusing on critical clinical questions, advanced AI techniques can extract valuable insights from vast datasets,ultimately helping healthcare professionals make well-informed decisions.[11]

Health systems around the world are at a crossroads: in order to maintain the sustainability of health systems, exponential advances in healthcare costs have exceeded growth rates of Gross Domestic Product (GDP).[12] When the COVID-19 pandemic of 2019 broke out & the Ukraine's war broke out, this issue was extremely simple. Health care systems are under pressure to meet the growing demand for accessible and available services due to a number of factors, including limited resources, an aging population, an increase in chronic illnesses and tight financial constraints.[13]

This is why term "HRO" highlights a Highly Reliable Organization By having one of them supervise its functions a "health maintenance organization (HMO)" or a "accountable care organization (ACO)".[14] prevalence of long-term illnesses is rising gradually within the USA's (USA), where 40% of persons have more than two chronic diseases and 60% have one chronic condition, resulting in yearly healthcare costs of USD 3.3 trillion.[15] Additionally, the situation rapidly changed with the emergence of an infectious disease that was officially identified as COVID-19 by WHO on 11 February 2020 After it the first was diagnosed in Wuhan, China, in 2019.[16] The digital revolution in healthcare that has been occurring since then will change many of the essential components of medical care.[17]

***Figure 1**: Artificial Intelligence and Control of Covid-19*

The revolution in healthcare brought about by the growth of biomedical science which encompasses disciplines requires a new workforce and set of Standards of conduct. Genomic revolutionize models of precision medicine, medicines, care delivery, regenerative treatment and diagnosis.[18]

Definitions associated with AI

Sr. No	Terminology	Description
1.	Artificial Intelligence	Artificial intelligence (AI) in the healthcare domain involves employing sophisticated algorithms and computing technologies to emulate human cognitive abilities, allowing machines to undertake tasks that usually require human intelligence.[19] These systemsplay a crucial role in areas such as diagnostics, treatment planning, drug development, and tailored medical attention. By processing high amounts of medical information, artificial intelligence may detect tendencies that could fail to be easily recognized by personnel specialists, thereby enhancing both accuracy and efficiency in healthcare services.[20]
2.	Machine Learning [ML]	AI has a subfield called ML that makes data-driven learning possible for computers & enhances their abilities over time in absent direct instructions. It allows computers to detect patterns and make forecasts. For instance, it can be used for recognizing images, understanding spoken language, and recommending products you might enjoy.[21] It is also a technology used in healthcare that helps medical staff manage clinical data and provide patient care. This uses artificial intelligence to program computers to think and learn like people.[22]
3.	NLP Natural Language Processing	NLP is an area of study which deals with how computers & human speech interact.[23] NLP approaches are able to capture unorganised medical care data, Examine the grammar in it., interpret it & convey it so that electronic healthcare systems can understand it with ease. These methods also lower expenses while enhancing healthcare quality.[24]
4.	Distributed Ledger Technology [DLT]	A novel and quickly expanding technique for storing and exchanging data across several data stores (ledgers) called DLT.[25] It is safe, unchangeable and easily accessible. In an industry that is important to all of us, it can eventually foster trust by empowering patients to take charge of their own data.[26,27]
5.	Transformer	A Transformer is an AI model designed to analyze and comprehend language. Unlike traditional models that process words sequentially, Transformers examine all the phrases in sentences simultaneously.[28] it permits them to grasp meaning more accurately and efficiently. They are used for tasks like translating languages, answering questions, & creation of

		messages, and they serve as the foundation for advanced AI systems like GPT and BERT. [29,30]
6.	Metaverse	In the metaverse, users can interact in real-time using personalized avatars within a 3D virtual and augmented reality space, allowing them to play, work, and engage with others. [31,32,33] This environment offers an immersive, user-friendly, and enjoyable patient-centred medical facilities expertise. [34,35]
7.	Chat General Pretrained Transformer [Chat GPT]	It is an artificial intelligence-powered virtual assistant which simulates human-like conversations.[36] The application of this technique in medical care, education, & investigation holds great potential, provided that its associated concerns are carefully examined and addressed in advance. Functioning as a chatbot, ChatGPT uses a text-based interface to comprehend and generate responses.[37]

Table 1: *Definitions Associated With AI*

Overview of research related to artificial intelligence (AI) in healthcare

Within this study, as we analyse conditions of Knowledge in medical fields today & talk about its prospects. First, from the viewpoints of medical investigators, we quickly go over four pertinent aspects:

Motivation

AI has the capacity to "learn" patterns through extensive healthcare information through advanced algorithms. The knowledge gained through this process can then be applied to enhance clinical practices. Additionally, AI systems can be outfitted with learning and self-correcting capabilities to enhance their accuracy over time. By leveraging up-to-date medical data from references Artificial Intelligence may assist doctors when supplying optimal caring to their patients.[38]

Healthcare Data

Prior Artificial Intelligence systems could be applied in medical care settings, it should be "trained" on information produced from medical practices, including examining, Identification and management. This training allows the systems to recognize patterns and connections. Clinical data can come in several formats, like digital health data from medical gadgets, physician notes, results from physical examinations, clinical lab images, and more.[39]

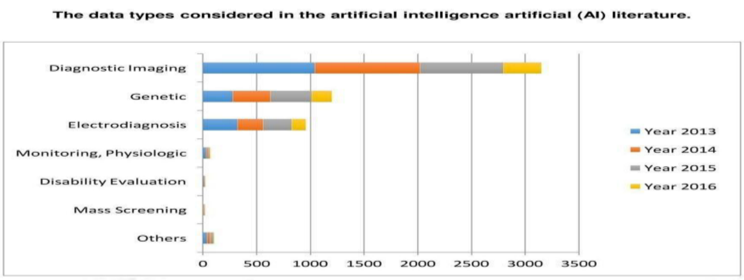

Figure 2: *The Categories of Data Taken into Consideration in the Literature on AI*

Artificial Intelligence Gadgets

Artificial intelligence gadgets can be divided into two primary categories. First section consists of Machine Learning methods that assess structured data, such as genetic details, imaging data & electrophysiological information. Within the healthcare sector, these machine learning techniques focus on grouping patient characteristics or predicting the probability of specific health outcomes. Second section encompasses NLP tools which enhance & supplement structured clinical data via extracting relevant data from unorganized sources such as medical publications and clinical notes. ML approaches can process the structured data generated by NLP algorithms, which convert text into a format that machines can understand.[40]

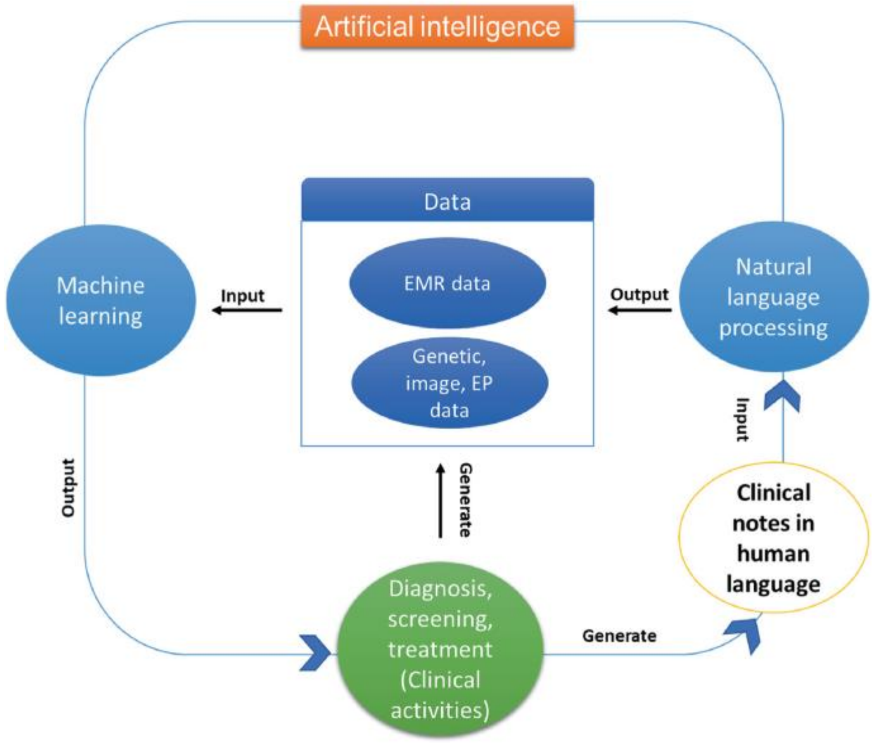

Figure 3: *AI Devices Used in Healthcare*

Disease Focus

Although the body of research on AI in healthcare is growing, it still mostly focuses on three illness categories: cancer, diseases of the nervous system, and cardiovascular disease. Below are a few examples that we talk about.

Cancer

Soma Shekhar and his team conducted a study on double-blind validation that confirmed IBM Watson for cancer treatment as reliable artificial intelligence for supporting cancerous detection.

Neuroscience

Bouton et al. designed an artificial intelligence system aimed at assisting quadriplegic individuals in regaining control over their movements.

Cardiac science

Dilsizian and *Siegel* studied utilising an artificial intelligence framework for diagnosing cardiac conditions via various heart imaging techniques.

AI previously was employed to address diseases beyond the three primary categories. For example, Long et al. used retinal fundus images to identify referable diabetic retinopathy, while Gulshan et al. analyzed ocular imaging data to diagnose congenital cataracts. Next, we will explore common AI devices utilized in NLP & ML with ML techniques classified into conventional methods & the more advanced DL methods. [41]

The AI Tools: NLP and ML

This section offers an overview of AI tools and methods that have demonstrated value in medical applications. These tools are grouped into three categories: Classical ML methods, modern DL models & NLP techniques.[42]

Classical Machine Learning

Machine learning involves extracting features from data through analysis techniques. In some cases, medical outcomes and patient interests are input into machine learning algorithms alongside patient traits. Common patient characteristics include basic information such as age, gender, and medical history, as well as disease-specific details like physical examination results, electrophysiology tests, diagnostic images, gene expression, clinical symptoms, and medication data.Clinical studies frequently gather both medical outcomes and patient characteristics. These may include disease metrics such as tumor size, survival time, and relevant disease markers.

Models in ML are generally categorised in two categories: supervised learning & unsupervised training, based on whether the results are provided. Supervised learning is utilized in predictive modeling by connecting patient features with desired results, while unsupervised learning is better recognized for feature extraction. Semisupervised approach, a blend of supervised & unsupervised methods, has also been suggested. This approach is useful in cases where outcome data is missing for certain subjects.Figure 5 illustrates the connections between these three learning approaches.

Clearly, supervised learning yields more clinically relevant findings than unsupervised learning, which is why supervised learning is most frequently used in AI applications in the healthcare industry. (Take note that in order to reduce dimension or identify subgroups during the preprocessing step, unsupervised learning can be employed. This will increase the efficiency of the subsequent supervised learning step.) Some often employed techniques are neural network, support vector machines, tree-based decision models, nearest neighbors, logistic regression,random forests, naïve Bayes, and discriminant analysis.[43,44]

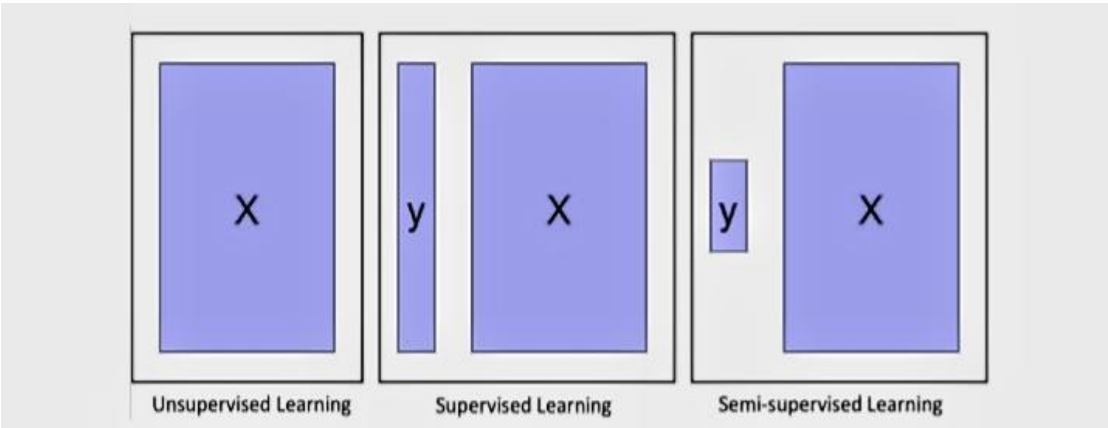

***Figure 4**: All Machine Learning Techniques that Use Different Types of Data to Train Algorithms.*

Support Vector Machine [SVM]

With SVM, subjects are primarily divided into two groups based on the outcome Yi, which acts as a categorization mechanism.Yi = -1 or 1 designates whether a patient is classified as Class 1 or Class 2, respectively.(This method might be extended to cover scenarios with several categories.) The idea that a decision boundary based on the characteristics of Xij, that may stated given below, can be used to divide subjects into two groups:

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

Wherever does j th trait's proportional relevance in influencing the outcome compare to the other traits? Choosing the I th patient for group 1 (Yi = -1) if ai > 0 or group 2 (Yi = 1) based on ai < 0 is the next phase in the decision-making process. The patient's membership in the group is unknown if ai = 0.
One of key characteristics of SVM is that it solves convex optimization problems, where the global optimum is always reached for the model parameter determination.
Sweilam *et al*l. investigated SVM's use in cancer detection. Early detection of Alzheimer's disease was accomplished by Khedher et al. by combining SVM with additional statistical methods.[45,46]

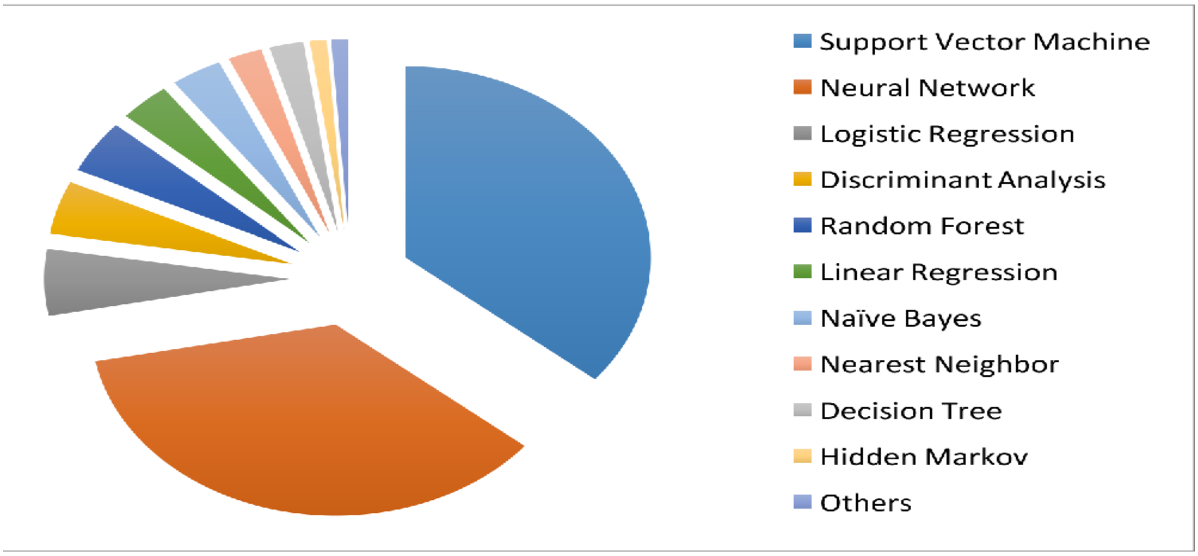

Figure 5: *The Medical Literature Uses Machine Learning Methods. The Information is Produced by Looking at Healthcare Related Machine Learning Methods on PubMed.*

Neural Network

An extension of linear regression is what a neural network looks like that aims to capture complex non linearity relationships among the relevant outputs and the input variables. It employs multiple latent levels with predefined functions to represent the connections between input variables and outcomes. The goal is to minimize the mean error between predicted results and actual results by adjusting weights based on the input and output data.
Artificial Intelligence in healthcare developed significantly In the past few years, with neural networks leading the way. For jobs like interpreting medical pictures, forecasting patient outcomes and streamlining drug discovery procedures, their capacity to autonomously learn from data without explicit programming makes them extremely effective. In areas such as genetics, radiology and oncology, where trends which are often undetectable to the naked eye are identified Through physicians with the help of neural networks, these networks have demonstrated encouraging outcomes.[47]

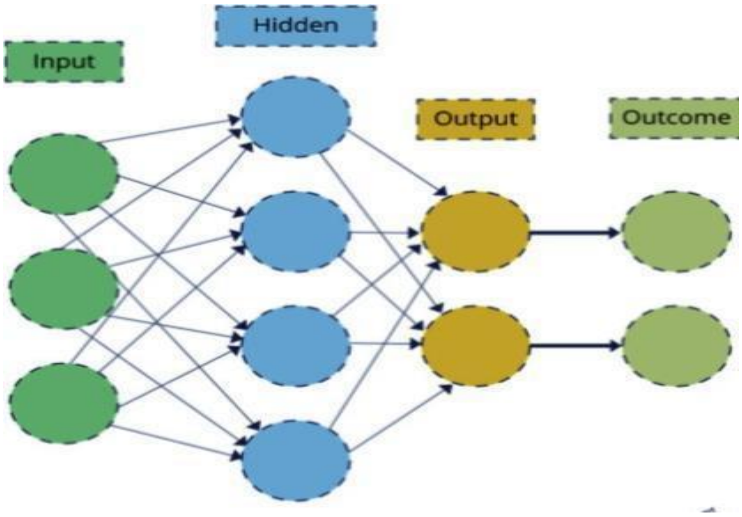

Figure 6: *An Illustration of Neural Networks*

Deep Learning [DL]: A Revolution in Machine Learning

The traditional neural network approach has been updated with deep learning. Deep learning makes it possible to create neural networks with many layers, something that standard neural networks cannot do due to the rapid advancement of current computing.Deep learning is hence capable of delving deeper into non-linear patterns within the data. The amount and complexity of data is another aspect influencing deep learning's recent surge in popularity.

During 2016, the application of DL in healthcare studies has almost doubled like fig. No.8 shows.

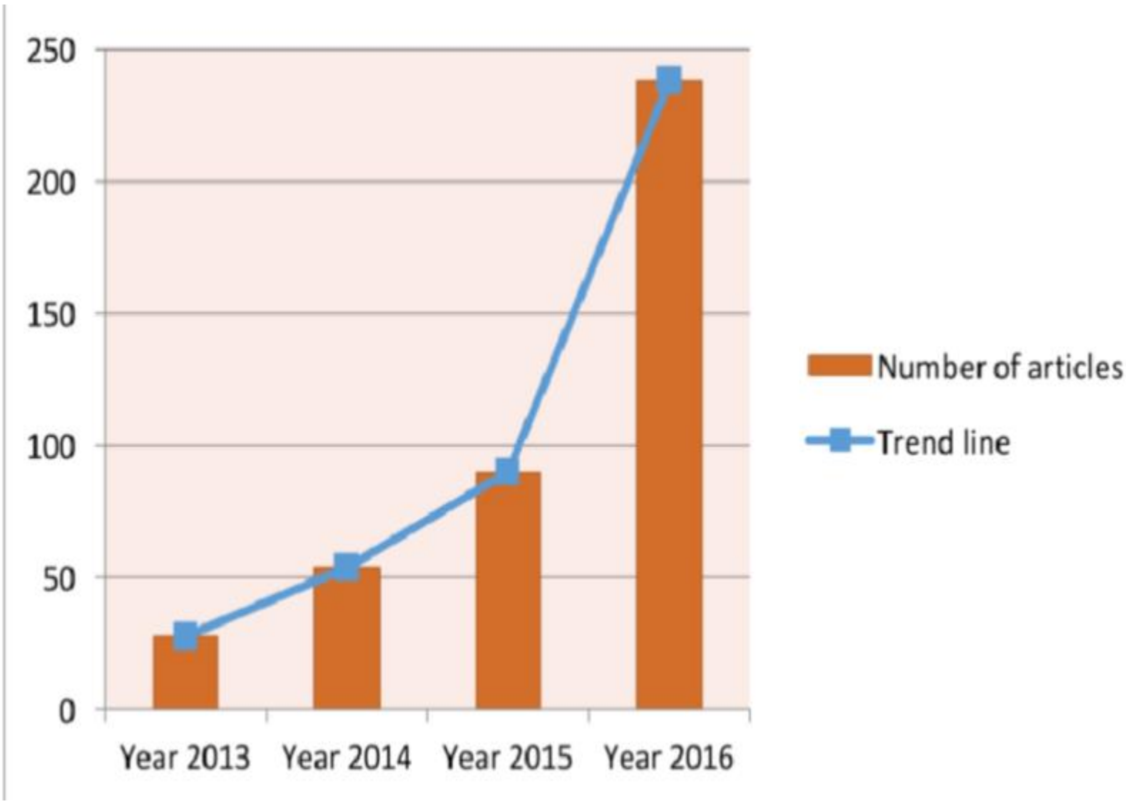

Figure 7: *Growth in the Number of Articles on Deep Learning in Healthcare from 2013 to 2016*

Furthermore, figure No.8 demonstrates that deep learning is largely applied to imaging analysis, which makes sense considering the huge volume and complexity of images by nature.

Deep learning has more hidden layers than a traditional neural network, enabling algorithms to handle complex data with a variety of architectures.[48]

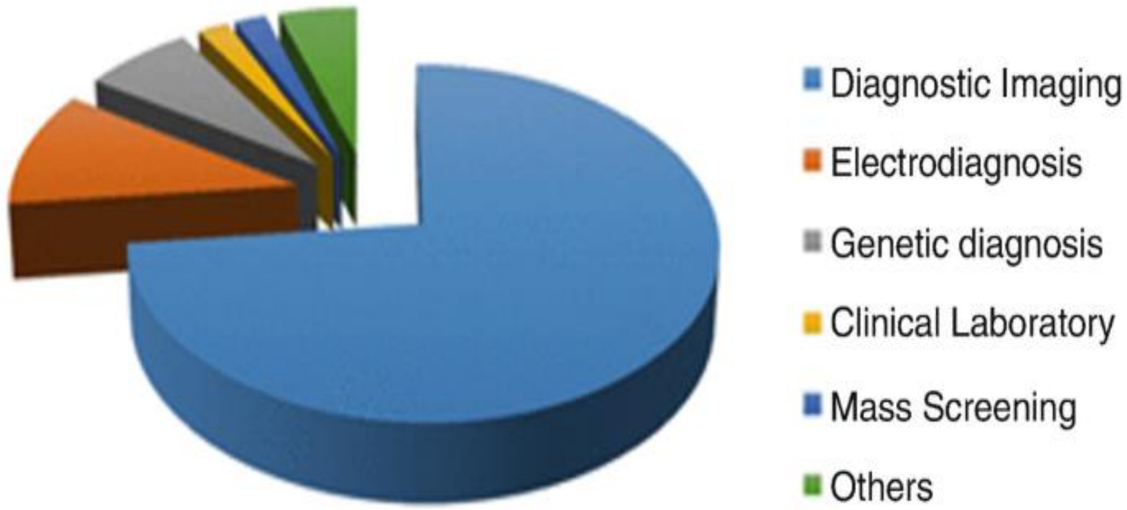

Figure 8: *Distribution of Diagnostic Methods in Healthcare*

Natural Language Processing

The genetic, image and EP data may all be understood by a machine, allowing the ML algorithms to be run immediately following the necessary quality control or preprocessing steps. On the other hand, most clinical data is unstructured and incomprehensible to computer programs; it is provided as narrative prose. Clinical laboratory results, discharge summaries, operation notes, and physical examinations are a few examples of this kind of documentation. Here, the aim of NLP is to help clinical decision-making by extracting pertinent information from the narrative text.

The NLP employs text processing to identify certain disease-related terms found in clinical notes using historical datasets.Next, a portion of the terms is chosen based on how they impact the categorisation of cases into normal l & abnormal l. To support clinical decision making, the structured data is then input and improved with the confirmed keywords.[49]

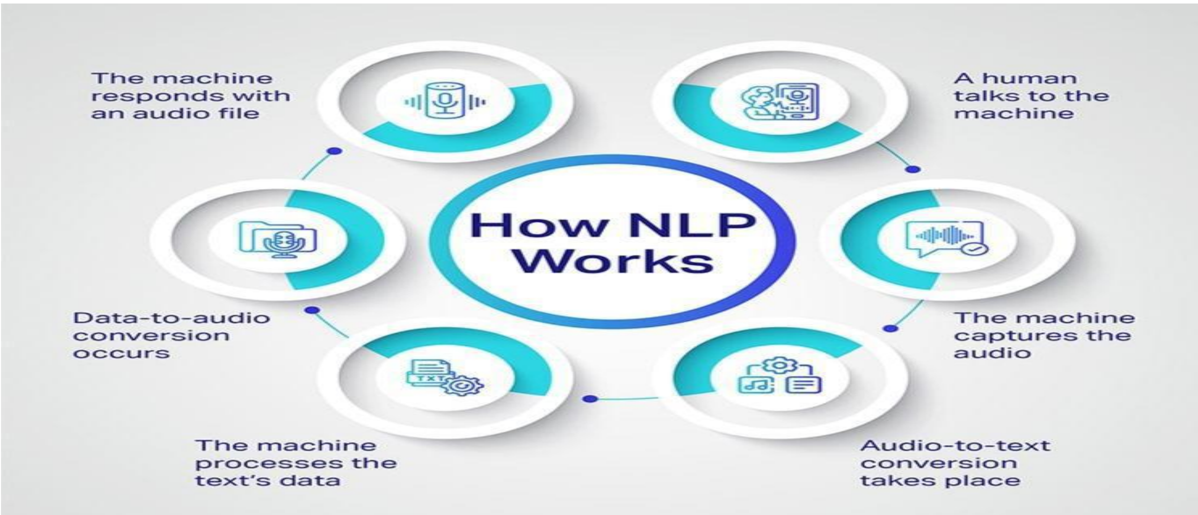

Figure 9: *Working of Nature Language Processing*

Application Of AI In Healthcare

Diagnostic And Imaging Tools

Artificial Intelligence in clinical imaging

AI technologies are utilized to examine medical imaging such as MRI's, CT scans & x-rays, to identify diseases such as cancer, fractures, and neurological conditions. Convolutional Neural networks, a type of DL algorithms, are especially skilled at recognizing patterns and features in medical imaging, making them highly effective for diagnostic purposes.

Example: DeepMind at Google has created a system that can diagnose eye conditions almost expertly using OCT retinal scans.

Radiology and Pathology

Artificial Intelligence algorithms are utilized in radiology to help with diagnosis, identify areas of concern, and automate picture interpretation. AI-powered microscopes in pathology can assist in finding patterns in biopsy samples to diagnose diseases early on.

Predictive Analytics and Risk Modeling

Disease Progression Predictive Models

AI is used to evaluate medical data to forecast patient outcomes, the course of prolonged illnesses (like diabetes mellitus and heart-related disorders), and illness outbreaks. Large datasets are used to train machine learning algorithms, which then anticipate patient risks and aid in preventive care.

One example is the use of AI models to continually monitor vital signs and forecast sepsis in ICU patients.

Risk Stratification for Precision Medicine

By matching medicines to the most suitable individuals, AI-powered technologies can better identify patient groups at high risk for more individualized and focused interventions, increasing treatment success.

The Process Of Drug Development & Discovery

Artificial Intelligence for Accelerating medication development: Through employing algorithms to simulate chemical interactions, predict the efficacy of novel compounds, and find viable drug candidates more quickly than with conventional techniques, AI is revolutionizing the drug development process. Large-scale databases of chemical structures and their biological consequences are analyzed using machine learning methods.

For example, IBM's Watson for Drug Discovery accelerates the process of discovery of potential novel medications for pharma businesses.

AI in Drug Repurposing

AI tools can analyze existing drugs and match them with new therapeutic uses, identifying potential treatments for diseases that previously had no known therapies.

Personalized Medicine

AI with Genomics for Customized Treatments

AI is essential to the analysis of genomic data that allows customized treatments based on individual genetic profiles. In cancer in particular, machine learning models are used to guide precision medicine techniques to find genetic alterations linked to diseases.

AI for Drug Dosage Optimization

By taking into consideration individual parameters like age, weight, genetics, and interactions with other medications, AI algorithms can help determine most appropriate medication doses for individuals while reducing adverse outcomes & optimizing efficacy.

Robotic surgery and assistance

AI in Surgical Robotics

Surgeons can operate more precisely on minimally invasive procedures using robots powered by AI. Robotic innovation, including the da Vinci Surgical System, utilize artificial intelligence to enhance the skills of surgeons by offering precise control and 3D visualizations during intricate surgeries.

AI for Surgical Training and Simulation

Medical personnel are receiving training through the use of AI and virtual reality (VR), which provides simulations of intricate surgical operations. This allows for more in-depth instruction without putting patients at danger.

Care & Observation of Patient

AI in Distance Patient Tracking

Wearables & monitoring devices driven by AI continuously monitor patients' health, identify any early indicators of decline, and notify medical professionals. For instance, atrial fibrillation symptoms can be detected by wearable AI algorithms that monitor cardiac rhythms.

Virtual nursing assistants

AI-driven virtual assistants, such as Molly from Sense.ly, offer patients round-the-clock assistance with scheduling appointments, adhering to drug regimens, and getting answers to medical questions.

Ethical considerations and AI Bias

Bias in AI Algorithms

Making sure AI systems don't reinforce bias is one of the largest problems, particularly in the healthcare industry. Inaccurate forecasts resulting from biased data might disproportionately impact minority populations.

AI and Patient Privacy

Increased worries about patient data security and privacy, particularly with regard to sensitive health data, are being raised by the application of AI. [50,51]

Benefits of artificial intelligence in medical field

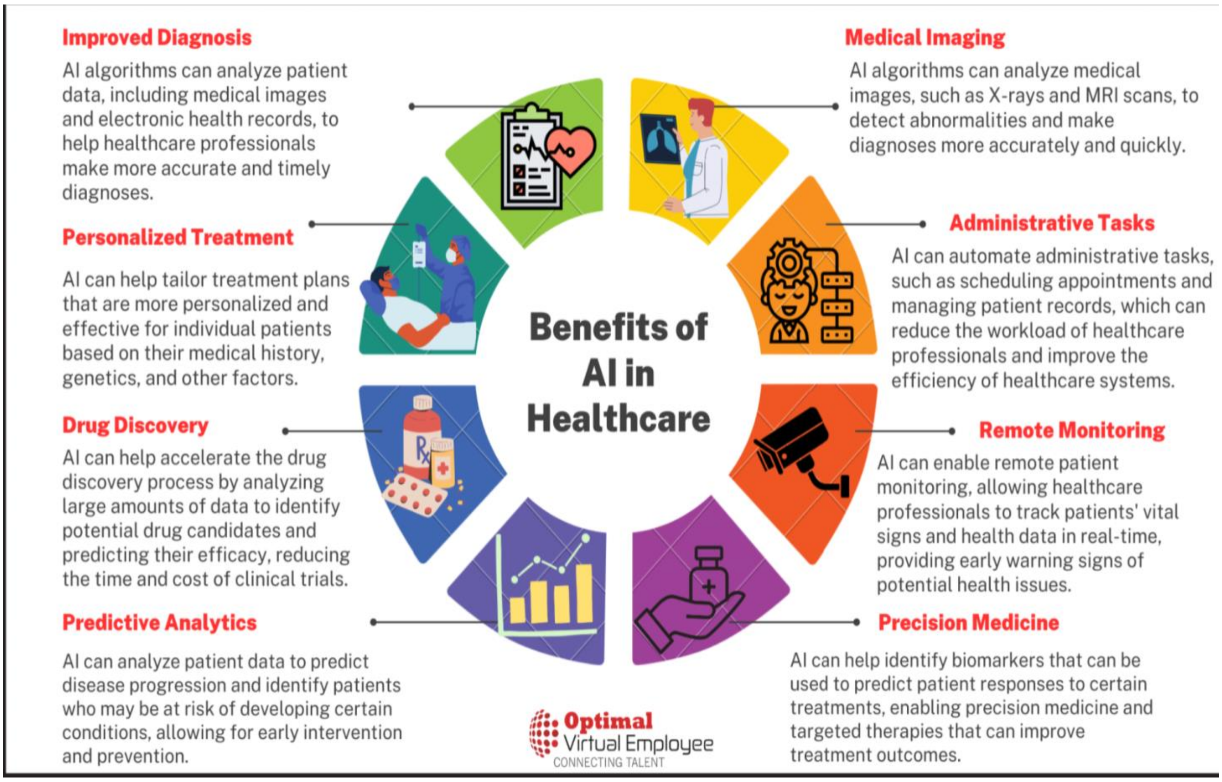

***Figure 10**: Benefits of Artificial Intelligence in Medical Field*

Difficulties faced by artificial intelligence utilisation within medical field

Privacy & Security of Data

Sensitive Health Information: AI models need to have access to a tonne of personal health information, including genetic information and electronic health records (EHRs). It is essential to keep this sensitive data safe from breaches.

Data Ownership and Consent: When sharing their data, patients frequently have little influence over its usage, which raises questions around ownership and informed consent when using health data in AI models.

Data Quality and Availability

Incomplete or Inconsistent Data: While AI models rely on clean, well-structured datasets, healthcare data is frequently fragmented and contains noisy or missing items, which reduces the reliability of model performance during training.

Lack of Standardization: It is difficult to deploy AI consistently across geographies or patient groups due to the variety of healthcare data across various institutions and systems.

Ethical Concerns

Autonomy and Trust: Patients may be wary of accepting advice generated by AI systems, which could diminish the autonomy of healthcare practitioners by assuming decision-making responsibilities.

Bias in Decision-Making: When AI algorithms accidentally favor some populations over others, leading to unequal healthcare delivery, ethical concerns arise.

Cost and Accessibility

High Implementation Costs: Creating and implementing AI systems in the healthcare industry necessitates a large financial outlay for continuing maintenance, training, and technology infrastructure, which may be out of reach for smaller healthcare providers.

Unfair Access: The availability of AI technologies is more widespread in high-resource environments, luring low- and middle-income nations behind and escalating global health inequalities.

Validation and Generalization

Absence of Clinical Validation: AI models may undergo testing and validation on restricted or controlled datasets that do not accurately represent the range of clinical circumstances that exist in the real world. When used extensively, this lack of generalization may lead to subpar performance.

Human-AI Collaboration

AI Augmentation vs. Replacement: The question of whether AI should support human healthcare providers or take over specific tasks is one that is always being debated. To enhance results without undermining human competence, cooperation between medical practitioner and artificial intelligence must be properly planned.[52]

CONCLUSION

The implementation of AI in health services presents vast potentiality to transform healthcare delivery, raise the standard of diagnosis, and boost productivity. By leveraging vast amounts of data, AI can improve early disease detection, personalize treatment plans and accelerate drug discovery. However, to fully realize these benefits, significant challenges must be addressed, including challenges with data security, bias in algorithms & necessity to explainable artificial intelligence systems. Building trust among clinicians and patients is essential, demanding cooperation between healthcare providers, technology experts and policymakers to ensure the moral & equitable use of artificial intelligence. Ultimately, with careful implementation and ongoing evaluation, Artificial Intelligence can build medical structure which is higher effective, accessible, & tailored as patient needs.

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