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Artificial Intelligence in Medicine

- A White Paper by Infoholic Research LLP

The term Artificial Intelligence conjures images of science fiction with advanced technologies used by governments and large corporations. The images are true to an extent in that it's the large corporations which were the early adopters of the technology. However, the technology has been in use and is being utilized by various industries such as retail, and healthcare among others. For instance, whenever an online retailer suggests complementary products to your purchase, its AI at work. Within the medical industry AI has been making rapid inroads into various sectors. From predicting diseases to clinical outcomes and reading radiology examinations, AI is slowly but surely pervading medicine.

Artificial Intelligence in Medicine – Making Machines Intelligent

AI is today one of the key technologies and is analogous to the introduction of electricity that revolutionized the world. The term Artificial Intelligence in Medicine (AIIM) refers to medical diagnosis, medical data, robotics, and genomics (human biology). AI in healthcare has brought a vast change in medicine, devices and diagnostics in assisting physicians with clinical decisions. AI in healthcare is expected to supplement human physicians in future as AI will bring better and accurate form of diagnosis especially (radiology) substituting the judgement in certain areas. Increasing digitization of healthcare data and rapid progress in data analytics with powerful AI techniques is offering a massive amount of data. This data is being used by medical investigators in two major categories - Machine Learning (ML) and Natural Language Processing (NLP) - to extract information from various clinical resources, scientific/medical journals, and highly structured medical data such as Electronic Health Records (EHR).

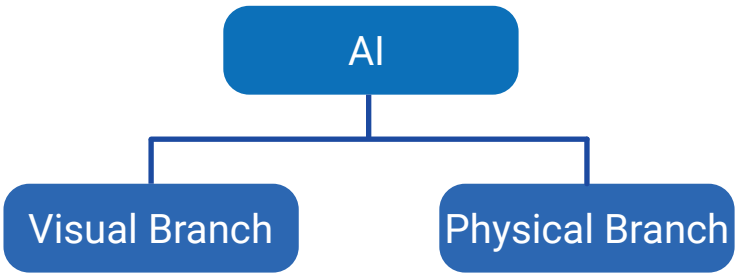
AI in medicine is classified into two branches, viz. virtual and physical. The virtual branch includes data and information control systems, including EMR/EHR, and other related medical data. The physical branch includes robots, which assist surgeons and nanorobots in drug delivery systems. AIIM has wide applications in both pharma and biotech. Top applications for AIIM include disease diagnosis, fastening drug delivery process, personalization of treatment, and improved gene editing. Diagnosis is one of the important aspects of standard activities practiced in medicine, where prognosis is considered as an important part of the practices.

In medicine there is huge demand for AI approaches, providing trustworthy with transparent outcomes for the human expert. Developing an explainable AI system for any application in medicine would require maintaining a high level of learning performance for human-computer interaction and ML techniques.

This paper would try to address some questions such as:

- How is AI in medicine changing the healthcare industry?
- Applications and examples for AI in medicine
- How accurate and supportive is AI in Medicine?
- Are physicians ready to accept AI?
- Risks to patient's privacy – manipulation and privacy concerns
- Benefits of AI in the supply chain

AI in Virtual branch: The virtual branch primarily comprises of mathematical algorithms and is represented by Machine Learning to improve the learning experience. It is also called as deep learning (DL). Its informatic approach allows to control health management systems and provide support and guidance to physician in treating patients.



AI in medicine has evolved into four major categories: diagnostics, drug development, treatment personalization, and genetics (gene editing).

Diagnostics – diagnosing diseases is one of the most important aspects of healthcare as it takes years of medical practice to diagnose it correctly. Diagnosis is often a time-consuming and demanding process. This waiting and demand for expert opinion with right diagnostics puts both patients and physicians under strain that often delays patient care, resulting in delay of diagnosis and life-saving patient treatment. Recent advances in Machine Learning (ML), specifically deep learning algorithms, have made dramatic changes in automating diagnosis and making them cheap and easily accessible. In ML – deep learning algorithms, the machine learns to see patterns with data similarly available to doctors with concrete examples of thousands of related medical records. These patterns are required to be designed and digitized such that the machine can read between the data provided. ML is gaining popularity among diagnostic manufacturers that develop systems in diagnosing chronic diseases such as CT scans, MRI images, skin lesions, and DR (Diabetic retinopathy).

The machines are trained to learn with all patterns of relevant data available, and IBM researchers estimate that medical images available currently account 90% of all medical data, making it the largest data source in healthcare industry. The ML/DL application in diagnosis in imaging has the capability to impact the medical industry over the long-term, with promising applications of automated image processing. For instance, detecting melanoma (skin cancer) would be the first automated image processing diagnosis as skin cancer is the most commonly diagnosed cancer and is increasing every year in the US. Recently an Australian based medical imaging company, Enlitic, was able to develop an algorithm, which can identify relevant characteristics of lung tumors with greater accuracy than radiologists. Similarly, another start-up has also developed DL algorithms to analyze and interpret X-ray ad CT images with 95% accuracy.

These algorithms are capable enough to draw conclusion for diagnosing disease conditions in real time, which can be replicated inexpensively across the globe. Further, its effectiveness of the diagnosis is purely based on patients' diseases, history, data available, and various clustering and pre-processing techniques involved.

Outcome:

- Early detection of chronic diseases will prevent patients from expensive treatment
- Classification of data with DM techniques and machine learning provides useful information to process related attributes in the predicting diseases, resulting in better treatment
- Algorithms are designed to detect the specific disease and early diagnose to provide better treatment
- Different techniques are used like KNN algorithm, SVM, HMM and every technique has its own advantage and disadvantage – the accuracy of the algorithm is set of performance metric

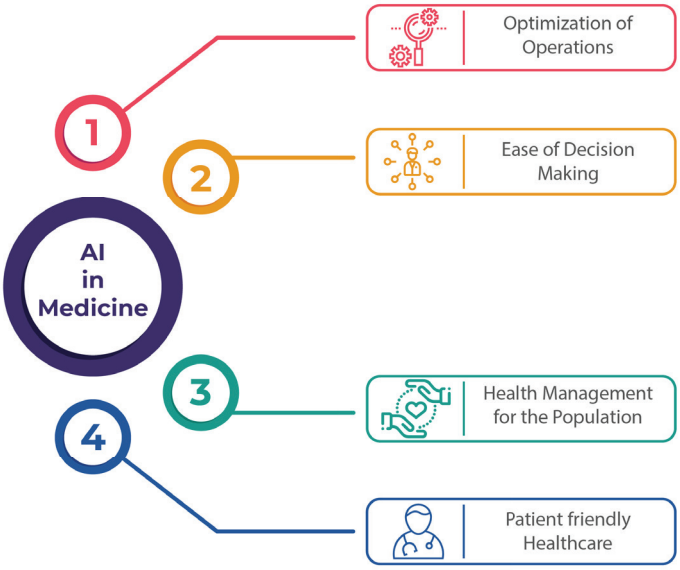
Drug development - In drug development, Artificial Intelligence offers immense opportunities in identifying target areas, and in screening potential drug candidates for further development. Analytical processes would enable researchers to expedite development of drugs, and in bringing down the costs of drug development.

The pharmaceutical industry can overcome its years of work and millions of investments made to develop a drug with the adoption of AI. Involving analytical process in drug development process can show remarkable improvement and with advancements in AI technology, it can revolutionize the drug development process.

Why AI?

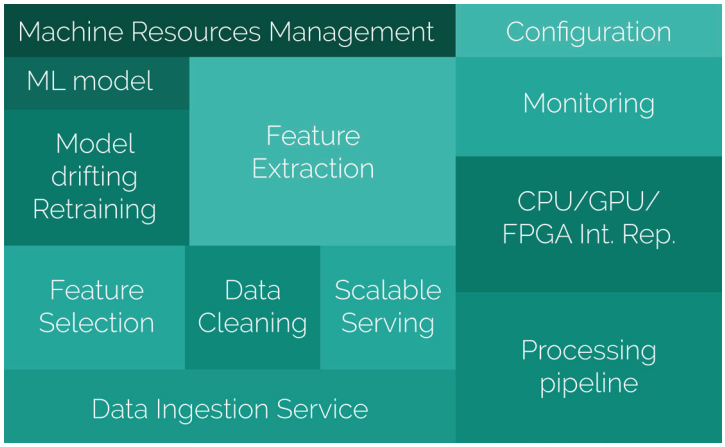
Artificial Intelligence in Healthcare/Medicine is being driven by two major concerns – exponentially increasing healthcare costs and transforming healthcare delivery to provide better outcomes. The two factors are intertwined with each other as better healthcare delivery arises lower costs and streamlining healthcare delivery leads to lower costs. For instance, the US Healthcare market is estimated at about $3.6 trillion (including Pharma), of which about $780 billion is avoidable. AI would enable elimination of duplicity resulting in huge savings for the healthcare industry, thereby leading to better outcomes.

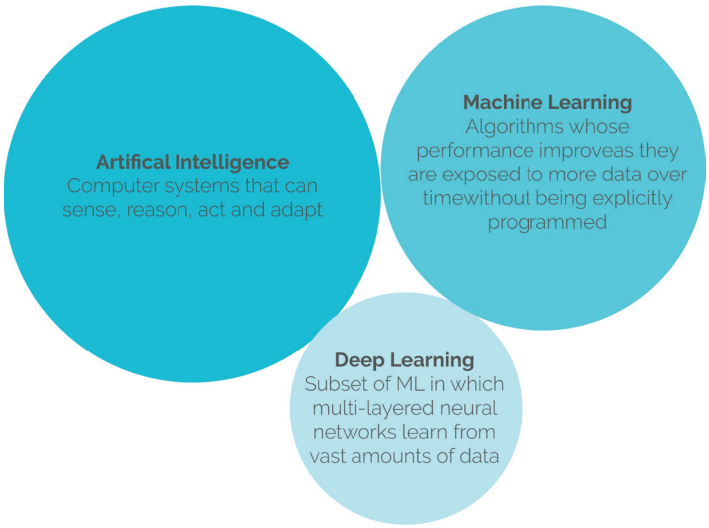
Benefits of AI for Medicine



Accuracy of AI in Medicine

Artificial Intelligence, by definition, involves machine learning, whereby the system improves itself as new data is fed into the system. As such, it is safe to say AI in medicine is progressing at a healthy rate and the accuracy of the systems is increasing by the day. As more data is being fed into the systems, the systems are evolving and have reached a stage where they can be termed at par with human intelligence, especially in radiology workflows. Latest radiology workflow solutions include AI based systems to diagnose and provide results and readings on par with expert radiologists. With millions of radiological images being processed every day, the systems are constantly evolving to provide better outcomes. However, this does not mean these systems would one day replace the radiologist – they would only supplement and complement the expertise of the radiologist to provide faster diagnosis and treatment.

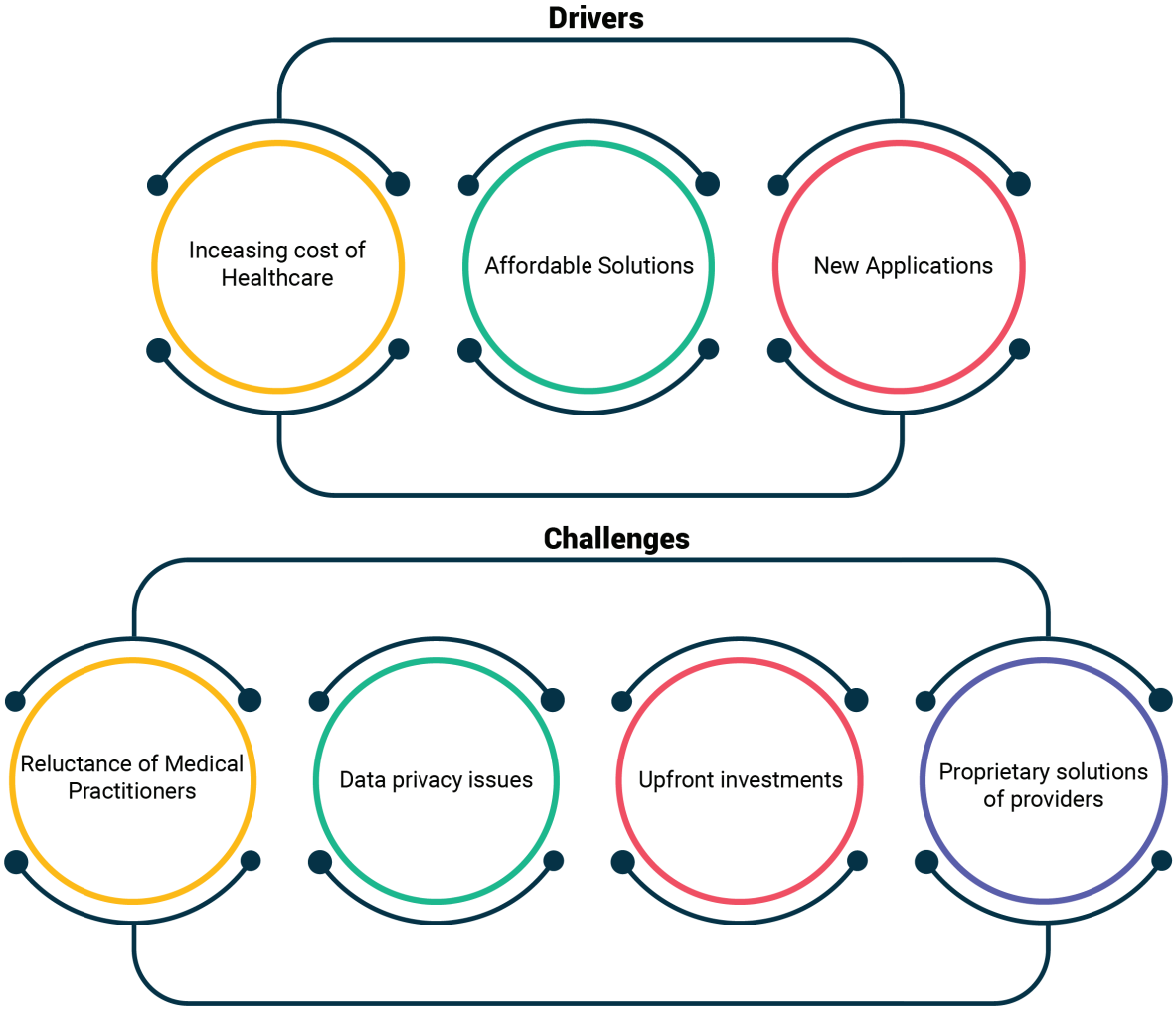




On another note some companies are developing new systems to map individuals and their body parts. For instance, Philips Healthcare is working on developing a digital twin for patients, which would enable physicians to instantly look up the physical patterns and functioning of various organs such as the heart, liver and kidney. The digital twin is being developed to provide faster and personalized treatment as the system would enable the physician to analyze the concerned organ digitally and even virtually test medications/drugs/dosages that would alleviate the patient's problems, thus eliminating the process of trial and error currently practiced to arrive at the correct medication and dosage, resulting in immediate improvement in quality of living. For instance, a physician would be able to predict if a congestive heart failure patient would be receptive to intervention with a pacemaker and the effectiveness of the same, thereby providing quick treatment options.

The Technology is Ready but is the Medical Practitioner Ready?

The biggest impediment to technology is not from external forces but from doctors/physicians. There exist some apprehensions from medical practitioners, especially senior doctors that AI based systems would relegate their experience and make them irrelevant, making them resistant to adopt new technologies such as AI. It is imperative on the industry to stress that these systems are a supplementary and complementary to their skills and are not alternatives to the experience and expertise of the practitioner. For instance, even though machine-based surgeries such as laparoscopic and robotic surgeries are growing by the day, they have not diminished the importance of the surgeon. These systems have only eased the surgery procedure and improved the



accuracy of surgeries, leading to better patient outcomes. In the same way, AI based systems would improve the efficiency of medical practitioners to provide better patient outcomes, at a lower cost.

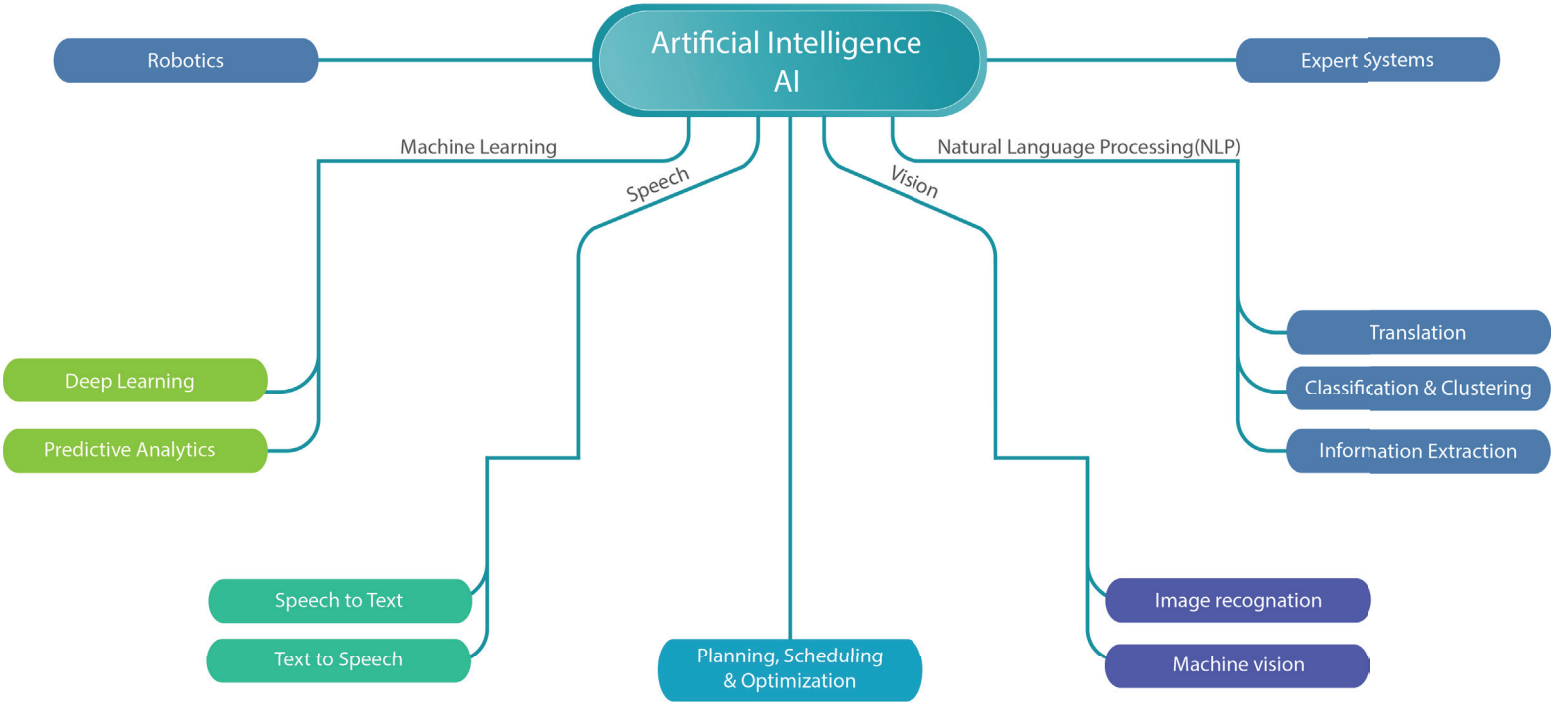
Challenges to be Addressed

AIIM is a game changer for the delivery of healthcare services, efficiently and cost-effectively. However, there exist challenges that need to be addressed for wider adoption of the technology. The primary concern relates to data privacy of the patients. AI works on continuous input of data to improve the system to provide better results, and with large-scale data breaches and loss of data privacy around the world, data acquisition and its safety is a challenge that needs to be addressed immediately. Recognized practices such as those followed for storing patient information on Electronic Medical Records (EMR) might be a guiding pathway to ensure data privacy. Data retrieved for AI systems would invariably arise from EMR systems and integrating similar data privacy should not be a major problem for providers.

AI in the Medical Supply Chain – Redefining Healthcare

While most healthcare related technology developments tend to assimilate into existing systems - being disruptive without changing the status quo, medical supply chain is moving a step ahead in providing better solutions for managing and delivering medicines. New solutions such as CognitiveRx to monitor demand, predict shortage, and ensure adequate inventory. The solution would enable pharmacies to stock optimal inventory to avoid over stocking and under stocking, thereby managing costs while ensuring delivery of critical medicines.

Artificial Intelligence - A Schematic Overview



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