

A Review on Use of Artificial Intelligence in Medicine

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Abstract: *Medicine is a domain where hugenumber of diagnosis is carried out every day. Prediction of disease with the help of medical reports for treating patients and improving the health care of an individual can be done more easily by integrating computing systems which give the most probable prediction diagnosis using artificial intelligence methodologies. The technologies used in AI can be imitation of human intelligence which classifies and predicts the patient disease using certain predictive and analytical approaches. The paper describes a short review on how the growth of AI in medicine took place, the primary methods used in AI along with the mechanisms that are used to determine the patient disease based on symptoms observed. A case study of a health care scenario along with the challenges in implementing AI in medicine is specified. Moreover, an intelligent system that determines the health of the patient using provided knowledge of symptoms using AI methodologies is primarily focused.*

Keywords: medicine, artificial intelligence, prediction, diagnosis

1. Introduction

Artificial Intelligence is theory and development of computer systems able to perform tasks normally requiring human intelligence. Artificial intelligence consists of mechanisms that behave in a certain way that is known as intelligent if a human acts on the basis of it. The examples include machines such as visual perception, speech recognition, decision-making, and translation between languages. These mechanisms can be used in a variety of ways to solve difficultiesthat affect a large area of applications that are associated with having some or the other intelligent behavior. This islinked to the capacity of observation and learning of a person and his/her ability to make concrete decisions on subjects that are related to intelligent reasoning.

2. History

In many of the countries, a scarcity of medical knowledge has led to the increase in the number of deaths that occur due to such diseases. The amount of doctors needed cannot be overcome over a short time. It is a process that may take years or even decades. However, while students are graduating and pursuing to beexperts in their field, many patients might already lose their lives. The practice in existence for the treatment requires patients to take the opinions of specialists for further checkup and the needed treatment [1]. But, the amount of time the patients have to wait in order to get proper treatments is normally more than a few days, or might even take a few months.

The disease might have already spread before the person can get an appointment and this will only lead to increase in more and more deaths. And the people suffering from high-risk diseases need the diseases to get detected at a fairly early stage in order to prevent living with the sufferings for the rest of their lives. These were some of the few reasons as to why inclusion of Artificial Intelligence in Medicine was thought of as one of the possible methods to solve these problems and bridge the gap between the suffering patients

and the specialist doctors [1]. The talk of studying AI with an aim to develop applications for medicine and biology started almost three decades ago.

AIMEs first ever conference on was held in 1985 in Italy. The idea was based on the thought that researchers in various fields such as Computer Science, Medicine, AI among others needed to be brought together in order to attain some noteworthy progress in these fields. This organization was initially named as “Artificial Intelligence in Medicine Europe”. This name was later changed to “Artificial Intelligence in Medicine (AIME)” [1] in order to generalize the organization for people around the world and not just pertain to those living in Europe. Since then, AIME has tried to establish itself as a conference that focuses on Healthcare and Biomedicine but with a strong attention to including Artificial Intelligence in its applications.

During the span of these 30 years, there were papers in these AIME conference which covered a wide range of themes such as Knowledge Engineering, NLP, Temporal information Management, Image and signal processing among others. It has also been observed that these different branches of AI have had their peaks at various times during the past 30 years [1]. Knowledge Engineering and Machine Learning have been the leading branches of AI that have been used in most of the applications of AI in Medicine.

Expert or knowledge-based system is another type of system that is a most commonly used AIM system in routine clinical use. They have knowledge about a specific task, and are able to respond to queries of the patients with data that they have collected from various individual patients to come up with conclusions that may in turn help the patient. Also, in the past three decades, Medicine has formed a rich test-bed for machine learning experiments, allowing experts to develop powerful learning systems which in turn solve problems related to various diseases that various patients face.

There have been many types of clinical tasks to which expert systems have been applied in the past decades. One of them

is Image recognition and interpretation which is used in CT and MRI scans [1]. Another application that has been in use is Therapy critiquing and planning. In these types of applications, errors and inconsistencies in an existing treatment plan is looked for and treatments can be re-formulated upon the condition of the patient and the accepted treatment guidelines.

3. Methods of AI primarily used

A. Fuzzy Logic

Fuzzy logic in AI is a powerful decision-making tool that is being used in many expert medical systems. As put forth by Zadeh, Fuzzy logic has applications more in medical diagnostics than in description of biological systems. Fuzzy sets deal with data that is not precise and contains information or data that is uncertain. Fuzzy logic brings in partial values into context which are in between true or false and in order to deal with this, the 1-0 logical values are used. This is done so that intermediate values can be chosen as most of the things in real life is not a "this" or a "that", a "here" or a "there" but majority of it is "somewhere in between". Let us assume two variables 'h' and 's', where h corresponds to the statement "One is healthy" and 's' corresponds to the statement "one is sick". Hence,

$$h+s=1.$$

If people are totally healthy then h would be equal to 1, whereas if a person is dead, then it would mean that s=1. All the uncertainties like the minor illnesses will lie it between both these extremes.

Fuzzy logic has an important role to play in medicine and been consistently used in a variety of different applications. Some of them are for making a decision on suitable dosage of lithium for a patient, to identify different types of cancers, to support tumor diagnosis and formulation of decisions for nurses among others. Also, when under anesthesia, the continuous examination of various parameters like the blood pressure and the respiratory rate is done by applying fuzzy logic [6]. Fuzzy controller system can also be used among new born infants as a method to control the oxygen concentration being delivered to the baby. Hence, fuzzy logic plays a very important role in the field of medicine and management of various diseases and bioinformatics.

B. Neural Networks

Neural networks (NNs) have been successfully used in science and has various applications in the fields of physics, chemistry among others. Neural Networks use data from different sources as input which when processed with respect to the data stored in a database produce an output germane for deducing certain outcomes that may be possible. NNs have been used in analysis of various samples of patients, especially those suffering from diabetes and tuberculosis. With respect to medicine, Neural Networks have applications in Image Analysis, Drug design and Diagnostic Systems.

If we were to define a neural network, then it is a network that is formed by a series of neurons organized in layers.

Every neuron in a particular layer is connected with each neuron in the next through a connection. A neural network contains mainly three layers in its structure, the input layer that accepts the input, the hidden layer that does the processing and the output layer that provides the output based on the inputs provided [6]. The neural networks in medicine take inputs in the form of symptoms like chest pain, palpitation etc., in form of biochemical analysis as well as in form of various other attributes like Age, gender, smoking habits etc. The output layer for the same can be defined as a Diagnostic layer that tells us the result in terms of Positive, Negative or Uncertain.

Steps in NNs-Based Diagnosis:

- The diagnosis starts with examining the patient and feeding all the required information as input.
- The hidden layer then compares the input to an existing verified database that contains trends of hundreds of patients suffering the same disease over the years.
- The diagnosis provided by the output layer can be deciphered by an expert medical doctor to further evaluate the disease and what needs to be done accordingly.

C. Natural Language Processing

In layman terms, Natural Language Processing describes the process of using computer based algorithms in order to identify key phrases and details in everyday language. It has been consistently observed that most Natural Learning Processing systems learn from their continued interaction with everyday language, absorbing all the details it can and providing results that are more and more accurate with each passing day [4]. The components of NLP include two major parts, the Natural Level Understanding (NLU) and Natural Level Generation (NLG). The first unit involves mapping of an input into a language that can be useful to make representation and analyze different aspects of it. As the name suggests, the second unit involves production of meaningful phrases and sentences from the input. That involves methods like Text planning, Sentence planning, Text realization etc. The NLP in general consists of five major steps.

- Lexical Analysis - involves identifying and analyzing the structure of words.
- Syntactic Analysis (Parsing) - involves analysis of words in the sentence for grammar and arranging words in a manner that shows the relationship among the words.
- Semantic Analysis - draws the exact meaning or the dictionary meaning from the text
- Discourse Integration - brings about the meaning of immediately succeeding sentence.
- Pragmatic Analysis - involves deriving those aspects of language which require real world knowledge.

The application of NLP in Medicine has helped increase the efficiency and accuracy in working of various expert systems. One such application is conversion of free text into data that is standardized and contains meaningful information. This helps make the process of documentation simpler and easier [4]. One of the foremost examples of inculcating NLP into the healthcare/medicine industry has been the IBM Watson, a machine that was used to flag patients likely to get a heart disease sooner than one would

have anticipated. This machine achieved an accuracy rate of 85% when it was first piloted and has been now expanded to various other diseases and involves even larger data sets.

4. Mechanisms used in AI

a) Knowledge based solution

Knowledge based approach uses the human logic to represent the solution to any given scenario. Since the central and the core part of this mechanism consist of interrelated statements which are not completely identical but has a similar representation of the natural language gives a significant advantage. Here the knowledge representation using parts of natural language are easy to understand and develop. The knowledge based solution can be used in automated decision system in which general solution to a problem is fed using the human logic. The solutions designed for knowledge based mechanisms are mostly represented using the logic operators or binary elements. The advantage of this technique is the simplicity in designing and implementing the logic on automated system.

Consider a general case example of diagnosis of a liver disease where there are three different types of hepatitis sets A, B and C. We can use three important labels and compounds derived from the laboratory analysis help in determining the hepatitis disease: HBV, HDV and HCV. These components derived can be either positive or negative; therefore, they have a representation similar to that of binary logic of true and false. It thus provides an important requirement of such systems: that all the analysis components need to be standardized.

The following rules have been created for the decisional system:

- $HBV * \sim(\text{anti-HDV}) = \text{Hepatitis B}$
- $HBV * \text{anti-HDV} = \text{Hepatitis B+D}$
- $\sim(HBV) * \text{anti-HCV} = \text{Hepatitis C}$

These rules can be written in sentences similar to natural human language:

- a) If HBV and not anti-HDV virus are present in the tested solution then the disease is Hepatitis B.
- b) If HBV and anti-HDV virus both are present then the disease is Hepatitis B+D.
- c) If not HBV and anti-HCV viruses occur together then the disease is Hepatitis C.

Some of the weak points of knowledge based system are that during translation and conversion from natural knowledge to logic rules for the system certain significant content can be damaged or compromised. Sometimes certain logic can produce complex result. However use of mathematical functions to produce proper logical diagnosis is an added advantage, using graphical diagram the logic can be understood and analyzed to generate knowledge based prediction.

b) Web based solution

The ever increasing stress among everyone has paved its way diseases such as diabetes and it has increased tremendously in the large scale. It is estimated that 75 million people in India would become diabetic by 2025. The current healthcare system is inadequate and inefficient to

meet the ever-increasing demands. A patient support system focusing on patient centric decision making and physician health monitoring would extensively help to reduce the treatment cost and improve the quality of life among patients. Analyzing useful knowledge from large medical datasets stored as database on web and providing decision making based on records is very difficult and yet important. A constructive solution to this can be using Artificial Intelligence techniques. The proposed model for Web-Based medical diagnosis and prediction consists of four components

- a) Databases- consist of patients and disease database.
- b) Prediction module - Prediction module follows neural networks techniques to predict patient's illness or conditions based on the previous cases. The database relating to disease can also be used for further testing and training.
- c) Diagnosis module-Diagnosis module utilizes fuzzy logic techniques to perform diagnosis task of patient data also set of rules and is defined for patient database and expert is assigned based on disease domain. All the systems like fuzzy logic are integrated for better prediction and performance.
- d) User interface-The World wide web acts as interface between patients and system[4].

5. Case Study

a) Post Operation health care scenario

In order to determine the post operation health of the patients all the data and reports of the patient needs to be categorized and fed into the AI model. After training the AI model a specific employee in the hospital (example: nurse) can check for the specific patient details and give the necessary medications on time by observing the results obtain from the AI model. The AI model also predicts what next can happen with the patient which can help in saving any future detrimental health condition of the patient. This is a faster and efficient method since the waiting time of doctor's visit can be eliminated and the predicted diagnosis are completely logic based using the mathematical analysis, hence giving correct results. This type of support gives greater patient satisfaction and hence prove to be greater help in patient recovery. In this paper we have considered a general case scenario where reports of certain patients are analysed to predict the health of the patient post the operation or surgery. The analysis of reports is done based on a given set of defined parameters such as the blood pressure of the patient, the surface body temperature, the stability of the body and the different oxygen parameters which help to decide whether the patient is fit to go home or should be admitted to the general care room for further assistance.

Training Dataset

INT	Surf	Oxygen sat	BPI	SURF-STBL	INT-STBL	BPI-STBL	Comfort	Decision
mid	low	best	mid	Stbl	Stbl	Stbl	10	GC
mid	mid	best	mid	Stbl	Stbl	Stbl	15	Home
high	low	best	high	Stbl	Stbl	Mod-Stbl	10	GC
mid	low	good	high	Stbl	Stbl	Stbl	15	GC
mid	mid	best	high	Stbl	Stbl	Stbl	10	GC

Description of the numerical attributes as inferred from the table are grouped and listed as follows:

- a) INT (patient internal temperature).
- b) SURF (patient surface temperature).
- c) Oxygen sat(oxygen saturation).
- d) BPI- measurement of blood pressure and its information.
- e) INT-STBL surface stability.
- f) CORE-STBL core stability.
- g) COMFORT and decision.

In this case the expert system is fed with the patient data and it predicts the results using hierarchical tree approach to predict the health of the patient efficiently. The decision making systems depend on the attributes of the patient. Examining the general diagnosis of the patient the system decides whether the patient is fit or should be moved to the general ward. Considering the above case data set if you examine the row 2nd the reports of a sample patient data are considered and evaluated as normal based on the set of reports through which the patient is examined hence the patient can be discharged to home. Evaluating a set of attributes using constraints the machine decides the health of the patient whether the patient is fit or not. Thus dependence on external doctors for evaluation of decision is reduced as expert system with the help of parameters and attributes decides the fitness of patient post operation.

b) Challenges in Implementation

Artificial intelligence is a wide collection of technologies and utilization of resources to achieve the desired goals. Research are made to extend their understanding of the working intelligent systems which can be applied as knowledge in the real world. Medicine, is a much older entity and has predefined criteria and has to be implemented by taking into consideration various factors and cannot be experimented in real life scenarios. Medical artificial intelligence focuses on the development of AI programs that perform diagnosis and predict effective treatment plan.

Along with the benefits of AI techniques which can be implemented to improve health and medical domain, the adoption of these technologies also have risks which have to be evaluated. The clinical settings, all the necessary healthcare provision and patient database demand the highest level of accuracy, reliability, security and privacy. Accuracy is important to preserve faith in the technology, but AI is in its rudimentary stages. Systems using AI may have been trained on large datasets, but in the medical implementation they may come across data and real life scenarios that they have are not aware of, making them less accurate, trustworthy and reliable and thereby increasing patient's vulnerability.

AI systems used may work with smart watches and wearables and use the data they generate to perform analysis on the datasets. According to a study which highlights that the heart rate readings measured by one of the most popular smart watches, the Fitbit Trackers, "do not provide a valid measure of the users' heart rate and cannot be used to provide estimate of a user's heart rate", and deviation of 20bpm from ECG readings was observed. 20 on 43 fitness apps analyzed are vulnerable high-risk data. If we work on idea that all personal data can be identifiable, then it is important that all data used in a medical setting is protected.

Both reliability and security are required to build faith in these new technologies. The information from non-clinical smart wearables may feed into medical AI systems, it will be necessary to identify where clinical-level accuracy and reliability is implemented.

Lack of trust in AI medical systems may be one of the significant factors acting as barrier in adopting technologies that may otherwise prove to be useful in patient outcomes. Considering the risks posed by medical AI is important as technological development and implementation. HealthCare Industry estimates that by 2019, 50 percent of the more than 3.4 billion smartphone and tablet users will have installed mobile health apps. The problem lies because the mechanisms for transferring evidence into real life clinical practice fail to keep up with the ever growing clinical trial data. Developing and inventing mechanism, large database of practice guidelines requires knowledge-based technologies to create and maintain them. Therefore, AIM's skills in knowledge acquisition and representation are needed to help develop methods that allow doctors to match the newly published data with current guidelines and to update the knowledge base.

6. Conclusion

Future of AI in medicine is in the developing stage it will get better gradually over a period of time. Advancements in the technology can give additional support in the medical diagnosis by making the process of healthcare much easier. The prediction and medical diagnosis using the different analysis mechanisms such as knowledge based system and web based solution can be of cardinal importance while detecting and diagnosing the health care of the patient. Improving the health of the patient is possible by analyzing the different health related parameters of the patients. The primary features in medical diagnosis and prediction using artificial intelligence techniques will make the consultation to be more effective and convenient. As clinical decision making inherently requires reasoning under uncertainty use of the fuzzy logic and the expert system can be helpful in certain scenario. Prediction using the neural networks can also provide good results in predicting the disease of humans.

There are huge advantages of such systems. The work of diagnosis can be made simple by saving the time energy and extra resources and thus generating faster conclusions. This helps the physicians to focus on the primary health of the patient. While, on the contrary the artificial intelligence machines can give us the most crucial and subtle parameters which are hard to detect by the human doctors the final decision on acceptance or rejection of these parameters depends on the humans. This system can thus be a great source of support in the health care sector providing the necessary analysis and generation of health reports proving it to be the beneficial support in the health care sector.

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