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An Analysis on The Convergence of Artificial Intelligence Techniques in Diabetic Management and Care

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Abstract. Diabetes Mellitus(DM) is a lethal and prevalent chronic disease which may lead to multi organ failures in patients. Artificial Intelligence technologies have made prominent progress in diagnosis and management of this chronic disease. AI methods with latest technological development in medical devices, mobile computing and sensor technologies provide better health care services for diabetic management and care. Machine learning and artificial intelligence based automated process for detection and diagnosis of diabetes mellitus is more beneficial than a manual diagnosis. Predictive models derived from the principles of machine learning can be used to develop algorithms for detecting diabetes and managing its consequent complications. These models assist in the self-management of the disease in patients and benefit the health care professionals through clinical decision support. Increase in the number of diabetic cases has resulted in the potential availability of data. Harnessing this data with the application of Artificial Intelligence and ML techniques and algorithms would give a deeper insight into the problems related to the disease and assist in devising comprehensive solutions for the same. This paper aims at analyzing the various AI techniques towards the strategic management of building targeted data driven precision care of the disease.

Keywords: Artificial Intelligence, Machine Learning,Diabetes Mellitus.

INTRODUCTION

Different Important advancements in biotechnology and high-throughput computers are continuously assisting in the generation of rapid and inexpensive data, bringing computational biology research

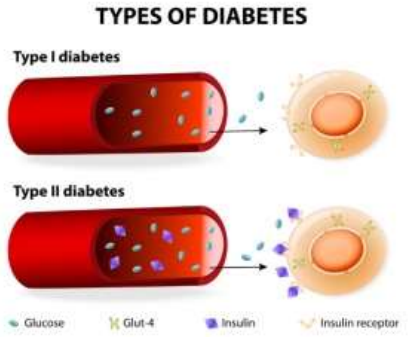
into the realm of big data. The major objective is to examine the rising amount of biotic data and to provide a framework for improving replies to fundamental medical and biological inquiries.Artificial intelligence (AI) is a wide phrase that refers to the theory and development of virtual systems that can do activities typically performed by humans, such as vision, speech recognition, decision-making, and language translation. [1] Artificial Intelligence is transforming our lives in every way, including healthcare. The most significantresearch applications of Artificial intelligence is the predication and treatment of human-threatening diseases like Diabetes Mellitus (DM). The application of artificial intelligence(AI), has the potential to substantially extend the reach and efficiency of diabetes care. This analysis focus on both ML and AI-based approaches in DM detection, diagnosis,self-management, and personalization.

DIABETES MELLITUS

Diabetes mellitus, or "diabetes," is a chronic illness characterized by unusually high blood sugar glucose levels.The two processes that causes diabetes are

1. Inadequate insulin synthesis (which is produced by the pancreas and reduces blood glucose)
2. Inadequate cell sensitivity to insulin action.

The two main types of diabetes correspond to these two mechanisms and are called insulin dependent (Type 1) and non-insulin dependent (Type 2) diabetes. In Type 1 diabetes there is no insulin or not enough of it. Type 1 diabetes is believed to be an autoimmune condition. This means the immune system mistakenly attacks and destroys the beta cells in the pancreas that produce insulin. The damage is permanent.In type 2 diabetes, there is generally enough insulin but the cells upon which it should act are not normally sensitive to its action. Type 2 diabetes starts as insulin resistance. This means the body can't use insulin efficiently. This stimulates the pancreas to produce more insulin until it can no longer keep up with demand. Insulin production decreases, which leads to high blood sugar.The signs and symptoms of both types of diabetes include increased urine output and decreased appetite as well as fatigue. Diabetes is diagnosed by blood glucose testing, the glucose tolerance test, and testing of the level of glycosylated hemoglobin (glycohemoglobin or hemoglobin A1C). The mode of treatment depends on the type of the diabetes.



While DM is incurable, medications and drugs may be used to controlit. Individuals with DM are at danger of having additional healthcomplications, like cardiac arrest and organ damage. Early detectionand management with DM will also avoid complications andhelp to decrease the threat with severe health issues. An automated device is capable to identify DM andhandle anomalies with far better simplicity and reliability comparedto manual detection and diagnosis. Several researchers have used ML and AI methods forDM control and self-management and personalization in recentyears.

ARTIFICIAL INTELLIGENCE

Artificial Intelligence [2] is an intelligent entity created by humans. It is capable of performing tasks intelligently without being explicitly instructed. It is also capable of thinking and acting rationally and humanely.Building an AI system is a careful process of reverse-engineering human traits and capabilities in a machine, and using it's computational prowess to surpass what we are capable of. The various sub domains of Artificial Intelligence and the methods of applying it into the various fields of the industry are as follows:

Machine Learning: ML teaches a machine how to make inferences and decisions based on past experience. It identifies patterns, analyses past data to infer the meaning of these data points to reach a possible conclusion without having to involve human experience. This automation to reach conclusions by evaluating data, saves a human time for businesses and helps them make a better decision.

Deep Learning : Deep Learning is a ML technique. It teaches a machine to process inputs through layers in order to classify, infer and predict the outcome.

Neural Networks : Neural Networks work on the similar principles as of Human Neural cells. They are a series of algorithms that captures the relationship between various underlying variables and processes the data as a human brain does.

Natural Language Processing: NLP is a science of reading, understanding, interpreting a language by a machine. Once a machine understands what the user intends to communicate, it responds accordingly.

Computer Vision : Computer vision algorithms tries to understand an image by breaking down an image and studying different parts of the objects. This helps the machine classify and learn from a set of images, to make a better output decision based on previous observations.

Cognitive Computing: Cognitive computing algorithms try to mimic a human brain by analyzing text/speech/images/objects in a manner that a human does and tries to give the desired output.

DIABETIC CARE THROUGH AI

AI is very useful in managing chronic diseases like DM. There are ways to use AI for diabetic management copiously. The various aspects of diabetic care using Artificial Intelligence or Machine Learning is depicted in the following table

Aspects	Depiction
Prediction	Algorithms based on clinical and genetic data is used to predict the occurrence of the disease
Glycemic Control	Automated insulin infusion is done based on the data obtained from a continuous glucose monitoring system
Prediction of glycemic events	High or Low blood sugar levels can be predicted using the system of continuous monitoring of glucose
Prediction of Complications	Risk of organ damage like retinopathy , nephropathy, neuropathy or cardiovascular event can be predicted
Diagnosis of complications	Based on clinical data, various stages of organ damage can be detected using AI / ML approach

AI Techniques for Diabetic Management and Care

Diabetes is increasingly becoming common with the current living style of people. Diagnosing and analyzing DM quickly and accurately would definitely be worthwhile in managing the disease. In medical terminology, the diagnosis of diabetes is done through the measurement of fasting blood glucose, glucose tolerance, and random blood glucose levels.Researches are emerging widely to handle the situation with ease that would have otherwise become worst. Early diagnosis would result in the control of the disease. Artificial Intelligence and Machine learning algorithms helps in the preliminary judgment about diabetes mellitus based on the daily physical examination data, and it can serve as a reference for doctors. Recently, numerous algorithms are used to predict diabetes,

including the traditional machine learning method. Machine learning methods are widely used in predicting diabetes, and they get preferable results. Decision tree is one of popular machine learning methods in medical field, which has grateful classification power. Random forest generates many decision trees. Neural network is a recently popular machine learning method, which has a better performance in many aspects. This investigation aims at analyzing the convergence of various AI and Machine Learning methods likeRandom Forest (RF), Neural Network (NN)and Support Vector Machine (SVM) in predictions related to DM.

Models Based on Artificial Neural Network (ANN)

Artificial neural networks are computational models analogous to biological neural networks present in the nervous system of living beings. Neural networks are made up of nodes or units connected through directed connections.

Model based on Hybrid ANN and the Genetic optimization algorithm is used to minimize the faults in the diagnosis of DM. The projected ANN system included one hidden layer architecture with several nodes or neurons in each layer. ANN algorithms[3], are applied for the classification of diabetic patients and a Genetic algorithm is used to reduce the errors and optimize the accuracy.This model has a better performance compared to its counterparts that are modelled on neural networks and fuzzy model. Here, Genetic algorithms are optimizing techniques that adjusted the neuron weights. So, this decision support model is an intelligent system that contributes toward the better understanding for the medical experts about the patients who are suspected to have acquired DM.

Another ANN [4], model works with the usage of knowledge acquired from expert experience on the patient pathological state. A number of factors have been recognized to have an impact on determining patients' cases in the subsequent period. These factors were pragmatically studied and coordinated with an appropriate number for coding the computer within the modeling environment ANN. These factors were categorized as input variables and output variables that reflect some possible levels of disease status in terms of the assessment system.

Model Based on Random Forest

The Random Forest technique[5] combines multiple decision trees to predict a value more accurately than to predict a single tree. Each tree predicts a value and finally, the technique is capable of average values predicted by all trees. The error generalization in this technique converges to a limit when the number of trees in the forest is large. Each tree makes a prediction independently and the technique averages those predicted values to have a single output value.

The Random Forest Classifier combined with SVM-SMOTE and LASSO feature reduction is used in identifying high-risk people of DM. This method is an efficient tool for early screening of DM. Medical data is always imbalanced, redundant and has a high dimensional feature space. This method address this problem through dimensionality reduction and classification of the survey sample data. Classification results are based on the supervised classifiers and the indicators like accuracy, precision and F1 – score and all these evaluates the performance of the model.

Model Based on Support Vector Machines

The Support Vector Machine algorithm[6], is a supervised machine learning method. It shows high performance in classification problems especially in the biomedical field. SVM technique is data driven and model free. It builds an optimal hyperplane in the form of a decision surface so the margin of separation between the different classes in the data is as wide as possible. Based on labeled data represented as points or vectors in a dimensional space, the algorithm outputs have a hyperplane that can classify new data instances. Support vectors refer to a small subset of the training observations that are used as support for the optimal location of the decision surface.This technique has recently been used to develop automated classification of diseases and to improve methods for detecting disease in the clinical setting.

The essential thought behind the SVM method[7], is to develop a n-1 dimensional isolating hyperplane to segregate two classes in a n-dimensional space. An information point is seen as a n-dimensional vector. For instance, two factors in a dataset will make a two-dimensional space; the isolating hyperplane would be a straight line (one dimensional) separating the space down the middle. At the point when more measurements are involved, SVM looks for an ideal isolating hyperplane called the most extreme edge isolating hyperplane. The distance between the hyperplane and the closest information point on each side (called support vectors) is amplified. The best situation is that two classes are isolated by a straight hyperplane. In any case, true circumstances are not generally that basic. A few information focuses in the two classes may fall into a "dark" region that isn't not difficult to be isolated. SVM tackles this issue by

1. Permitting a few information that focus to some unacceptable side of the hyperplane by presenting a client indicated boundary C that determines the compromise between the minimization of the misclassifications and boost of edge;
2. Utilizing kernel functions to add more measurements to the low dimensional space, therefore that two classes could be divisible in the high dimensional space.
3. The SVM approach will in general arrange elements without giving appraisals of the probabilities of class enrollment in the dataset, which is a crucial contrast from various strategic relapse. SVM model is implemented as a web based tool that is called a Diabetes Classifier.

RESULT

METHOD	ASPECT	ACCURACY
ANN-GA based diagnostic system	Diagnosis of DM	84.5 %
Random Forest Classifier combined with SVM-SMOTE and LASSO	Identify high risk people of DM	89 %
Support Vector Machine algorithm	Classification of DM	83%

CONCLUSION

AI and machine learning algorithms are used to predict, identify and classify the most prevalent disease, Diabetes Mellitus. Artificial neural networks model can be designed and implemented in predicting, diagnosing, treating DM and helping the surgeons, physicians, and the general population. Support vector machine modeling is a favorable classification approach for identifying people with common illnesses like diabetes and pre-diabetes. In epidemiologic investigations, the SVM strategy can possibly perform better compared to conventional statistical methods, particularly in circumstances that incorporate multivariate danger factors with little impacts, restricted sample size, and a limited knowledge on hidden relationships among threat factors.Random Forest is a great algorithm for both classification and regression problems, to produce a predictive model. However it has a few disadvantagessuch as large time and space complexity and requirement of huge computational power, the benefits overwhelm the downsides because of its more prominent exactness and perfect execution.

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