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A Review on the Diagnosis of Diabetes Mellitus

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Abstract – **Diabetes mellitus is an interminable disease that forces excessively high human, social and financial expenses for a nation. Additionally, minimizing its commonness rate and in addition its excessive and risky confusions requires viable administration. Diabetes administration depends on close participation between the patient and health awareness experts.**

Data mining gives a diversity of methods to investigate large data keeping in mind the end goal to find hidden knowledge. This paper gives an effort to review descriptive data mining approach and to devise association standards to predict diabetes behaviour in arrangement with particular life style parameters, including physical activity and emotional states, especially in elderly diabetics.

Keywords – **Data mining, Diabetes mellitus.**

I. INTRODUCTION

Diabetes is a standout amongst the most well-known non-transmittable diseases in the world. It is assessed to be the fourth or fifth cause for death in most of the nation. Diabetes is nominated by International Diabetes Federation (IDF) as one of the most challenging health issues of 21st century [1]. In this chapter after a review on diabetes and diabetics, main challenges in its management especially in elderly along with recent researches and the methodologies to improve its management are discussed.

In Diabetes is an unending malady that happens when the body cannot sufficiently deliver insulin or cannot utilize it adequately which brings about BG (Blood Glucose) not to be ingested appropriately by the body cells and stays circulation in the blood.

Categories of diabetes:

- Type-1 diabetes
- Type-2 diabetes
- Gestational diabetes

Type 1 diabetes incorporates diabetes that is basically an aftereffect of pancreatic beta cell devastation that prompts insufficient creation of insulin. This type can influence any age yet typically happens in youngsters and youth. These diabetics can lead a typical life through mix of a day by day insulin treatment, solid eating regimen, close checking and normal physical activity [2].

Type 2 diabetes is the most well-known, one that generally happens in adult peoples yet is progressively seen in kids and young people, as well. This type is otherwise called an insulin resistance in light of the fact that, in this type the body can create insulin yet possibly it is not adequate or the body can't react to its impact leading glucose remains flowing in the blood. This type likewise incorporates LADA (Latent Autoimmune Diabetes in Adults), depicting a lessened number of individuals with diabetes type 2 who seem to have an insusceptible intervened loss of pancreatic beta cells [3]. Numerous type 2 diabetics can control their BG level through a healthy eating routine and an expanded physical movement.

Gestational diabetes mellitus alludes to a glucose intolerance with onset or first acknowledgment amid pregnancy because of ineffectively oversaw BG. This collection must be nearly checked to control their BG level and minimize the danger for the child. This could be possible by healthy eating regimen, moderate physical activity and at times insulin treatment or oral drug [2].

II. DIABETES IN ELDERLY

The definition of elderly varies although it is generally agreed as a concept referring to a person with age 60 and over who is characterized by a slow, progressive frailty which continues to the end of life [4]. Population aging has an increasing trend around the world in a way that the global share of elderly from 9.2 percent in 1992 reached to 11.7 percent in 2013 and is estimated to reach 21.1 percent by 2050. As aging population increases, the reasons for death and disabilities are changing from infectious to non-communicable diseases such as diabetes [5].

The prevalence of diabetes increases with aging. Studies show that 10% of population over 60 of age and 16% to 20% over 80 of age, have diabetes. In addition to considerable elderly diabetics' population, the importance of early diabetes diagnosis and management increases in elderly due to their increasing potential for premature death, functional disability and coexisting illnesses such as hypertension and stroke. They are

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also at greater risk for several common geriatric syndromes such as depression, cognitive impairment, urinary incontinence, injurious falls, and persistent pain [6]. These conditions increase the complexity of diabetes management in elderly. Lifestyle interventions including nutrition therapy and exercise, is one of the best known ways for diabetes prevention and management in elderly.
abc.

III. Literature Review

Diabetes is a particularly opportune disease for data mining technology for a number of reasons. First, because the mountain of data is there and second, diabetes is a common disease that costs a great deal of money, and so has attracted managers and payers in the never ending quest for saving money and cost efficiency. Third, diabetes is a disease that can produce terrible complications of blindness, kidney failure, amputation, and premature cardiovascular death, so physicians and regulators would like to know how to improve outcomes as much as possible. Data mining might prove an ideal match in these circumstances. Preventing the disease of diabetes is an ongoing area of interest to the healthcare community.

Based on the data from the 2011 National Diabetes Fact Sheet, diabetes affects an estimate of 25.8 million people in the US, which is about 8.3% of the population. Additionally, approximately 79 million people have been diagnosed with pre-diabetes [7]. Pre-diabetes refers to a group of people with higher blood glucose levels than normal but not high enough for a diagnosis of diabetes. Increased awareness and treatment of diabetes should begin with prevention. Much of the focus has been on the impact and importance of preventive measures on disease occurrence and especially cost savings resulted from such measures. Many studies regarding diabetes prediction have been conducted for several years. The main objectives are to predict what variables are the causes, at high risk, for diabetes and to provide a preventive action toward individual at increased risk for the disease. Several variables have been reported in literature, which are explained in the next heading.

According to WHO 2011 report:

- 347 million people worldwide have Diabetes Mellitus.
- In 2004, an estimated 3.4 million people died from consequences of high blood sugar.
- More than 80% of Diabetes Mellitus deaths occur in low- and middle-income countries.
- WHO projects those Diabetes Mellitus deaths will double between 2005 and 2030.

Healthy diet, regular physical activity, maintaining a normal body weight and avoiding usage of tobacco can prevent or delay the onset of type 2 Diabetes Mellitus [8].

Data mining is the process of retrieving data from a large data warehouse where data is retrieved based on prediction. Data mining is also called as knowledge discovery in database (KDD) [9] [10]. The predictions that are used to find the data from the warehouse are determined with the help of various domains like artificial intelligence, machine learning, statistics, business intelligence and database system. Data mining has impact on various fields which includes games, business, science and engineering, human rights, medical data mining, spatial data mining, sensor data mining, visual data mining, music data mining, surveillance, pattern mining, subject based data mining, knowledge grid [10]. Our medical health care systems are rich in information but poor in knowledge so there is a huge need of having a techniques and tools to extract information from the huge data set so that medical diagnosis can be done [11].

Santi Wulan Purnami et al. [11], in their research work used support vector machine for feature selection and classification of breast cancer and also emphasizes how 1-norm SVM can be used in feature selection and smooth SVM (SSVM) for classification. Two problems addressed here are, the first is to identify the importance of the parameters on the breast cancer. The second research problem is to diagnose breast cancer based on nine attributes of Wisconsin breast cancer dataset. To identify the importance of the parameters, the 1-norm SVM of the original data was done. The stronger parameters are as follows: parameter 1 (Clump thickness), parameter 3 (Uniformity of Cell shape), parameter 6 (Bare Nuclei), parameter 7 (Bland Chromatin), and parameter 9 (Mitoses), while parameter 2 (Uniformity of Belsize), parameter 4 (Marginal Adhesion), parameter 5 (Single Epithelial Cell Size) and parameter 8 (Normal Nucleoli) are weaker. The obtained training and testing classification accuracy using 10 fold cross validation were 97.52% and 97.01% respectively. When one of the weak parameters was removed both training and testing shows a little decrease in accuracy.

Pardha Repalli [12], in their research work predicted how likely the people with different age groups are affected by diabetes based on their life style activities. They also found out factors responsible for the individual to be diabetic. Statistics given by the Centers for Disease Control states that 26.9% of the population affected by diabetes are people whose age is greater than 65, 11.8% of all men aged 20

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years or older are affected by diabetes and 10.8% of all women aged 20 years or older are affected by diabetes. The dataset used for analysis and modeling has 50784 records with 37 variables. They computed a new variable age_new as nominal variable, dividing in to three group's young age, middle age and old age and the target variable diabetes_diag_binary is a binary variable. They found 34% of the population whose age was below 20 years was not affected by diabetes. 33.9% of the population whose age was above 20 and below 45 years was not affected by diabetes. 26.8% of the population whose age was above 45 years was not diabetic.

Joseph L. Breault [13], in his research work used the publicly available Pima Indian diabetic database (PIDD) at the UCIrvine Machine Learning Lab. They tested data mining algorithms to predict their accuracy in predicting diabetic status from the 8 variables given. Out of 392 complete cases, guessing all are non-diabetic gives an accuracy of 65.1%. Rough sets as a data mining predictive tool applied rough sets to PIDD using ROSETTA software. The test sets were classified according to defaults of the naïve Bayes classifier, and the 10 accuracies ranged from 69.6% to 85.5% with a mean of 73.8% and a 95% CI .The accuracy of predicting diabetic status on the PIDD was 82.6% on the initial random sample, which exceeds the previously used machine learning algorithms that ranged from 66-81%. Using a group of 10 random samples the mean accuracy was 73.2%.

G. Parthiban et al. [14], the main objective of their research paper is to predict the chances of diabetic patient getting heart disease. They proposed a system which predicts attributes such as age, sex, blood pressure and blood sugar and the chances of a diabetic patient getting a heart disease. They used Naïve Bayes Classifier. It is a term dealing with simple probabilistic classifier based on applying Bayes Theorem with strong independence assumptions. The data set used in their work was clinical data set collected from one of the leading diabetic research institute in Chennai and contain records of about 500 patients. The clinical data set specification provides concise, unambiguous definition for items related to diabetes. The WEKA tool was used for Data mining. They used 10 fold cross validation. They found most of the diabetic patients with high cholesterol values are in the age group of 45 – 55, have a body weight in the range of 60 – 71, have BP value of 148 or 230, have a Fasting value in the range of 102 – 135, have a PP value in the range of 88 – 107, and have a A1C value in the range of 7.7 – 9.6.

Padmaja et al. [15], in their research aimed at finding out the characteristics that determine the presence of diabetes and to track the maximum number of women suffering from diabetes. They used Data mining functionalities like clustering and attribute oriented induction techniques to track the characteristics of the women suffering from diabetes. Information related to the study was obtained from National Institute of Diabetes, Digestive and Kidney Diseases. The results were presented in the form of clusters. Those clusters denote the concentrations of the various attributes and the percentage of women suffering from diabetes. The results were evaluated in five different clusters and they show that 23% of the women suffering from diabetes fall in cluster-0, 5% fall in cluster-1, 23% fall in cluster-2, 8% in cluster3 and 25% in cluster-3.

Prominent Research Work

Lingaraj, Haldurai, Rajmohan Devadass, Vidya Gopi, and Kaliraj Palanisamy, "Prediction of Diabetes Mellitus using Data Mining Techniques: A Review", 2015.

Data mining techniques are used to find interesting patterns for medical diagnosis and treatment. Diabetes is a group of metabolic disease in which there are high blood sugar levels over a prolonged period. This paper concentrates on the overall literature survey related to various data mining techniques for predicting diabetes. This would help the researchers to know various data mining algorithm and method for the prediction of diabetes mellitus [16].

Thirumal, P. C., and N. Nagarajan, "Utilization of Data Mining Techniques for Diagnosis of Diabetes Mellitus-A Case Study", 2015.

Data mining looks through a large amount of data to extract useful information. The most important and popular data mining techniques are classification, association, clustering, prediction and sequential patterns. In health concern businesses, data mining plays an important role in early prediction of diseases. In general to detect a disease numerous tests must be conducted in a patient. The usage of data mining techniques in disease prediction is to reduce the test and increase the accuracy of rate of detection. One of the most common diseases among young adult is Diabetes mellitus. This develops at a middle age and more common in obese children and adolescents. In order to reduce the population with diabetes mellitus it should be detected at an earlier stage, hence a quick and efficient detection mechanism has to be discovered. This paper apply various data mining techniques which are noteworthy to prediction of diabetes mellitus and

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extract hidden patterns from the PIMA Indian diabetes dataset available at UCI Machine Learning Repository [17].

Aiswarya Iyer, S. Jeyalatha and Ronak Sumbaly, "Diagnosis of Diabetes Using Classification Mining Techniques", 2015.

Diabetes has affected over 246 million people worldwide with a majority of them being women. According to the WHO report, by 2025 this number is expected to rise to over 380 million. The disease has been named the fifth deadliest disease in the United States with no imminent cure in sight. With the rise of information technology and its continued advent into the medical and healthcare sector, the cases of diabetes as well as their symptoms are well documented. This paper aims at finding solutions to diagnose the disease by analyzing the patterns found in the data through classification analysis by employing Decision Tree and Naïve Bayes algorithms. The research hopes to propose a quicker and more efficient technique of diagnosing the disease, leading to timely treatment of the patients [52].

Vijayan V, Veena, and Aswathy Ravikumar, "Study of Data Mining Algorithms for Prediction and Diagnosis of Diabetes Mellitus", 2014.

Diabetes mellitus or simply diabetes is a disease caused due to the increase level of blood glucose. Various available traditional methods for diagnosing diabetes are based on physical and chemical tests. These methods can have errors due to different uncertainties. A number of Data mining algorithms were designed to overcome these uncertainties. Among these algorithms, amalgam KNN and ANFIS provides higher classification accuracy than the existing approaches. The main data mining algorithms discussed in this paper are EM algorithm, KNN algorithm, K-means algorithm, amalgam KNN algorithm and ANFIS algorithm. EM algorithm is the expectation-maximization algorithm used for sampling, to determine and maximize the expectation in successive iteration cycles. KNN algorithm is used for classifying the objects and used to predict the labels based on some closest training examples in the feature space. K means algorithm follows partitioning methods based on some input parameters on the datasets of n objects. Amalgam combines both the features of KNN and K means with some additional processing. ANFIS is the Adaptive Neuro Fuzzy Inference System which combines the features of adaptive neural network and Fuzzy Inference System. The data set chosen for classification and experimental simulation is based on Pima Indian Diabetic Set from University of California, Irvine (UCI) Repository of Machine Learning databases [19].

Soliman, Omar S., and Eman AboElhamd. "Classification of Diabetes Mellitus using Modified Particle Swarm Optimization and Least Squares Support Vector Machine", 2014.

Diabetes Mellitus is a major health problem all over the world. Many classification algorithms have been applied for its diagnoses and treatment. In this paper, a hybrid algorithm of Modified-Particle Swarm Optimization and Least Squares Support Vector Machine is proposed for the classification of type II DM patients. LS-SVM algorithm is used for classification by finding optimal hyper-plane which separates various classes. Since LS-SVM is so sensitive to the changes of its parameter values, Modified-PSO algorithm is used as an optimization technique for LS-SVM parameters. This will guarantee the robustness of the hybrid algorithm by searching for the optimal values for LS-SVM parameters. The proposed Algorithm is implemented and evaluated using Pima Indians Diabetes Data set from UCI repository of machine learning databases. It is also compared with different classifier algorithms which were applied on the same database. The experimental results showed the superiority of the proposed algorithm which could achieve an average classification accuracy of 97.833% [20].

Poonguzhali. E, Sabarmathi Kabilan, Sandia Kannan, Sivagami. P, "Diagnosis of Diabetes Mellitus Type 2 using Neural Network", 2014.

In today's world, one of the major threats to human health is Diabetes Mellitus. Diabetes Mellitus is of two types, type1 or insulin dependent and type2 or non-insulin dependent. Type1 Diabetes is when a person suffers from the complete deficiency of insulin secretion by the pancreas. Type2 Diabetes is when the body does not produce sufficient amount of insulin or the cell fails to intake insulin due to various factors. In some cases of type2 Diabetes, there are no symptoms, which may cause the person to be unaware of the disease for an extended period of time and hence it is of importance to detect type2 Diabetes. There are a few methodologies for type2 Diabetes which are considered to serve as second opinion after various medical tests. The paper can improve the strategy to a better level where artificial metaplasticity on perceptrons is implemented on neural network. The nodes of the neural network are parameters containing features like thirst increase, hungry increase, nausea, fatigue, vomiting etc. This proposed system can increase the efficiency of the system which is in existence [21].

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Rahman, Rashedur M., and Farhana Afroz. "Comparison of Various Classification Techniques Using Different Data Mining Tools for Diabetes Diagnosis.", 2013.

In the absence of medical diagnosis evidences, it is difficult for the experts to opine about the grade of disease with affirmation. Generally many tests are done that involve clustering or classification of large scale data. However many tests could complicate the main diagnosis process and lead to the difficulty in obtaining the end results, particularly in the case where many tests are performed. This kind of difficulty could be resolved with the aid of machine learning techniques. In this research, we present a comparative study of different classification techniques using three data mining tools named WEKA, TANAGRA and MATLAB. The aim of this paper is to analyze the performance of different classification techniques for a set of large data. A fundamental review on the selected techniques is presented for introduction purpose. The diabetes data with a total instance of 768 and 9 attributes (8 for input and 1 for output) are used to test and justify the differences between the classification methods. Subsequently, the classification technique that has the potential to significantly improve the common or conventional methods will be suggested for use in large scale data, bioinformatics or other general applications [22].

Motka, Rakesh, Viral Parmarl, Balbindra Kumar, and A. R. Verma. "Diabetes mellitus forecast using different data mining techniques", 2013.

In this paper with the improvements in expert systems and ML tools, the effects of these innovations are entering to more application domains day-by-day and medical field is one of them. Decision-making in medical field can sometimes be a trouble. Classification systems that are used in medical decision-making provide medical data to be examined in shorter time and in a more detailed manner. In this paper, four different approaches have been proposed for the classification of subjects into two classes namely: Diabetic & Non-diabetic. The techniques undertaken are ANFIS, PCA + ANFIS, Neural Networks & PCA + Neural Networks. The results obtained are very interesting and show improvement from the previous works. There is enough scope for improvement in this field and with the advent of faster and more accurate learning techniques the results can surely be improved considerably. Again the application on live subjects rather than relying on stored datasets can lead to breakthrough research in the field of diabetes [23].

Hosseinpour, Najmeh, Iran Dezfoul, Saeed Setayeshi, Karim Ansari-asl, and Mohammad Mosleh. "Diabetes Diagnosis by Using Computational Intelligence Algorithms." 2012.

Diabetes mellitus is a chronic disease and one of the most public health challenges in worldwide. Most of discoveries indicate that the best way to overcome diabetes is to prevent the risks of diabetes before becoming a diabetic. Data mining techniques could be used as an alternative way in discovering knowledge from the patient medical records and they have shown remarkable success in the area of applying Computer Aided Diagnostic (CAD) systems. This paper applied several intelligence classifiers such as Bayesian, Functional, Rule-base, Decision Trees and Ensemble for diagnosing diabetes mellitus. Experimental results on Pima Indian Diabetes (PID) dataset show that bagging ensemble classifier with Logistic core has better performance in comparison with other presented classifiers [24].

K. Rajesh, V. Sangeetha, "Application of Data Mining Methods and Techniques for Diabetes Diagnosis", 2012.

Medical professionals need a reliable prediction methodology to diagnose Diabetes. Data mining is the process of analysing data from different perspectives and summarizing it into useful information. The main goal of data mining is to discover new patterns for the users and to interpret the data patterns to provide meaningful and useful information for the users. Data mining is applied to find useful patterns to help in the important tasks of medical diagnosis and treatment. This project aims for mining the relationship in Diabetes data for efficient classification. The data mining methods and techniques will be explored to identify the suitable methods and techniques for efficient classification of Diabetes dataset and in mining useful patterns [25].

Sonu Kumari, Archana Singh, "A Data Mining Approach for the Diagnosis of Diabetes Mellitus", 2012.

The aim of this paper is to propose an intelligent and effective methodology for the automated detection of Diabetes Mellitus. This methodology is based on Neural Network. There have been many computerized methods to diagnose Diabetes Mellitus but the drawback of all these methods is that patient still has to undergo various medical tests to provide the input values to the computerized diagnostic system and the overall cost for diagnosis will remain almost same for the patient but in this proposed model user itself sitting from home can diagnose whether he/she is suffering from Diabetes

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Mellitus or not. There is only need to provide some physical parameter values and on the basis of provided information's our model will detect whether that person is suffering from Diabetes Mellitus or not. This paper used Neural Network for designing and testing [9].

Sa-ngasoongsong, Akkarapol, and Jongsawas Chongwatpol. "An Analysis of Diabetes Risk Factors Using Data Mining Approach." 2012.

Preventing the disease of diabetes is an ongoing area of interest to the healthcare community. Although many studies employ several data mining techniques to assess the leading causes of diabetes, only small sets of clinical risk factors are considered. Consequently, not only many potentially important variables such as pre-diabetes health conditions are neglected in their analysis, but the results produced by such techniques may not represent relevant risk factors and pattern recognition of diabetes appropriately. This paper categorize the analysis into three different focuses based on the patients' healthcare costs. It examine whether more complex analytical models sing several data mining techniques in SAS® Enterprise Miner™ 7.1 can better predict and explain the causes of increasing diabetes in adult patients in each cost category. The preliminary analysis shows that high blood pressure, age, cholesterol, adult BMI, total income, sex, heart attack, marital status, dental checkup, and asthma diagnosis are among the key risk factors [26].

Barakat, Nahla, Andrew P. Bradley, and Mohamed Nabil H. Barakat. "Intelligible support vector machines for diagnosis of diabetes mellitus." 2010.

This paper utilizes Support Vector Machines (SVMs) for the diagnosis of diabetes. In particular, this paper use an additional explanation module which turns the "black box" model of an SVM into an intelligible representation of the SVM's diagnostic (classification) decision. Results on a real life diabetes data set show that intelligible SVMs provide a promising tool for the prediction of diabetes where a comprehensible rule set have been generated, with prediction accuracy of 94%, sensitivity of 93% and specificity of 94% . Furthermore, the extracted rules are medically sound and agree with the outcome of relevant medical studies [27].

Venkatesan, P., and S. Anitha. "Application of a radial basis function neural network for diagnosis of diabetes mellitus." 2006.

In this article an attempt is made to study the applicability of a general purpose, supervised feed forward neural network with one hidden layer, namely. Radial Basis Function (RBF) neural network. It uses relatively smaller number of locally tuned units and is adaptive in nature. RBFs are suitable for pattern recognition and classification. Performance of the RBF neural network was also compared with the most commonly used multilayer perceptron network model and the classical logistic regression. Diabetes database was used for empirical comparisons and the results show that RBF network performs better than other models [28].

Breault, Joseph L., Colin R. Goodall, and Peter J. Fos. "Data mining a diabetic data warehouse." 2002.

The diabetic data warehouse is from a large integrated health care system in the New Orleans area with 30,383 diabetic patients [29]. Methods for translating a complex relational database with time series and sequencing information to a flat file suitable for data mining are challenging. This paper discusses two variables in detail, a comorbidity index and the HgbA1c, a measure of glycemic control related to outcomes. We used the classification tree approach in Classification and Regression Trees (CART®) with a binary target variable of HgbA1c > 9.5 and 10 predictors: age, sex, emergency department visits, office visits, comorbidity index, dyslipidemia, hypertension, cardiovascular disease, retinopathy, end stage renal disease. Unexpectedly, the most important variable associated with bad glycemic control is younger age, not the comorbiditity index or whether patients have related diseases. If we want to target diabetics with bad HgbA1c values, the odds of finding them is 3.2 times as high in those < 65.6 years old than those older. Data mining can discover novel associations that are useful to clinicians and administrators [29].

IV. CONCLUSION

Data mining and machine learning algorithms in the medical field extracts distinctive concealed patterns from the medical data. They can be utilized for the examination of vital clinical parameters, expectation of different diseases, estimating assignments in pharmaceutical, extraction of medical knowledge, treatment planning support and patient administration. Various algorithms are present in literature for the prediction and finding of diabetes. These techniques give more precision than the accessible conventional frameworks.

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