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Diabetic Disease Prediction Using Machine Learning Algorithm

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Abstract: Diabetes leads to health problems for hundreds of millions of people globally every year. Available medical records of patients quantify symptoms, body features, and clinical laboratory test values, which can be used to perform biostatistics analysis aimed at Ending patterns or features undetectable by current practice. In this work, we proposed a machine learning model to predict the early onset of diabetes patients. It is a novel wrapper-based feature selection utilizing Grey Wolf Optimization (GWO) and an Adaptive Particle Swam Optimization (APSO) to optimize the Multilayer Perceptron (MLP) to reduce the number of required input attributes. Moreover, we also compared the results achieved using this method and several conventional machine learning algorithms approaches such as Support Vector Machine (SVM), Decision Tree (DT), K-Nearest Neighbor (KNN), Naïve Bayesian Classifier (NBC), Random Forest Classifier (RFC), Logistic Regression (LR). Computational results of our proposed method show not only that much fewer features are needed, but also higher prediction accuracy can be achieved (96% for GWO - MLP and 97% for APGWO - MLP). This work has the potential to be applicable to clinical practice and become a supporting tool for doctors/physicians.

Keywords: K-Nearest Neighbor (KNN), Naïve Bayesian Classifier (NBC), Random Forest Classifier (RFC).

1. Introduction

The postprandial glycemic response (PPGR) is an important characteristic of blood glucose (BG) control effectiveness and glucose metabolism in patients with all types of diabetes. Clinical trials have shown the importance of The associate editor coordinating the review of this manuscript and approving it for publication was Donato Impedovo . controlling one's blood glucose level after meals within the normal range. Diabetic pregnancy, despite the improved metabolic control, is still a strong risk factor for alterations in fetal development and keeping fasting glucose levels in range can contribute to decreasing number of fetal malformations. Machine Learning Approach for Postprandial BG Prediction in Gestational Diabetes Mellitus learning algorithms and different sets of input data. Feed forward neural networks, combinations of physiology-based models and machine learning techniques, recurrent neural networks and support vector machines appear to be the most frequently used algorithms for blood glucose prediction. With the same data, in a direct comparison with other models, gradient boosting tends to show the most precise results. Although different input parameters that might be for blood glucose prediction models were comprehensively discussed, specific data preprocessing, feature engineering and model tuning steps were not explained in detail in many of these papers. There is also a lack of studies on gestational diabetes mellitus (GDM) and pregnant women in general. The aim of this study was to develop a PPGR prediction model based on data collected from GDM patients that can also be utilized as a main component of a mobile-based recommender system. Diabetes is one of the world's largest ongoing chronic metabolic disorders. There are two types of diabetes, Type-1, and Type-2. **[1].** (2020) The authors EVGENII A. PUSTOZEROV, said that, this subject

has recently attracted a lot of interest, leading to numerous study initiatives and academic papers. Despite the fact that numerous input variables that might be useful for blood glucose prediction models were carefully considered. In this work, we developed and comprehensively described a data-driven blood glucose model.

[2]. (2022) The authors Usama Ahmed and said that, to prevent diseases, early disease prediction is crucial in the medical field. One of the most dangerous diseases in the world is diabetes. Our dietary habits in modern lifestyles are usually high in sugar and fat, which has raised the risk of diabetes. It is exceedingly difficult to predict the disease.

[3]. (2021) The authors Farrukh Aslam Khan said that, For the detection, prediction, and classification of diabetes, numerous techniques have been created. In this paper, we give a thorough analysis of the state-of-the-art in the field of data mining-based diabetes diagnosis and prediction. First, we examine and research data mining-based diagnosis and prediction solutions in the area of glycemic control for diabetes. This is the first of two goals for this paper.Bogdan Walek, Petra Spackova, published the paper (Content-based recommender system for online stores using expert system) in the year of 2018. This paper said an algorithm that modifies material according to user preferences and the stuff they have watched. To propose and provide is the recommender system's primary objective appropriate content for the user.

[4]. (2020) The authors Lifeng Qiao said that, Diabetic retinopathy (DR) is caused by elevated blood glucose levels for an extended period of time, which causes microvascular problems and temporary vision loss. The development of microaneurysms and macular edoema in the retina is the first indication of DR, and early detection can decrease the risk of non-proliferated diabetic retinopathy. Deep learning is rapidly improving, and it is steadily becoming an efficient method for providing an interesting answer to medical image analysis issues.

[5]. (2021) The authors Xiaokang Liang said that, Diabetic foot (DF) therapy depend primarily on physician monitoring and laboratory tests, which have significant constraints, such as the high expense of detection and the high demands on clinicians' professional skills. Currently, research on DF prediction has primarily concentrated on clinical data regression analysis and skin identification based on foot ulcers. In light of this, we analyse the patients' fundus pictures to investigate an efficient method for DF prediction. We suggested a DF prediction algorithm.

2. Concepts of diabetic disease prediction:

The system damages pancreatic Beta cells, Type-1diabetes transpires inside the body, which leads to the release a tiny amount of insulin or no insulin. Type-2 diabetes is an autoimmune disease in which cells of the body fail to interact with insulin, or the pancreatic cells do not produce enough insulin to regulate blood glucose levels. An insufficient amount of insulin causes the blood glucose levels to rise and the metabolism of carbohydrates, fats, and proteins to weaken, resulting in Type-1 diabetes. Diabetes symptoms include (i) Polyuria The associate editor coordinating the review of this manuscript and approving it for publication was Baozhen Yao .(ii) Polydipsia (iii) Weakness (iv) Polyphagia (v) Obesity (vi) Sudden-Weight-Loss (vii) Genital-Thrush (viii) Visual Blurring (ix) Itching (x) Irritability (xi) Delayed-Healing (xii) Partial-Paresis (xiii) Muscle-Stiffness (xiv) Alopecia, etc. Diabetes is a metabolic disease and which causes millions of deaths around the world yearly due to various health complications. An increase of 70% death ratio from diabetes has been observed between 2000 to 2019 in all over the world. An intelligent ML-based diagnostic system is required to detect these types of fatal diseases. An ML-based expert decision system can successfully diagnose diabetes patients at an early stage. Researchers used various different types of datasets for the prediction of diabetes. ML based framework need an appropriate dataset having necessary features for training, and validation. Prediction of Diabetes Empowered with Fused Machine Learning dataset increases the abilities of the ML model to predict accurately. Preventive measures against malnutrition or obesity that are sometimes primary causes of diabetes include healthy diet and change of lifestyle. Furthermore, these measures help to control the blood pressure, and lower the risk of health complications. Medical checkup makes it easier to diagnose the disease of diabetes. Some laboratory tests are also conducted to detect the disease. Type-2 DM patients need life-saving insulin for as long as they stay alive. Thus, if left unaddressed, this unhealthy condition drains individuals, families, and national resources. Early detection and symptomatic treatment are essential to ensure the healthy life and well-being of pre-diabetic patients. An intelligent medical diagnosis system based on symptoms, signs, laboratory tests, and observations will be helpful in disease detection and prevention. Artificial Intelligence (AI) has also been applied to medical diagnosis systems in several interesting ways for disease detection. This research proposes a framework for early detection of diabetic patients using machine learning fusion. Diabetes is a chronic and non-communicable disease that destabilizes the normal control of blood glucose concentration in the body. The blood glucose concentration is usually regulated by two hormones, namely insulin and glucagon, which are secreted by beta and alpha cells of pancreas respectively. The normal secretion of both hormones sustains normal blood glucose concentrations in the

body, which are in the range of 70 _ 180 mg/dl (4.0 _ 7.8mmol/L). Insulin decreases the level of glucose concentration, whereas glucagon increases it. However, abnormal secretion of these hormones leads to diabetes. There are a number of different types of diabetes with different prevalence; however, the most common types are type 1 diabetes, type 2 diabetes, and gestational diabetes mellitus (GDM). Type 1 diabetes commonly develops in children; type 2 diabetes is more prevalent in the middle-aged and elderly persons, while GDM appears in women and is diagnosed during pregnancy. In type 1 diabetes, the secretion of insulin fails due to the destruction of pancreatic beta cells, whereas in type 2, failures occur in both insulin secretion and action. GDM is a condition of glucose intolerance of any degree that is recognized during pregnancy; mainly, it occurs in the second half of pregnancy. It can be mild, but it can also be associated with considerable hyperglycemia and high insulin requirements during pregnancy. All of these types result in unbalanced blood glucose concentration in the human body, which leads to severe health conditions in the body. Consequently, when the blood glucose concentration increases and exceeds the normal concentration range, then this condition is known as hyperglycemia. On the other hand, when it decreases and becomes lower than the normal range, then such a condition is known as hypoglycemia. Both of these conditions can lead to adverse consequences on an individual's health, for instance, hyperglycemia has long-term complications and can cause nephropathy, retinopathy, cardiovascular and heart diseases, and other tissue injuries, whereas hypoglycemia has short-term effects that may result in life-threatening diabetic coma . Diabetes has become one of the major public health problems in today's world due to its prevalence in children as well as in the adult population. According to, approximately 8.8% of the adult population was diabetic worldwide during 2015, which counts for around 415 million people, and is expected to reach around 642 million by 2040. In addition, the disease has affected more than half a million children during this period and has caused about 5 million deaths. On the other hand, in 2015, the estimated global economic burden of diabetes was nearly USD 673 billion, which is projected to be around USD 802 billion in 2040. Self-monitoring of blood glucose (SMBG) using blood samples is a common approach of diabetes therapy that has been introduced three decades ago. In this approach, diabetics measure their blood glucose levels three to four times a day in an invasive way by pricking the skin of their using glucose meters. The notion here is to collect blood glucose concentration levels at different times, and accordingly, adjust the insulin intake, diet, and exercise in order to maintain normal glucose levels.

Nevertheless, this method is not only troublesome and painful but can also be misleading if the approximation of inulin intake is made based on merely few SMBG samples. Consequently, this could result in plasma glycemic levels to exceed the normal range. To overcome this problem, continuous glucose monitoring (CGM) has been introduced that provides maximal information about variations in blood glucose concentration throughout the day and enables optimal therapy decisions for diabetic patients. In this approach, the blood glucose concentration is continuously monitored through small wearable devices/systems, which track the glucose concentration levels in the blood round the clock. Such systems could be invasive, minimal-invasive, or noninvasive. Moreover, the CGM systems can be classified into two types: retrospective systems and real-time systems. The introduction and availability of a variety of innovative CGM devices/systems open new opportunities for diabetic patients to manage glycemic control with ease. Most of the modern CGM devices normally compute and record the current glycemic state of a patient every minute through continuous measurement of interstitial (ISF) by adopting a minimally invasive mechanism. These systems/devices are minimally invasive, since they compromise the skin barrier but do not puncture any blood vessels. Besides, there are non-invasive methods, for instance, measuring blood glucose concentration by applying electromagnetic radiation through the skin to the blood vessels in the body. Moreover, the emergence of e-Health in the form of telemedicine not only enables the physicians to observe the patients remotely and regularly, but also transmits the CGM data to the remote database in the hospital, which could be used to forecast critical events in the glycemic control such as hypo/hyperglycemia. One of the challenges in diabetes management is the prevention of hypo/hyperglycemia events, which could be overcome by accurately forecasting the blood glucose concentration from the CGM/SMBG and related (i.e., exercise, food intake, insulin intake, etc.) data. Thus, the development of tools for the processing and interpretation of CGM/SMBG and diabetes related data for future glucose values is crucial. To this end, data mining plays an important role in the development of such tools for the diagnosis and prediction of diabetes. Data mining is a process of extracting valuable information from a large volume of data in order to discover previously unknown trends, patterns, and relationships that could be used to build models for prediction. In the literature, different data mining based glucose forecasting approaches and methods have been developed based on various models. These techniques extract, analyze, and interpret the available diabetes data in order to make clinical decisions. A generic framework of such techniques. In this paper, we present a state-of-the-art review in the of glycemic control concerning the diabetes diagnosis and prediction using data mining. We classify the commonly used data mining based solutions for diabetes diagnosis and prediction based on the

underlying model used. Moreover, we compare them based on key parameters and metrics. Finally, we point out the challenges that need to be addressed and future research directions in the area. The main causing of visual loss in the world is diabetic retinopathy. In the initial stages of his disease, the retinal microvasculature is affected by several abnormalities in the eye undus such as the icroaneurysms and/or dot hemorrhages, vascular hyper permeability signs, xudates, and capillary closures. Microaneurysm dynamics primarily increase the risk that the laser photocoagulation requires progression to the level. Diabetic retinopathy lesions are commonly accepted to be reversed and the progression of the retinopathy can only be slower during the early stages of the disease. The identi_cation by repeated examination of patients affected of these initial lesions (mainly Microaneurysms and small blood cells) is expected as a newpossibility of improving retinopathy treatment. Floating and ashes, blurred vision, and loss of sudden vision can be common symptoms of diabetic retinopathy. Early detection and treatment of DR are very important because it is a progressive disease and its severity depends on the number and types of lesions in the fundus image The main components of a healthy retina are blood vessels, opticdiscs, and macula, and any ariations in these components are symptoms of eye disease. DR is divided widely into two levels: DR (PDR) proliferative and DR (NPDR) nonproliferative. NPDR, referred to as the Diabetic Retinopathy background occurs when the blood vessels inside of the retina are weakened by diabetes, causing blood leakage and _uidon the retinal surface. This leak reduces the sensitivity of the retina when wet and swollen. NPDR may include multiple retinopathic signs like hemorrhages(H) microaneurysms, cotton wool (CWS) or soft exudates, hard exudates (HE). Besides, NPDR is divided into three phases: mild, moderate and extreme, depending upon the occurrence and number of these lesions. MAs are the _rst signs of NPDR and are caused by focal thin blood vessel dilation. Tiny, nearly round-shaped and red-colored MAs. The following symbol is H, known as the dot or blot H. If the wall is excessively weakened with thin vessels or MAs, it can break and release. Dot bleeding looks like bright red spots and blot bleeding is bigger red hemorrhages. The hemorrhages and MA are sometimes considered to be one red lesion class recognized by HMA. shows the Enlarged regions containing MAs. In this paper, Microaneurysm quanti_cation is not currently being applied in clinical practice, because of variability in detection and problems associated with angiography withuorescein inter-and intra-observer. Semantic segmentation of the medical image is the automated or semiautomatic method of identi_cation of boundaries in 2D or 3Dimages. Image segmentation is a method for dividing a particular image into relevant regions with standardized features. A variety of attempts has been made to produce algorithms to automatically classify and track microaneurysms in the ocular fundus to resolve this variability. Deep Convolutional Neural Networks (DCNNs), a deep learning branch has impressive data on image analysis and interpretation applications, including medical imaging. Currently, large CNNs can successfully perform highly complex image recognition tasks with an outstanding norm for many object classes. In many typical image-classi_cation projects, CNNs, like the annual ImageNet, are used. The major involvement of this paper is, To propose the Prognosis of Microaneurysm and early diagnosis system for non - proliferative diabetic retinopathy (PMNPDR) utilizing a deep convolutional neural network for semantic segmentation of fundus images which can increase the eficiency and accuracy of NPDR. Maximum matching _lter response (MFR) mutual information (MI) and maximum Gaussian answer laplacian (LoG) in the 2-dimension function space utilizing Differential Evolution which, has not been previously explored in the detection of lesions._ The experimental results have been performed based on the datasets The rest of this paper decorated as follows: Section 1 and Section 2 discussed the background and existing method of DR disease identi_cation. In section 3 the Prognosis of Microaneurysm and early diagnosis system for non-roliferative diabetic retinopathy (PMNPDR) has beenproposed. The main causing of visual loss in the world is diabetic retinopathy. In the initial stages of his disease, the retinal microvasculature is affected by several abnormalities in the eye undus such as the icroaneurysms and/or dot hemorrhages, vascular hyper permeability signs, xudates, and capillary closures. 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In 2012, the number of deaths directly caused by diabetes was 1.5 million, ranking it in the top eight causes of death and the top ve among women. Diabetes has become The associate editor coordinating the review of this manuscript and approving it for publication was Alessandra Bertoldo. one of the major causes of death, disability, and shortened life. The real horror of diabetes lies not in itself but in a series of related complications, such as diabetic retinopathy, diabetic nephropathy, and diabetic foot (DF), which is the main cause of amputation in diabetic patients. DF is a common chronic complication in type 2 diabetes, which is mainly caused by the destruction of vascular endings and neuropathy, resulting in infection or ulcer of the lower limbs, or even amputation if treatment is not timely. Bi Y's study showed that the average prevalence of DF in the world was 6.3%. The prevalence rate in North America was 13%, ranking rst, and that in Africa was 7.2%, ranking second. Asia and Europe were ranked third and fourth with Automatic DF Prediction Through Fundus Images by Radiomics Features 5.5% and 5.1%, respectively. Australia had the lowest incidence, only 3%. The current clinical examination methods for DF mainly include neurologic examination, vascular examination, and foot pressure examination, but these methods involve tedious steps and strict requirements for the examiners. A simple and efcient inspection method is urgently needed. In recent years, radiomics, with its extraction and analysis of hidden information in medical images, has helped researchers make signicant achievements in various elds of medical imaging, especially tumor research. Radiomics refers to the high ux to extract the image features of a region of interest (ROI) in great quantities, to help researchers in the data mining of medical images; this data can be recognized by machine learning algorithms, so as to help doctors diagnose patients, assess the stages of cancer, determine the best treatment more accurately, and reduce the burden on doctors, adiomics mainly consists of four steps, namely dividing the ROIs, extracting the features of the ROIs, selecting and reducing the dimensions of the features extracted, and establishing a model to complete the prediction or class cation of diseases. Compared with traditional clinical examination methods, computer-aided diagnosis technology is known as the doctor's ``third eye'' due to its noninvasive nature, high efficiency, and accuracy, which plays a crucial role in the diagnosis and recognition of many diseases. How to use machine learning algorithms for the data mining of massive raw data remains a current research hot spot. As a comprehensive data mining method, ensemble learning has made great achievements in opinion mining, text mining, web mining, and medical information mining. The main idea is to construct a better and more comprehensive model by comprehensively considering the results of various feature selection algorithms or classifer algorithms. Inspired by the idea of ensemble learning, we separate the features into two steps and get better results than the single basic algorithm. Fundus imaging is crucial to medical imaging research. Since the blood vessels in the fundus re the only blood vessels that can be observed directly from the body surface, doctors

can check whether there are lesions in the optic nerve and retina of the fundus by analyzing the fundus images. For the fundus examination of diabetic patients, current studies mainly focused on the automatic recognition and classication of diabetic retinopathy, while another complication of diabetes, DF, has not been reported. In view of this research status, we proposed an automatic prediction model for fundus images of DF patients based on radiomics features. The main contributions of this paper are as follows to our best knowledge, this is the rst time that DF has been determined by an automated analysis through fundus images, with encouraging results. It can be used as an effective way to nd potential DF patients. Main process of the proposed method I On the basis of the four commonly used gray-scale matrix features, we added a total of eight categories of feature descriptors, which greatly enriched the extracted information. At the same time, compared with the case that used only the four gray-scale matrix features, the newly added features can play a role in assisting the classication and improving the prediction performance.

3. Methodology

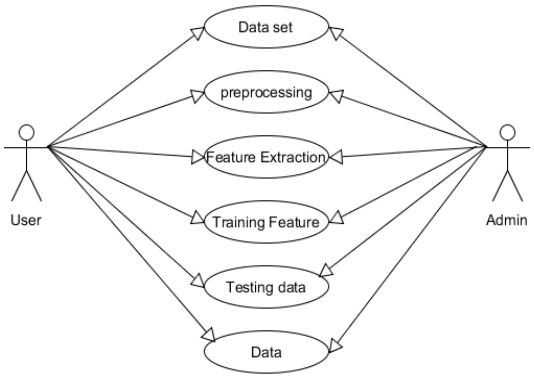

Fig 1. Overall Architecture

4. Conclusion

In Diabetes is a slow killer with no known curable treatments. However, its complications can be reduced through proper awareness and timely treatment. Three major complications are related to blindness, kidney damage and heart attack. It is important to keep the blood glucose levels of patients under strict control for avoiding the complications. One of the difficulties with tight control of glucose levels in the blood is that such attempts may lead to hypoglycemia that creates much severe complications than an increased level of blood glucose. Researchers now look for alternative methods for diabetes treatment. The goal of this paper is to give a general idea of the current status of diabetes research. The author believes that diabetes is one of the highly demanding research topics of the new century and wants to encourage new researchers to take up the challenges

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