

Early Detection of Diabetic Retinopathy Using Ensemble Learning Approach

Mehrbakhsh Nilashi^{a,*}, Sarminah Samad^b, Elaheh Yadegaridehkordi^c, Azar Alizadeh^d, Elnaz Akbari^e, Othman Ibrahim^a

^a School of Computing, Faculty of Engineering, Universiti Teknologi Malaysia, 81310, UTM, Johor Bahru, Johor, Malaysia

^b CBA Research Centre, Department of Business Administration, Collage of Business and Administration, Princess Nourah Bint Abdulrahman University, Saudi Arabia

^c Department of Information Systems, Faculty of Computer Science & Information Technology, University of Malaya, 50603, Kuala Lumpur, Malaysia

^d School of Engineering, University of California, Merced, USA

^e Faculty of Electrical & Electronics Engineering, Ton Duc Thang University, Ho Chi Minh City, Viet Nam

* Corresponding authors email addresses: nilashidotnet@hotmail.com

Abstract

Diabetes has been one of the leading health problems in all over the world. Diabetic retinopathy is the most common retinal vascular disease. Supervised data mining techniques have been successful in detecting diabetic retinopathy through a set of datasets. However, the most methods developed by supervised methods do not support the ensemble learning of data. The aim of this paper is to take the advantages of ensemble learning and develop a new method for diabetic retinopathy using data mining techniques. We use Non-linear Iterative Partial Least Squares for data dimensionality reduction, Self-Organizing Map for clustering task and ANFIS ensemble to classify unlabeled retinal images with high accuracy. We evaluate our method on a publicly available Messidor dataset and present our results in comparison with the latest results of previous studies. For classification task, features of retinal images used for experimental analysis have been extracted by two algorithms, anatomical part recognition and lesion detection. The experimental analysis showed that the proposed method is robust in classifying the retinal images with Accuracy= 0.915, Sensitivity=0.946 and Specificity=0.917. The results of experimental analysis also demonstrated that our method performance is superior to Neural Network (NN), Adaptive Neuro-Fuzzy Inference Systems (ANFIS), Decision Trees (DT), K-Nearest Neighbor (KNN) and Support Vector Machine (SVM). The hybrid intelligent system has potential to assist medical practitioners in the healthcare practice for early detection of diabetic retinopathy.

Keywords: Healthcare, Early detection, Diabetic Retinopathy, NIPALS, SOM, Ensemble Learning

1. Introduction

Diabetes has been one of the leading health problems in all over the world. It has attained the dubious distinction of becoming the fifth leading cause of disease-related death (Hamburg et al., 1982). Diabetes is a chronic endocrine disorder affecting the body's metabolism and resulting in structural changes affecting the organs of the vascular system (Court, 1988; Egede, 2004). Generally, diabetes is characterized as existing in two major forms: (a) insulin-dependent (Type I) (Frandsen et al., 2016) and (b) noninsulin-dependent (Type II) (Kramer et al., 2013). The latter appears to be the more common, accounting for 80% of all cases (Hamburg et al., 1982). Diabetes mellitus will manifest The Pima are one of the most studied populations regarding diabetes, not only among American Indians, but in the world (Knowler et al., 1983). The most studied populations regarding diabetes is Pima, not only among American Indians, but in the world (Knowler et al., 1983).

The samples of studied populations regarding diabetes refer to discrete Type-2 positive and negative instances.

The only way for the diabetes patient to live with this disease is to keep the blood sugar as normal as possible without serious high or low blood sugars this is achieved when the patient uses a correct management (therapy) which may include diet and exercising, taking oral diabetes medication or using some form of insulin (Hamburg et al., 1982). On the other hand, treating the diabetes disease is also a difficult, an expensive and a complex task for the medical staff (Egede and Miohel, 2001). There are number of important things to record about the patient and disease that help the doctors to make an optimal decision about the patient to make his/her life better.

As a micro vascular complication of diabetes, diabetic retinopathy has been one of the most common retinal vascular diseases (Zhang et al., 2001). Diabetic retinopathy is the leading cause of blindness in the working population in most industrialized countries (Spaide and Fisher, 2006).