Disease Diagnosis using Soft Computing Model: A Digest

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ABSTRACT

In today's era, medical diagnosis has become one of the most progressive disciplines. Since people are taking hybrid food in the daily life, different disease came into existence. It made people very careful for their health. In some cases, lack of knowledge of disease in doctor causes the patient death. Therefore, we require such diagnosis system for non-expertise so that right prescription can come for the patient. Over the years, soft computing plays the major role for computer aided disease diagnosis in physician decision process. Considering these issues, a lot work has been devoted to this discipline. Several disease diagnosis systems based on fuzzy, rule based reasoning, case based reasoning etc. have been proposed for different disease using their symptoms. Hepatitis diagnosis system is good example which is based on CBR. In this paper, we reviewed such types of diagnosis system and their techniques used. We also emphasizes on the liver disease diagnosis system. Moreover, we also found shortcoming in the present systems that cause the vague diagnosis system. Hence, patient gets more illness or sometimes costs as death. We also directed future work that will help to make the present system more robust, reliable, and helpful for non-expertise.

Keywords

Soft computing, Disease Diagnosis, neural network, case based reasoning

1. INTRODUCTION

The feasibility and sustainability of a country's economic and social growth depend largely on a vibrant healthcare sector of that nation. A computerized medical diagnosis system can maintain a steady economic growth in the absence of an adequate healthcare system. Medical diagnosis depends on a vast degree it may take years for a physician, particularly a novel or junior one, to build up enough experiences. A physician's realistic experience cannot be inherited in coming generation. We need some diagnosis system that helps to store their experiences of years. Several disease diagnosis models have been proposed to help physicians compact with diagnostic problems. These diagnosis systems take care of all decision making process during which the findings of unusual and anonymous case from disorder clinical experience induced by the physician [5]. Recent developments of diagnosis system have set aside physician's decision by maintaining patient's medical histories to use in latest years. These patient histories associated with medical information can be gathered in large amount in databases for quick recovery, and study. In huge amount, statistical techniques are hired to model the diagnosis system due to complexity in accessing a substantial amount of medical data [2]. The emergence of information technology (IT) has opened unmatched opportunities in health care such as hepatitis, child delivery, malaria and other complex diseases as the demand for as technology enabled medical practices advance. Thus, there is a need to take care an easy and automatic procedure for diagnosis complex diseases to lessen the mortality rate.

In recent times, Artificial Intelligence (AI) techniques have expressively been used in medical applications. Research efforts have focused on medical diagnosis systems as complementary solution to the health care for tropical disease. These conventional techniques are used for finding solution to medical problems. Liver disease is one of top ten incurable diseases in World. Every organ in our body depend on the liver, this disease can be hindrance for our survival. Major role of liver is in metabolism and serving numerous functions e.g. decomposition of red blood cells etc. Inflammation or injured hepatocytes is main reason of liver disease [7]. Statistical tools and machine learning techniques are recently introduced to assist the liver disease diagnosis. Use of diagnosis system explored the faults of experts made in the course of diagnosis process. It assists to avoid them in other tropical diseases, and also examined in shorter time and more detailed too [8]. Hence, to examine huge and complex data, more efficient strategies are required. For example, data mining and soft computing methods may offer a constructive result.

2. WHY SOFT COMPUTING?

Over the years, soft computing plays the major role for computer aided disease diagnosis in physician decision process. Actually, the role model for soft computing is the human mind. The fundamental principle of soft computing is: bearing of inaccuracy, fuzziness, partial truth, and guesstimate to attain tractability, strength and low solution cost. Several methods of soft computing have been proposed for application to medical- related fields [3] over the former few decades. The soft computing based diagnosis system uses symptoms for identification of the disease. Symptoms may be clinical parameters like blood pressure, blood glucose, scanning reports etc. or linguistic expressions like nauseas, weakness, repulsion towards social gatherings etc. In proposed model, few selected attributes would be considered which are shown as symptoms by a person suspected with a particular disease. Those attributes can be taken as input for the proposed symptom analysis and classification model, which is a soft computing model for classifying a sample first to be diseased or disease free and then, if diseased, predicting its type (if any).

3. ANALYSIS OF SOFT COMPUTING METHODS BASED DIAGNOSIS SYSTEM

Over the past years, different types of soft computing methods have been used to deal with the diagnosis process. Some of the soft computing methods are Genetic Algorithms, Artificial Neural Networks, Fuzzy Sets, Rough Sets inductive logic programming Fractal Theory, Chaos Theory, Probability Theory, Possibility Theory, and Learning Theory. For medical diagnostic processes, artificial neural networks can be applied as one of the most famous techniques. Artificial neural networks have previously demonstrated its efficiency and popularity for the medical diagnostic processes with dissimilar existing applications worldwide [4]. On the basis of these soft computing, many diagnosis systems have been proposed that are dealing to a specific disease. Some of them, we explained as follows

3.1 Adaptive neuro-fuzzy inference system to diagnosis of diabetes disease [14]

Diabetes is one of the common diseases in human which is characterized due to lack of insulin in the body. Along with heart disease, it also becomes the cause of other diseases like kidney disease, blindness, nerve damage, and blood vessel damage. Adaptive neuro-fuzzy inference system (ANFIS) was proposed that diagnosed this daemon using principal component analysis (PCA). Basically, this system improved the accuracy of detecting diagnosis system by combining PCA and ANFIS. PCA is used to reduce the 8 features of the diabetes disease dataset to 4 features, and ANFIS is a classifier that diagnoses the diabetes more accurately. This study was validated over diabetes disease dataset of UCI Department of Information and Computer Science, University of California) Machine Learning Database, and gave classification accuracy of 89.47%. This classification accuracy was very promising as compared to other systems for this problem.

3.2 Diabetes Diagnosis using Feature Weighted Support Vector Machines based on Mutual Information and Modified Cuckoo Search [15]

This is 3 stages diabetes diagnosis system which works based on Mutual Information, Modified Cuckoo Search, Support Vector Machine (MI-MSC-SVM). In first stage, preprocessing of data is done with the help of principal component analysis (PCA) which is used for feature reduction. In this literature, Weighted Support Vector Machines was used to classify patients, and feature selection property of MI was used to reduce the diabetes dataset. In the second stage, Modified Cuckoo Search (MCS) is applied to find optimal tradeoff between margin maximization and error minimization and to build FWSVM based on their degree of importance. In last stage, data is chosen from the given dataset to train it by SVM. This remaining dataset is used to test the trained FWSVM. This proposed method was applied over the UCI dataset and gave 93.58% accuracy. Obtained experimental results exhibit that the proposed MI -MCS-FWSVM is giving better accuracy and significant classification speed than previous methods.

3.3 Thyroid disease diagnosis using neural networks [16]

Abnormalities due to thyroid disorder may lead to hypothyroidism or hyperthyroidism that causes the patient's death. This dysfunction of thyroid comes just because of too little and too much thyroid hormone. This disease cannot be underestimated as thyroid storm and myxedema coma. Proper classification of thyroid dataset has an important role in the diagnosis of this disorder. In this literature, a vast study of thyroid disease diagnose systems was investigated by using multilayer, probabilistic, and learning vector quantization neural networks. To analyze this promising work, dataset of thyroid was taken from UCI machine learning database. Analysis of this work exhbits that Neural network structures based methods are very useful to diagnosis thyroid disorder. Moreover, result exhibits that the methods based on probabilistic neural network classifies the thyroid disease more accurately, and the 3-fold and 10-fold cross-validation method give such generalization using neural networks that helps to see performance of neural networks for test dataset.

3.4 Thyroid disorder diagnosis using Bayesian-type and SOM-type neural networks [17]

In this literature, reanalysis of thyroid disorder diagnosis was done by multivariate analysis which used bayesian regularized neural network (BRNN) and self-organizing map (SOM). SOM gave the clusters based analysis that charaterized clusters according to laboratery tests, and obtained the clusters corresponding to hyperthyroid, hypothyroid and normal. Automatic relevance determination (ARD) method of BRNN classified more effective for all possible combiation of tests than BRRN without ARD. Conclusion is that proposed method predicts the more robust thyroid disorder diagnosis system.

3.5 Automated identification of diabetic type 2 subjects with and without neuropathy using wavelet transform on pedobarograph [10]

The major problem with diabetes is type-2 which comes due to abnormal plantar pressure in the pathologies of neuropathic ulcers. The purpose of this analysis was to investigate the plantar pressure distribution of diabetic Type-2 with and without neuropathy by wavelet transform. Discrete wavelet transform (DWT) was used to extract the foot scan parameter that were obtained from F-scan (Tekscan USA) pressure measurement system. After extraction, classification was done using Gaussian mixture model (GMM) and a four-layer feed forward neural network. This proposed method demonstrated a sensitivity of 100% and a specificity of more than 85% for the classifiers.

3.6 A cascade learning system for classification of diabetes disease: Generalized Discriminant Analysis and Least Square Support Vector Machine [11]

In this letrature, a combined approach of Generalized Discriminant Analysis (GDA) and Least Square Support Vector Machine (LS-SVM) was used to diagnose the diabetes dataset. This proposed method used GDA for pre-processing to extract the healthy and diabetes patient feature from the dataset and LS-SVM was used to classify the diabetes dataset. This proposed study gave 82.05% classification accuracy using 10-fold cross validation which was 3.84% more accurate than LS-SVM. The obtained classification accuracy is 82.05% and it is very promising compared to the previously reported classification techniques.

3.7 Comparison between statistical and fuzzy approaches for improving diagnostic decision making in patients with chronic nasal symptom [12]

This proposed study investigated the fuzzy model and the logistic regression model for improving diagnosis decision making in patients with chronic nasal symptom. Dataset was obtained from a questionnaire administered to 13-59 patients with nasal symptoms. Evaluation of fuzzy and statistical approaches were validated using this dataset. The result predicted that the accuracy of both was similar in identifying patients with positive or negative skin prick test (SPT). This preliminary step of computer aided diagnosis system make the doctor to take the strong diagnostic decision for primary care of chronic nasal symptom.

3.8 A Simple Bayesian Network for Tuberculosis Detection [13]

Tuberculosis is one of the major in factitious disease that requires early diagnosis to prevent the other it's infections. In this proposed work, a simple Bayesian network for detecting pulmonary tuberculosis was developed. The network was developed with Hugin Expert, a development environment for Bayesian network construction. The network consists of 19 Boolean-valued nodes with five groups: demographics, clinical findings, radiological findings, laboratory and medications. The conditional probability tables (CPTs) for each node according to a literature review was estimated with consultation of 2 board certified internists and specifically parameterized the structure and CPTs to exclude HIV infected patients. The reason for excluding HIV infected patients in the network was the lack of knowledge, expert or literature-based, to parameterize the CPT of the “tuberculosis” node when conditioned on HIV status.

3.9 A Clinical Decision Support System for Diagnosis of Hearing Loss [18]

A decision support system (DSS) was developed to support doctor's decision-making in diagnosing hearing loss. The final diagnosis encompassed 41 diseases with the problem of hearing loss. The system was developed by integrating model-oriented DSS technique and artificial intelligence technology. The system can be used as both diagnosis tool and teaching tool for medical students. Furthermore, the Al technology obtained from this study may also be used in developing DSS for hospital management.

3.10 Clinical decision support system (DSS) in the diagnosis of malaria [19]

The purpose of this study is to make the case for the utility of decision support systems (DSS) in the diagnosis of malaria and to conduct a case comparison of the effectiveness of the fuzzy and the AHP methodologies in the medical diagnosis of malaria, in order to provide a framework for determining the appropriate kernel in a fuzzy–AHP hybrid system. The combination of inadequate expertise and sometimes the vague symptomatology that characterizes malaria, exponentially increase the morbidity and mortality rates of malaria. The task of arriving at an accurate medical diagnosis may sometimes become very complex and unwieldy. The challenge therefore for physicians who have limited experience investigating, diagnosing, and managing such conditions is how to make sense of these confusing symptoms in order to facilitate accurate diagnosis in a timely manner. The study was designed on a working hypothesis that assumed a significant difference between these two systems in terms of effectiveness and accuracy in diagnosing malaria. Diagnostic data from 30 patients with confirmed diagnosis of malaria were evaluated independently using the AHP and the fuzzy methodologies. Results were later compared with the diagnostic conclusions of medical experts. The results of the study show that the fuzzy logic and the AHP system can successfully be employed in designing expert computer based diagnostic system to be used to assist non-expert physicians in the diagnosis of malaria. However, fuzzy logic proved to be slightly better than the AHP, but with non-significant statistical difference in performance.

Likewise, recent development in diagnosis systems is showing that several tropical diseases are also still lacking. It needs to be incorporated them in the present diagnosis systems.

4. METHODOLOGY USED IN THE EXISTING SYSTEM

4.1 Knowledge Discovery in Databases

Knowledge Discovery [14], [15] in Databases is the process of identifying a valid, potentially useful and ultimately understandable structure in data. It involves selecting or sampling data from a data warehouse, cleaning or preprocessing it, transforming or reducing it, applying a data mining component to produce and evaluate a structure.

4.2 Basic Rough Sets

Let U be a universe of discourse, which cannot be empty and R be an equivalence relation or indiscernibility relation [13], [16], [19] over U. By U/R we denote the family of all equivalence class of R, referred to as categories or concepts of R and the equivalence class of an element x U is denoted by [x] R. By a knowledge base, we understand a relational system k = (U, R), when U is as above and R is a family of equivalence relation or indiscernibility relation over U and k is called an approximation space. Elementary sets in k are the equivalence classes of R and any definable set in k is a finite union of elementary sets in k.

Therefore for any given approximation space defined on some universe U and having a n equivalence relation R imposed on it, U is partitioned into equivalence classes called elementary sets which may be used to define other sets in k; Given that X Î U, X can be defined in terms of definable sets in k by the following

Lower approximation of X in A is the set

R*X = ı{Y U | R: Y ı X}

Upper approximation of X in A is the set

R*X = ı{Y U | R: Y ı X }

4.3 Rule Induction

The one of the most important techniques of machine learning is the Rule induction [12], [18]. Using rules the Regularities hidden in data are frequently expressed and the fundamental techniques of data mining is the rule induction . Generally the rule are used in the following form

If (attribute1, value1) and (attribute2, value2) and (attributen, valuen) then (decision, value)

Data from which rules are induced are usually presented in a form similar to a table in which cases (or examples) are labels (or names) for rows and variables are labeled as attributes and a decision where Attributes are independent variables and the decision is a dependent variable. The set of all cases labeled by the same decision value is called a concept.

4.4 Classification

Extracting comprehensible classification rules is the most emphasized concept in data mining researches. In order to obtain accurate and comprehensible classification rules from data bases, a new approach was attempted on combining advantages of artificial neural networks and swarm intelligence [1]. Artificial neural networks are a group of very powerful tools applied to prediction, classification and clustering in different domains. The main disadvantage of this general purpose tool is the difficulties in its interpretability and comprehensibility. In order to eliminate these disadvantages, an approach was developed to uncover and decode the information hidden in the black box structure of support vector machines. Therefore, knowledge extraction from trained support vector machines for classification problems is carried out. This approach makes use of particle swarm optimization (PSO) algorithm to transform the behaviors of trained support vector machines into accurate and comprehensible classification rules. The weights hidden in trained support vector machines a novel improvement in neural network training for pattern classification is presented in this paper. The proposed training algorithm is inspired by the biological plasticity property of neurons and Shannon's information theory. This algorithm applicable to artificial neural networks in general, although here it is applied to multilayer perceptions. During the training phase, the artificial met plasticity multilayer perceptron algorithm assigns higher values for updating the weights in the less frequent activations than in the more frequent ones. Applied multilayer perceptron algorithm achieves a more efficient training and improves multilayer perceptron performance [3].

4.5 Multiplier perceptron

We studied the efficiency of multilayer perceptron networks to classify eight different medical data sets with typical problems connected to their strongly non-uniform distributions between output classes and relatively small sizes of training sets. We studied especially the possibility mentioned in the literature of balancing a class distribution by artificially extending small classes of a data set. The results obtained supported our hypothesis that principally this does somewhat improve the classification accuracy of small classes, but is also inclined to impair the classification accuracy of majority classes [6].

4.6 Rule Extraction

The support vector machines were successfully applied to a wide range of applications in the recent years. However, since the classifier is described as a complex mathematical function, it is rather incomprehensible for humans. This opacity property prevents them from being used in many real-life applications where both accuracy and comprehensibility are required, such as medical diagnosis and credit risk evaluation. To overcome this limitation, rules can be extracted from the trained support vector machines that are interpretable by humans and keep as much of the accuracy of the support vector machines as possible. It provides an overview of the recently proposed rule extraction techniques for support vector machines and introduce two others taken from the artificial neural networks domain, being Trepan and G-REX. The described techniques are compared using publicly available datasets, such as Ripley's synthetic dataset and the multi-class iris dataset. The experiments show that the support vector machines rule extraction techniques lose only a small percentage in Performances compared to support vector machines and therefore rank at the top of comprehensible classification techniques [7].

5. SHORTCOMINGS

Despite a lot of research work has been devoted to this discipline, several short coming still exist.it needs attention to overcome below mentioned problems

- Vague symptomatology still exist in the present diagnosis system that is not able to characterize liver disease
- System is lacking statistical tools in the preprocessing of training data or symptoms which makes system too difficult to understand the non-expert physician.
- Regional and sessional wise symptoms of patient can vary accordingly on the basis of their diet .so system is lacking right prescription of liver disease.
- System is not able to use recommending properties of medical diagnosis in the case when the symptoms belong to multiple disease.
- Present liver disease diagnosis system is not adaptive and not able to use machine learning techniques like classification and clustering etc
- Response time is the major problem with these systems.
- Alone one type of soft computing techniques is not substantial, liver diagnosis system should use hybrid soft computing techniques so that robust diagnosis system can come in to existence

6. FUTURE DIRECTION

In our investigation, we found several diagnosis system have been proposed that are dealing to a specific disease so called mono-objective. System should be multi-objective that can work for more tropical diseases. Liver disease (LD) is a global public health problem. Cases of the disease caused by inflammation or damaged hepatocytes ranks among the top ten fatal diseases in the world. The design of an effective diagnosis model is therefore an important issue in LD treatment. Diagnosis system can further be explored in Neuro-fuzzy systems for pattern classification and rule generation. The rule generation can be done by various modified versions of different neural network architectures so as to handle fuzzy input, provide fuzzy output labels.

7. CONCLUSION

A lot of effort has been devoted to make the diagnosis system more responsive, robust, and user friendly for non-expertise. From literature review, we found some of the problems still exist in the proposed diagnosis systems that are mentioned in shortcomings. Vague symptomatology still exist in the present diagnosis system that is not able to characterize liver disease. System is lacking statistical tools in the preprocessing of training data or symptoms which makes system too difficult to understand the non-expert physician.

In spite of the advancement in the field of medical sciences, diagnosis of disease remains a challenging task. Liver disease in particular is not easily discovered at its initial stage; early diagnosis of this leading cause of morality is therefore highly important. As a part of the ongoing efforts to make diagnosis more effective, this study accordingly developed a two-phase intelligent diagnosis model aiming to provide a comprehensive analytic framework to raise the accuracy of liver diagnosis. In classification phase, MLP is employed to distinguish between healthy liver and diseased liver. In the concluding phase, Rule extraction is improved the accuracy.

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