MACHINE LEARNING APPROACHES FOR NURSES DECISION SUPPORT SYSTEM

Elizabeth Sony Thomas, Anju Pratap

Abstract: Cutting edge technologies lead to the early detection of diseases in the medical field. Now a day the main focus of health industry is to give high quality patient care. Some of the modern areas like clinical decision support system (CDSS) have been used by the clinicians to assist them for giving efficient patient care. This research work is focused on nurse practitioners for using such decision support systems. The initial stage of research carried out on two emergency situations that are handled by the nurses: Post Operative patient situation and Cardiac Arrhythmia. The identification of these conditions is very prevalent for the nurse practitioners in the absence of doctors. Cardiac arrhythmia can be diagnosed by taking ECG, usually identified by doctors. This paper introduces an approach for making suitable decision for nurses in the post operative ward and, also for interpreting the ECG signals for giving better care for the patients. The data set for the proposed work is taken from the UCI repository: postoperative data and cardiac arrhythmia. To build a decision support system, different machine learning techniques are used in this work. In order to take a better decision, the accuracy of desired model should be high so it is necessary to select the best feature from the existing attributes. This work compares the accuracy of the model for the postoperative datasets by using the classification machine learning algorithms like Random Forest, Linear Vector Quantization, Gradient Boosting Method algorithms, hence predict the best model.

Index Terms: Cardiac Arrhythmia, Decision Support System, Electrocardiography (ECG), Nurses, Postoperative

I. INTRODUCTION

Technology advancement has been growing faster for the few years. The main focus of health care industry is to give cost effective patient care; this can be given by adopting some latest technologies. In foreign countries, the clinicians use Clinical Decision Support System (CDSS) as an assistant for easy diagnosis and, also for giving better care to the patients.The role nurses in the hospital setting is very mandatory; sometimes they were forced to use this CDSS system to make some decisions in a particular context. Whenever an emergency situation occur in the hospital, most of the times nurses take advice from the doctors through telephone upon their absence. The problem of this scenario is, if there is any delay occurs for giving care for the patients in emergency, it causes serious issues or may leads to death. In the absentia of doctors, sometimes the nurses must take decisions. This work is mainly focused on nurse practitioners and to study the system referred Nurses Decision Support System (NDSS) for assisting the nurses in the hospital. At the initial stage of this research the authors are focusing only on two emergency situations in the hospital which can be handled by the nurse practitioners. The first one is the postoperative emergency situation. Postoperative care is given to the patients after their surgery. The time period of this care starts after the surgery up to the recovery of a patient. All these period, the nurses are taken care of the patient and note down their each relevant parameters like blood pressure, oxygen saturation, body temperature of the patients etc.. According to certain parameters, if any variations occur from the present condition the nurses suppose to take a decision like shifting the patient to ICU, shifting to general ward etc [1]. Arrhythmia is a disease condition, where early prediction is necessary. It is caused due to the irregularity in heart beats. Cardiac arrhythmia can be detected by taking ECG; from the ECG signals the clinicians can interpret the result. Based on certain symptoms we can predict if the person having which type of arrhythmic condition.This paper, aims to build Nurses Decision Support System to assist nurses. For this system the authors are considering only two emergency decisions like postoperative shifting and cardiac arrhythmia as the preliminary study. Various machine learning techniques are used to build the model.

This paper proceeds as follows: Section II describes the literature survey. Section III presents the methodology of the work. In section IV, the discussions and sample results are included. At last section V conclusion.

II. Literature Survey

Based on certain studies it is identified that, in any developing country the nurse practitioners did not use any type of decision support system. But the research studies done by other researchers during 2011 to 2017 identified certain barriers for nurse practitioners utilizing clinical decision support in the hospitals outside India [2]. Having the right information, including up-to-date evidence-based practice guidelines, accurate clinical pathways, and current clinical algorithms, was the most common barrier [2]. The list of barriers are indicated in TABLE 1.

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AUTHORS	BARRIERS
Smith and Colleagues, Eldredge, Stanik-Hutt[3],[4],[5]	Lack of knowledge about system, Lack of patients information
Ariosto's, Knoble and Bhusal[6],[7]	Unnecessary alerts/CDS alerts, Wrong CDS format
Oh and Colleagues, De Wit and Colleagues[8],[9]	Unsupported CDS algorithms, Unfavorable timing of CDS, Trust on manual input
Miller and Colleagues[10]	Problems in system software, Lack of interoperability

TABLE 1: Barriers of CDSS

2.1 Postoperative Emergency

Various data mining algorithms are used to classify many data sets and from the classification accuracy we choose the best one. Chinky Gera and colleague [1] did a research on applying data mining algorithms on medical data. They choose the dataset from the UCI repository named Postoperative data set. From the entire data set they identified that surface temperature is not necessary for taking the decision for the clinicians. They use six classification comparison technique named BayesNet, Logistics, Multilayer Perception, Decision Table, PART, J48. From all these techniques they got J48 as the best technique for classification accuracy comparison.

2.2 Cardiac Arrhythmia

Cardiac Arrhythmia is detected by taking ECG of patient. Interpretation of ECG signal is not an easy task. Many researchers did different study for the easy analysis of ECG signals.

The authors in [11], use a machine learning approach for the classification of arrhythmia dataset. To improve the accuracy of the model they used two approaches: principle component analysis for feature selection and bag of visual words for clustering. By using these approaches, they applied the data set on different classification algorithms. They got highest accuracy of 91.2% for the SVM classifier.

The authors in [12], use neural network with some features for the classification of cardiac arrhythmia. For the improved accuracy they used different feature selection techniques: correlation-based feature selection (CFS), incremental back propagation neural network (IBPLN) and Levenberg-Marquardt (LM). They got 87.71% accuracy for average of 100 simulations.

The authors in [13], uses unsupervised learning techniques like clustering and regression for predicting arrhythmia, DBSCAN algorithm and logistic regression technique is used for prediction. They got 80% of accuracy compared with different existing methods.

III. Methodology

A Nurses Decision Support System (NDSS) that helps to take decisions like preliminary diagnosis, treatment options, immediate actions etc. during certain emergency situations upon doctor's absentia. The Proposed methodology for doing this by machine learning approaches. The general objective of this work is to understand the need of a Nurses Decision Support System (NDSS) during doctors absentia, to make a NDSS using classification data mining technique as a preliminary study and, to improve the accuracy of NDSS using some classifier models like Linear Vector Quantization (LVQ), Random Forest (RF), Gradient Boosting Model (GBM).

3.1 Data Set

The data set are taken from the machine learning UCI Repository named Post Operative Data and Arrhythmia[15],[16],[17]. These are some of the emergency situation in the hospital were the nurse practitioners take the decision in the absence of doctor after the surgery of the patients. In postoperative situation certain factors with which a nurse can take the decision for the patients whether they may sent the patients to ICU or sent to general ward or sent to home. There are 90 instances in the post operative data set and also it consists of 8 attribute patient feature and one class label. The attribute features are: patient's core temperature in C, patient's surface temperature in C, oxygen saturation in %, last measurement of blood pressure, stability of patient's surface temperature, stability of patient's core temperature, stability of patient's blood pressure, patient's perceived comfort at discharge, measured as an integer between 0 and 20 [1].

The arrhythmia data consist of 452 instance and 279 attribute feature and 16 class label. Also the data set consist of 407 missing values. Fig.1 shows the class distribution of arrhythmia data set.

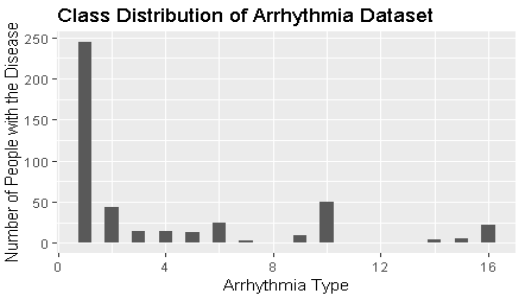

Fig.1: class distribution of arrhythmia dataset

3.2 Data Pre-processing

The data pre-processing technique can convert the raw data into an interpretable format. In the post operative data set, we identified the importance of the attributes first for that particular situation after that a model built based on the important feature attribute. The 10 fold cross validation technique is used and data is partitioned in the ratio 70:30, i.e. 70 is for training and 30 is foe testing. Arrhythmia data set consist of 407 missing values so the model does not give better result. To solve these problem one of the missing value imputation method is used. Thus the number of attributes gets reduced to 274 and the execution gets faster.

3.3 Classification Models

For developing a decision support system different classification models are used: Linear Vector Quantization (LVQ), Random Forest (RF) and Gradient Boosting Model (GBM).

- LVQ: It is considered as supervised classification algorithm. LVQ can create a model based on any application domain which can be easily interpretable.
- RF: This algorithm is used in both classification and regression. Multi model classification method is similar to this algorithm. It creates decision tree on a program domain and gives outcome as a class label for the problem
- GBM: It is a predictive model; this model can predict the future possibilities of the particular application domain by finding the individual accuracy.

IV. RESULTS AND DISCUSSIONS

The aim of healthcare sector is to provide safe, efficient, and high- quality patient care in a cost-effective way. Clinical decision support system (CDSS) is such an automated application that analyses data, to help clinicians in making decisions for improving patient care. People know that, nurses are the assisted service providers to in-patients and emergency care units in every hospital or clinical department. In spite of a pretty big work and working hours, nurses have to take decisions some times during doctor's absence. Lack of nursing expertise during their preliminary career stages or physical tiredness due to overwork, many times wrong decisions would be made from nurse's end. As they are the direct contact point for every in-patient, development of specific decision support systems for nurses is highly relevant. The cardiac arrhythmia is a disease condition in which early detection is necessary. It can be revealed only through taking ECG of that particular patient. The ECG signals cannot be interpreted by the nurse practitioners. In order to solve this problem, our goal is to develop a system which can easily interpretable to the nurse practitioners and, to give better first aid for the patient. The outcome of the system may classify which type of arrhythmia is the patient having and according to that output the system will suggest the first aid also. This system will be very helpful for the nurses to take immediate decision in doctor's absentia. One of the sample outputs of the system is given below. The tool used for this work is R programming language. In R language Caret package is used for partitioning the dataset by a function CreateDataPartition ()[17]. Then finds the accuracy of each individual classifier models TABLE 2. Fig 2 shows the accuracies of different classifier models. The X-axis shows the classifier models LVQ, RF, GBM. The Y-axis represents the accuracy of the models. From the figure we can identifies that the GBM model has the highest accuracy of 76% that of the others.

MODEL	ACCURACY
LVQ	70%
RF	75%
GBM	76%

TABLE 2: Classification model and Accuracy

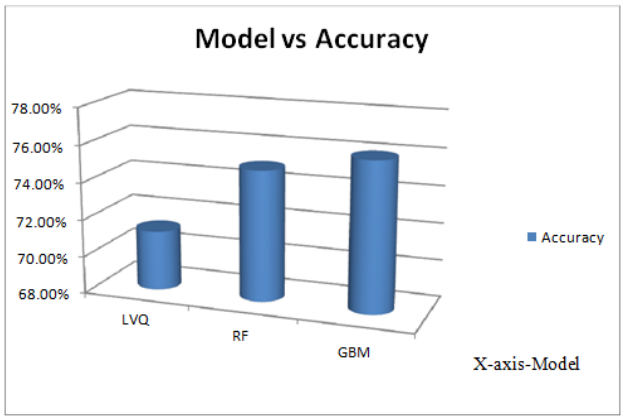

Fig 2: model vs. accuracy

V. CONCLUSIONS

The trends in biomedical field are increasing day by day. During emergency cases, nurses need take necessary actions in the absence of doctors for a better patient care. In that situation, a system which assists the nurses by providing right information at right time will help them so the CDS play a role at the point of patient care. The nurse practitioners face some barriers for utilizing the existing CDSS in hospital. The objective of this work is to solve all these barriers by making an efficient CDSS for nurse practitioners. This paper specified only two emergency situations: postoperative and cardiac arrhythmia. In the postoperative data set we got an accuracy of 76% in RF model. The ECG interpretation system will also helpful for the nurses for giving better care for patients. In future we can add more emergency situations which is handled by nurse practitioners and to take better decisions for the patients.

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