



A Robust Decision Support System for Wireless Healthcare Based on Hybrid Prediction Algorithm

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Abstract

Analysis of healthcare data becomes a tedious task as large volume of unlabelled information is generated. In this article, an algorithm is proposed to reduce the complexity involved in analysis of healthcare data. The proposed algorithm predicts the health status of elderly from the data collected at health centres by utilizing PCA (principle component analysis) and SVM (support vector machine) algorithms. The performance of proposed algorithm is assessed by comparing it with well-known methods like quadratic Discriminant, linear Discriminant, logistic regression, KNN weighted and SVM medium Gaussian using F-measure. At that point, the pre-prepared information is subjected to the dimensionality decrease process by playing out the Feature Selection errand. So, chosen component analysis are investigated by the proposed work SVM-based enhanced recursive element determination, and its precision is assessed and contrasted with the other customary classifiers, for example, quadratic Discriminant, Linear Discriminant, Logistic Regression, KNN Weighted and SVM Medium Gaussian. Here, we built up a shrewd versatile information module for the remote procurement and transmission of EHR (Electronic Health Record) chronicles, together with an online watcher for showing the EHR datasets on a PC, advanced cell or tablet. So as to characterize the highlights required by clients, we demonstrated the elderly checking system in home and healing facility settings. Utilizing this data, we built up a portable information exchange module in light of a Raspberry Pi.

Keywords Machine learning · SVM · PCA · EHR · Healthcare · Elderly

Introduction

Information mining is the procedure of example disclosure and extraction where the gigantic measure of information is included. Both the information mining and social insurance industry have raised some of solid early identification frameworks and different human services related frameworks from the clinical and conclusion information. The fundamental focal point of this paper is to investigate the information digging procedures required for medicinal information mining particularly to find locally visit infections in the elderly. We additionally contrast information mining systems and ordinary techniques. Telemedicine conveys wellbeing administrations

electronically to patients with the headway of correspondence frameworks and wellbeing informatics. The EHR is a noteworthy key player for prosperity amid the elderly. Information mining calculations, when properly utilized, are fit for enhancing the nature of forecast, determination and sickness grouping. It exhibits that the arranged strategy has accomplished enhanced results. The primary debate in applying information mining procedures to wellbeing informatics is a cut-off between the Information and correspondence building and restorative networks [1]. Early finding and predictive analysis models built with simple clinical information are important for arrangement of prevention schemes, especially in unlabelled data [2]. Huge amount of information looking for reliable designs or potentially precise connections between factors, and after that to approve the discoveries by applying the recognized examples to new subsets of information. Keeping in mind the end goal to help such circumstance, information mining network is focusing on applying the latest and most complex calculations to medicinal datasets for accomplishing the most astounding precision conceivable. This standard likewise makes the non-scholarly clinicians lean toward basic and

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justifiable models [3]. Despite the fact that the Clinical Decision Support framework is working great, social insurance experts are not using this because of the outrageous troubles looked by the doctors in requesting records electronically. In any case, the trust of social insurance examination on information is expanding [4]. In the field of telemedicine and network solution, learning extraction for diagnosing and giving the restorative treatment assumes a crucial part. The utilization of therapeutic information incorporates different machine learning calculations, for example, counterfeit neural system, hereditary calculations, choice tree, unpleasant set, and support vector machine. Additionally, there emerges a more prominent extension for include choice alongside the other machine learning strategies. The events which don't fit to marginally cluster are called as anomalies, and expulsion of this exceptions helps in enhancing the effectiveness of the characterization framework. Shape the past overview, it has been demonstrated that SVM is the all the more capable machine calculation created with standards and has made vital achievement in the field of therapeutic association, medicinal information order and different applications. Various new research has expressed that the SVM, for the most part, are expert as disseminating more noteworthy introduction in affinities of indexing accuracy than the other information course of action calculations [5] with kernel base and PCA. The fundamental thought is to develop the model with great exactness by knowing the number and subtle elements of best qualities chose in the dataset [6]. Subsequently, as a pre-processing technique, the element choice strategy is utilized to channel the best quality [7]. The channel approach plays out the component choice process, and those highlights are assessed independently by the students. At long last, under wrapper approaches, a calculation for characterization is connected over the dataset keeping in mind the end goal to distinguish the best highlights [8, 9]. DoronShalvi and Nicholas DeClariss talked about medicinal information mining through unsupervised neural systems other than a strategy for information perception [10]. They likewise underlined the requirement for pre-processing preceding medicinal information mining. In the year 2000 Krzysztof J. Cior, bioengineering educator, recognized the requirement for information mining strategies to mine therapeutic mixed media content [11]. Further work distinguished issues in restorative information mining [12]. The issues incorporate missing qualities, information stockpiling regarding worldly information and multi-esteemed information, diverse restorative coding frameworks being utilized as a part of Hospital Information Systems (HIS). Later it investigated and broke down two programming models, for example, neural systems, and linear hereditary programming for medicinal information mining [13]. Researcher proposed govern extraction workbench for producing developing principle sets from reuse of clinical Data to improve the hospital service [14]. Biomedical information is demonstrated utilizing

Logistic Regression, a strategy that depends on fitting information to a foreordained model. On the other hand, the Support Vector Machine (SVM) calculation is a regulated machine learning strategy that is a "sans model" technique that does not require suppositions of dissemination and interdependency of indicator factors. In SVM every datum point is spoken to as an n-dimensional vector and the calculation builds n-1 dimensional isolating hyperplane to segregate two classes, with amplified remove between the hyperplane and information focuses on each side. Nonlinear capacities, pieces, can likewise be utilized to change information into multidimensional space. Past research shows that SVM has comparative or enhanced prescient abilities for ailment arrangement in contrast with Logistic Regression [15]. What's more, it has been discovered that chart hypothesis measurements give valuable data to the infection order issue. Studies arranging maladies, for example, Alzheimer's and Multiple Sclerosis [16, 17] joined chart hypothesis with machine learning techniques. Further researcher developed graph derived metrics with machine learning to make a powerful classification tools with help of SVM [18]. The Research work addresses the challenge in computing to optimize the efficiency of prediction data with the IoT-enabled information architecture-driven approach [19].

Background study

The content order gives the conceptualized significance to genuine accumulations. A content grouping framework arranges reports in at least one predefined classes as indicated by the printed substance. This can be further valuable for content-based observation framework particularly in online networking and wellbeing related bits of knowledge for opportune and monstrous data extraction from vast datasets. The part of web-based life for biomedical space significantly affects pertinent information extraction utilizing medicinal services philosophy. The content digger can extricate the content data that can be shared amongst patients and social insurance leaders for an expansive scale content based illness observation framework. It can likewise be utilized for mining wellbeing related data that can be used by the two patients and specialists. Content information mining has transcendently adapted machine learning (ML) calculations for content grouping.

The points of value human services administrations are providing safe human services medications and using logical restorative learning to give social insurance administrations to everybody. For providing different medicinal services medications in view of the patient's needs, side effects and inclinations limiting an opportunity to sit tight for the restorative treatment and minimizing the defer time in giving restorative treatment in terms of Health Determinants. This proposed

method will work as Inputs to the wellbeing framework and related procedures and it also used for Sociality as wellbeing foundation, human furthermore, money related assets, gear, arrangement, and association. Typically, the execution of a model is made by an errand. For example, bunching, association rules, relationship examination, are frequently utilized for enlightening models.

Strategies utilized as a part of information mining

Affiliation Association is a standout amongst other known information mining method. In affiliation, an example is found in view of a relationship of a specific thing on different things in a similar exchange. For instance, the affiliation strategy is utilized as a part of coronary illness forecast as it discloses to us the relationship of various characteristics utilized for investigation and deals with the patient with the entire hazard factor which are required for the expectation of infection.

Arrangement Classification is an exemplary information mining method in view of machine learning. Essentially order is utilized to arrange everything in an arrangement of information into one of a predefined set of classes or gatherings. Arrangement strategy makes utilization of numerical procedures, for example, choice trees, straight programming, neural system, and measurements.

Clustering Clustering is an information mining system that influences an important or valuable group of items that to have comparative trademark utilizing programmed strategy. Not the same as order, grouping strategy likewise characterizes

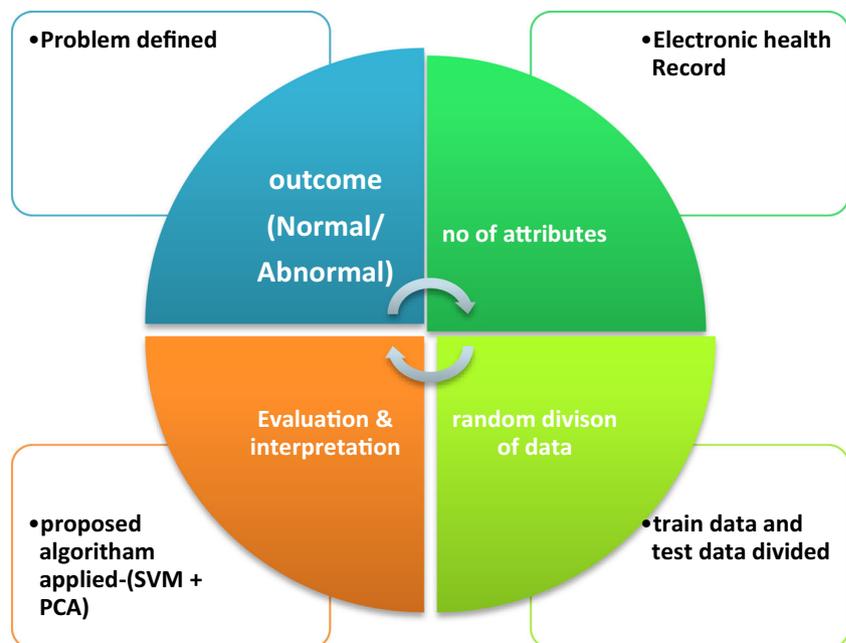
the classes and place questions in them, while in arrangement objects are doled out into predefined classes. For instance, in the forecast of coronary illness by utilizing grouping we get a bunch or we can state that rundown of patients which have the same hazard factor. Means this influences the different rundown of patients with high blood to sugar and related hazard factor and so on.

Forecast The expectation as it names inferred is one of an information mining procedures that finds a connection between autonomous factors and connection amongst reliant and free factors. For example, forecast examination method can be utilized as a part of an offer to foresee benefit for the future on the off chance that we consider deal is an autonomous variable, the benefit could be a needy variable. At that point in light of the chronicled deal and benefit information, we can draw a fitted relapse bend that is utilized revenue driven expectation.

Methodology

Used in Data Mining Data Mining is the centerpiece of Knowledge Discovery Database (KDD). Numerous individuals regard Data Mining as an equivalent word for KDD since it’s a key piece of KDD process. Learning disclosure as a procedure is portrayed in Fig. 1 and comprises of an iterative grouping of the accompanying advances in form of Cleaning to evacuate clamour or superfluous information. The Data Integration Where different information sources might be joined the Data Selection Where information significant to the investigation undertaking is recovered from the database and Data Transformation Where information is changed or

Fig. 1 Generic Architecture of the proposed predictive data mining model



united into shapes fitting for mining by performing rundown or accumulation activities. Finally the Data mining a basic procedure where smart strategies are connected keeping in mind the end goal to form information designs and Pattern Evaluation Done for distinguish the genuinely intriguing examples speaking of learning in light of some intriguing quality measures. Then the proposed algorithm Examined and learning portrayal methods have been utilized to exhibit the mined information to the client.

Information mining application in human services

Healthcare industry today creates huge measure of complex information about patients, doctor’s facility asset, malady analysis, electronic patient records, therapeutic gadgets and so forth bigger measures of information are a key plan of action to be prepared and examined for learning extraction that empowers bolster for cost sparing and basic leadership. Information mining applications in medicinal services can be gathered as the assessment into general classes.

Proposed models

The feature of PCA is that to reduce the dimension of axes to increases its separability. In datasheet many of these features will measure related properties and so will be redundant, PCA makes a linear transformation in the original set of features to create a new space composed by principal component. It includes by the SVM-PCA calculation are then assessed by ten times cross-verification standards and additionally connected with other conventional strategies. Figure 2 shows the full working of the proposed framework with the included

segments; for example, information gathering, and information pre-processing lastly highlight determination and assessment by the SVM-PCA calculation. As the first phase of this work, the pre-processing is conveyed with standardization technique for the information cleaning. The pre-processed information is assembled by the k-implies calculation to discover the outliers. Then, the element determination is accomplished on the bunched information by wrapper calculation SVM-IRFS, and they chose result is assessed by a similar calculation for the precision estimation (Fig. 2). Dimensionality Reduction assumes an extremely imperative job in machine adapting, particularly when we are working with so many highlights. Principle Components Analysis is one of the best dimensionality decrease calculations, it isn’t difficult to comprehend and utilize it in genuine ventures. This method, notwithstanding making crafted by highlight control less demanding, despite everything it enhances the aftereffects of the classifier. Anytime $x = (x_1, x_2), x \neq 0$, in \mathbb{R}^2 , where \mathbb{R} for all Real number Which indicates a vector in the plane, in particular, the vector beginning at the source and consummation at x . This definition implies that there exists a vector between the starting point and closure at x . In this research work the information sheet select two hyperplanes, which separate the information without any focuses between them, augment their separation (the margin). The area limited by the two hyperplanes will be the greatest conceivable edge. In our information depiction, the information will be made out of n vectors X_i . Every X_i will likewise be related with an esteem Y_i demonstrating if the component has a place with the class (+1) or not (-1). Note that Y_i can just have two conceivable qualities - 1 or + 1. Moreover, more often than not our vector x_i winds up having numerous measurements. We can say that X_i is a p -dimensional vector on the off chance that it has p

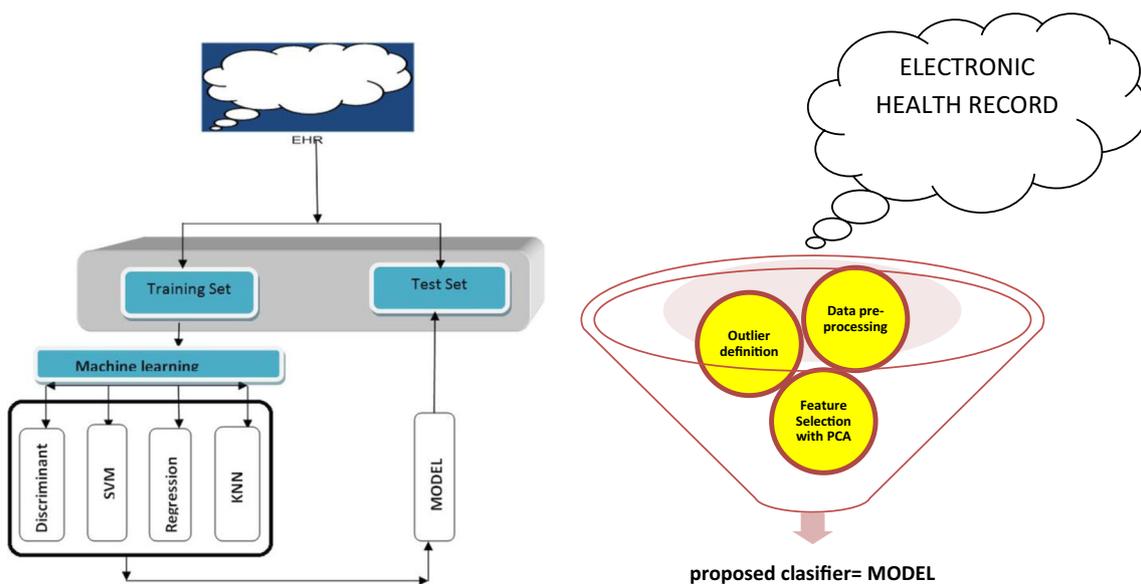


Fig. 2 Proposed method for prediction Algorithm

Table 1 Simulation parameters for the Electronic Health Care (Sample Data)

Gender	Age	Glucose	HIGH BP	LOW BP	PULSE	TEMPERATURE	Alcoholic	Smoking	Obesity	outcome
M	81	148	140	72	74	97	No	No	Yes	Abnormal
F	72	85	120	76	66	98	No	No	No	Normal
F	70	183	145	64	75	96	Yes	Yes	No	Abnormal
M	87	129	134	76	80	98	No	No	No	Normal
M	83	137	124	40	68	97	Yes	Yes	Yes	Abnormal
M	68	116	125	74	68	97	No	No	No	Normal
F	67	78	110	50	70	97	Yes	No	No	Abnormal
M	76	115	110	73	74	96.4	No	No	No	Normal
M	61	197	180	70	69	99.2	No	No	Yes	Abnormal
M	66	125	150	96	69	97	No	No	Yes	Abnormal
F	71	110	120	80	72	98	No	No	No	Normal
M	69	168	120	74	71	99.1	No	No	Yes	Abnormal
M	60	139	136	80	62	97	No	No	No	Normal
F	65	189	110	60	64	100	Yes	Yes	Yes	Abnormal
F	66	166	120	72	68	98	No	No	Yes	Abnormal
F	65	100	115	70	70	97	No	No	No	Normal
F	64	118	120	84	70	97	No	No	No	Normal

measurements. So here our dataset D is the arrangement of n couples of component (xi, yi). The increasingly formal meaning of an underlying dataset in the set hypothesis is:

$$D = \{(X_i, Y_i) | X_i \in \mathbb{R}^p, \& Y_i \in \{-1, 1\}_{i=1}^n\}$$

The condition of hyperplanes can be composed $W^T x = 0$. However, in the Support Vector Machine, it is said that any hyperplane can be composed as the arrangement of focuses x Satisfying $w \cdot x + b = 0$. herefirst, we perceive another documentation for the dot product, the article utilizes $w \cdot x$, rather than $W^T x$. Given two 3-dimensional vectors w (b,-a,1) and x(1,x,y)

$$w \cdot x = y - ax + b \tag{1}$$

Given two 2-dimensional vectors w (-a,1) and x (x,y)

$$w' \cdot x' = y - ax \tag{2}$$

Combining eq. 1 and 2

$$w' \cdot x' + b = w \cdot x \tag{3}$$

For this article, we will use 2-dimensional vectors (as in eq. (2)). Given a hyperplane H_0 Separating the dataset and satisfying: $w \cdot x + b = 0$. We can select two others hyperplanes H_1 and H_2 , which also separate the data and have the following equations: $w \cdot x + b = \delta$ and $w \cdot x + b = -\delta$ so that H_0 is equidistant from H_1 and H_2 . However, here the variable δ is not necessary. So we can set $\delta = 1$ to simplify the problem. $w \cdot x + b = 1$ and $w \cdot x + b = -1$ Now we want to be sure that they have

Table 2 Attributes collected from Electronic Health Record For average Person

Serial No.	feature	Data type	description
1	Age	Scale	Age > 60
2	Gender	category	Male/Female
3	Systolic	Scale	Yes > up to 139 mm of Hg
4	Diastolic	Scale	Yes < up to 60 mm of Hg
5	Pulse rate	Scale	The range of 66 to 85 = Normal Less than 66 and more than 85 = Abnormal
6	Glucose level	Scale	80 to 140 mg/dl in a fasting state
7	temperature	Scale	97 °F (36.1 °C) to 98.6 °F (37 °C)
8	Alcoholic	category	Yes/No
9	Smoking	category	Yes/No
10	Obesity	category	Yes/No

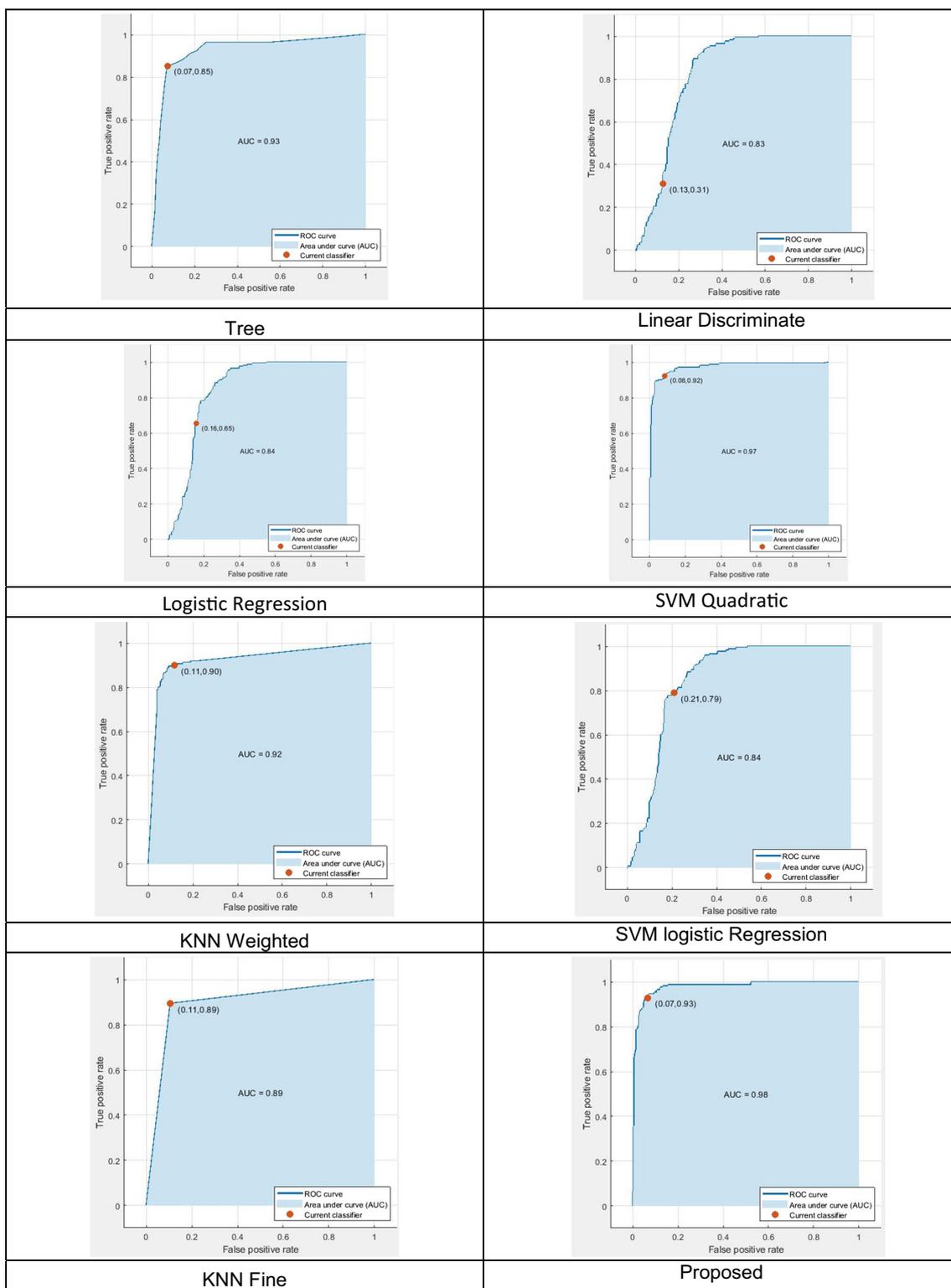


Fig. 3 Comparison of ROC graph with various algorithm

no points between them. We will not select any hyperplane; we will only select those who meet the two following constraints: For each vector x_i either:

$$w \cdot x_i + b \geq 1 \text{ for } x_i \text{ having the class 1} \tag{4}$$

Or

$$w \cdot x_i + b \leq -1 \text{ for } x_i \text{ having the class -1} \tag{5}$$

Combining both the constrained as Eqs. (4) and (5) into a single constraint. Start with eq. (5) for x_i having the class-1w

$x_i + b \leq -1$ and multiply both sides by y_i . (Which is always -1 in this equation) $y_i (w \cdot x_i + b) \geq y_i (-1)$ which means eq. (5) can also be written:

$$y_i(w \cdot x_i + b) \geq 1 \text{ for } x_i \text{ having the class } -1 \tag{6}$$

In eq. (4), as $y_i = 1$, it doesn't change the sign of the in the equation.

$$y_i(w \cdot x_i + b) \geq 1 \text{ for } x_i \text{ having the class } 1 \tag{7}$$

We combine eqs. (6) and (7):

$$y_i(w \cdot x_i + b) \geq 1 \text{ for all } 1 \leq i \leq n \tag{8}$$

Experimental results and analysis

Table 1 contains sample data which is collected from Electronic Health Record, here in this Research the Data taken from the hospital is not violating any ethics as per Rule and it's only for purpose of research.

All the attributes are used as input are taken from WHO or medical council of US/UK/India, some data taken from the real-time also. This work process incorporates three noteworthy assignments: (1) standardization guideline of supplanting the missing esteems with its mean; (2) following stage 1, the end of anomalies is finished by utilizing K-implies bunching calculation and the concentrated information are utilized for picking the perfect structures with recursive element determination (RFS); (3) at long last, the reduced dataset is ordered utilizing RFS-SVM classifier to accomplish enhanced rightness related to current methodologies in writing. The classifier execution is evaluated by the ten times cross-confirmation procedure with and without uproarious information (the missing qualities with mean). Bolster vector machines (SVMs) are effective strategies for taking care of order issues on extensive datasets. They consolidate dependable strategies from straight learning with the fascinating hypothesis of portion initiated spaces. In this paper, we address the twofold order of unequal datasets with accentuation on high affectability. Here, a dataset is thought to be unequal if either the sizes of the two classes vary fundamentally, or the cost for a false negative grouping is high while a false positive is worthy, or if the two conditions hold. High affectability guarantees that false negative characterizations are uncommon. One of the real difficulties for certifiable applications is the tuning of parameters that are in charge of the nature of the SVM classifier. Table 2 presents the order execution of RFS-SVM with the chose most astounding positioned. Utilizing the whole dataset without include choice failures to improve classifying on the grounds that the extraordinary list of capabilities may involve

Table 3 Accuracy, precision, recall and G mean values of different algorithms

classifier	Accuracy	Precision	Recall	G-mean
Tree	0.89	0.8769	0.95	0.8718
Linear Discriminate	0.9	0.9167	0.9167	0.8956
Logistic Regression	0.86	0.8382	0.95	0.82989
SVM Quadratic	0.9	0.8906	0.95	0.8853
KNN Weighted	0.93	0.9344	0.95	0.9247
SV logistic Regression	0.93	0.9344	0.95	0.9247
KNN Fine	0.87	0.9123	0.8667	0.8708
Proposed	96.28	0.95	0.95	0.9374

potentially ended and disconnected highlights. After running all the code the Receiver operating characteristic (ROC) curve is plotted for evaluation of all applied classification algorithms. The performance evaluator used in proposed and defined algorithm are as follows: (Fig. 3, Tables 3 and 4).

- *Sensitivity:*

Sensitivity of a test is the percentage of all patients with disease present who have a positive test.

$$\frac{TP}{TP + FN} \times 100 = \text{Sensitivity}(\%) \tag{9}$$

- *Specificity:*

Specificity of a test is the percentage of all patients without disease who have a negative test.

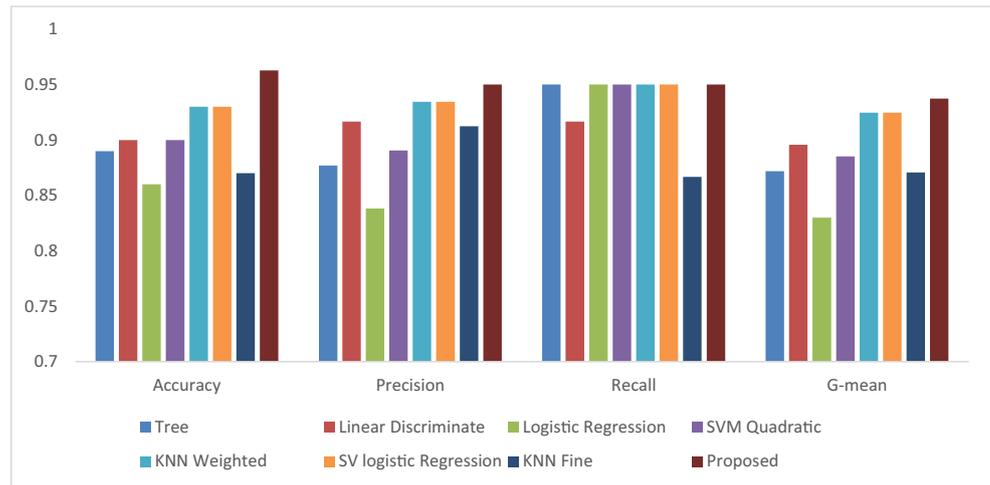
$$\frac{TN}{TN + FP} \times 100 = \text{Specificity}(\%) \tag{10}$$

Recall is the number of True Positives divided by the number of True Positives and the number of False Negatives. On the other hand it may be defined as the number of positive

Table 4 Analysis of efficiency, F –measure, sensitivity and specificity with proposed algorithm

classifier	Efficiency	F-measure	sensitivity	specificity
Tree	0.88	0.912	0.95	0.8
Linear Discriminate	0.89	0.9167	0.9167	0.875
Logistic Regression	0.84	0.8906	0.95	0.725
SVM Quadratic	0.89	0.9194	0.95	0.825
KNN Weighted	0.92	0.9421	0.95	0.9
SV logistic Regression	0.92	0.9421	0.95	0.9
KNN Fine	0.86	0.8889	0.8667	0.875
Proposed	0.94	0.95	0.951	0.891

Fig. 4 Comparison of Accuracy, precision, Recall, and G-mean with all defined algorithm with proposed Algorithm



expectations partitioned by the quantity of positive class values in the test information. It is likewise called Sensitivity or the True Positive Rate. Precision is the number of True Positives separated by the number of True Positives and False Positives. Put another way, it is the number of positive forecasts partitioned by the complete number of positive class esteems anticipated. It is likewise called the Positive Predictive Value (PPV). (Figs. 4 and 5).

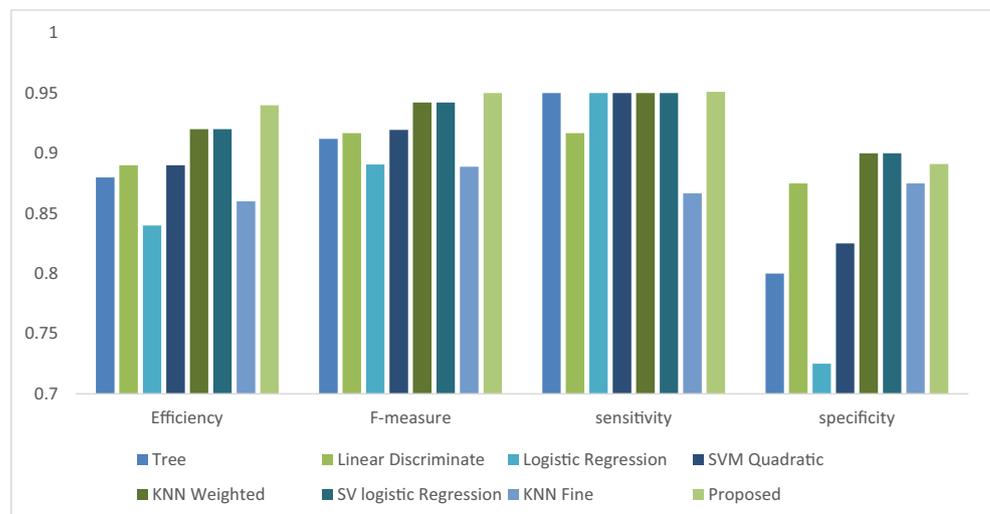
- *Accuracy*: it is the ratio of correct decisions made by a classifier

$$\frac{TP + TN}{TP + TN + FP + FN} = \text{Accuracy} \tag{11}$$

Conclusions

Support Vector Machines and Principle component Analysis are important tools to be considered for disease classification problems. Mining of health records examination information is challenging particularly because of its heterogeneity, inherent clamor, and especially the expansive volume of unlabelled information. Outlier detection on uncertain data is challenging and demanding. In this paper, we presented a specific prediction algorithm to address these difficulties. Our proposed model construct order in light of mining healthcare examination records initially, wellbeing examination records are spoken to as a pre-processed data that every single applicable case together. And, also the SVM + PCA will became versatile algorithm for other disease. Here we compare between those pre-processing techniques and optimal technique is found. Finally, check for the efficiency and accuracy of the results.

Fig. 5 Comparison of parameter like Efficiency, F measure, sensitivity and specificity among defined and proposed work



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Compliance with ethical standards

Conflict of Interest. The authors have no conflict of Interest.

(In case animal were involved) ethical approval) Animal were not involved.

(And/or in case humans were involved) ethical approval) This article does not contain any studied with human participants performed by any of the author.

Ethical approval This Article does not contain any studies with human participants or animals performed by any of the author.

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