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Research Paper

A Comparative study of machine learning algorithms on thyroid disease prediction

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Abstract

Thyroid illness is a medicinal state that influences the functionality of the thyroid organ that is thyroid gland [1](Guyton, 2011).The indications of thyroid ailment differ basing upon the type. There are four most common varieties: hypothyroidism (low capacity) which is caused due to the insufficiency of the thyroid hormones; hyperthyroidism (high capacity) which is caused due to the existence of the thyroid hormones more than just sufficient, basic variations from the norm, most normally an augmentation of the thyroid organ; and tumors which can be benign or can cause cancer. It is additionally conceivable to have irregular thyroid capacity tests with no clinical side effects [2](Bauer & al, 2013). In this study a comparative thyroid disease diagnosis were performed by using Machine learning techniques that is Support Vector Machine (SVM), Multiple Linear Regression, Naïve Bayes, Decision Trees. For this purpose, thyroid disease dataset gathered from the UCI machine learning database was used.

Keywords: *SVM, Multiple Linear Regression, Naïve Bayes, Decision Trees.*

1. Introduction

Thyroid issues are impact on the thyroid organ, it is a butterfly shaped organ within the front of the neck.
The thyroid has basic components to coordinate totally different metabolic ways during the body. Different types of thyroid issue impact either its structure or limit.
The thyroid organ is organized beneath the Adam's apple wrapped around the trachea (windpipe). A small tissue of inside the organ called as the isthmus; attach the two thyroid projections on all sides. The thyroid utilizes iodine to convey the major hormones. Thyroxine, usually known as T4, is the essential hormone made by the organ. When transport by ways for the dissemination framework to the body's tissues, a small piece of the T4 released from the organ is modified over to triiodothyronine (T3) that is the most unique hormone.
The cerebrum includes the limit of the thyroid organ is overseen by an info framework. When thyroid hormone levels are precisely low, the hypothalamus in the cerebrum transfer a hormone known as thyrotropin releasing hormone(TRH) that causes the pituitary organ (arranged at the base of the brain) to release thyroid invigorating hormone (TSH). TSH enables the thyroid organ to release more T4.

1.1 Dataset Description: [3]

Attribute	Data Type	Value Range
Age	Real	[0.00,0.93]
Sex	Integer	[0,1]
On_thyroxine	Integer	[0,1]
Query_on_thyroxine	Integer	[0,1]
antithyroid_medication	Integer	[0,1]
Sick	Integer	[0,1]
Pregnant	Integer	[0,1]
Thyroid_surgery	Integer	[0,1]
I131_treatment	Integer	[0,1]
Query_hypothyroid	Integer	[0,1]
Query_hyperthyroid	Integer	[0,1]
Lithium	Integer	[0,1]
Goitre	Integer	[0,1]
Tumor	Integer	[0,1]
Hypopituitary	Integer	[0,1]
Psych	Integer	[0,1]
TSH	Real	[0.0, 0.53]
T3	Real	[.0005,.18]
TT4	Real	[0.0020, 0.6]
T4U	Real	[0.017, 0.233]
FTI	Real	[0.0020, 0.642]
Class	Integer	{1,2,3}

Where class is varied as following
Normal - 1
Hyperthyroidism - 2
Hypothyroidism - 3

1.2 Implementation

As the data set has no missing values at the pre-processing stage the data set is imported using the pandas library in python, and it is then splitted into training set and test set which consists of 5760 and 1440 observations respectively and they are tested on various algorithms of machine learning and the split as of randomness and the predicted values are compared and the accuracy of the model or the algorithm is calculated using the below formula

$$Accuracy = \frac{TP + TN}{n} * 100$$

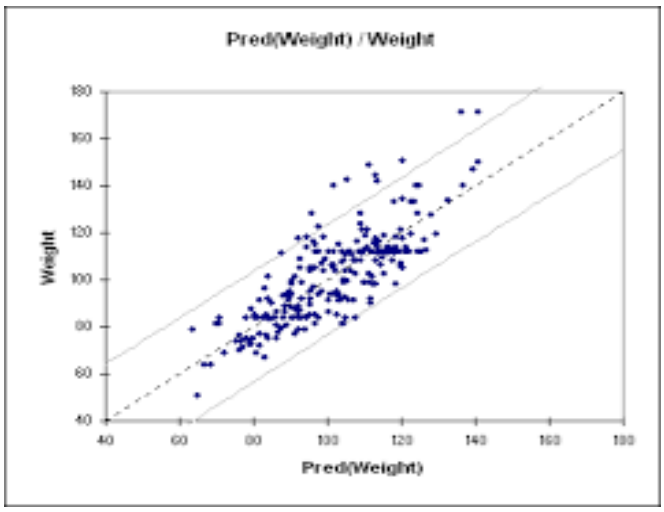
Where TP=True Positives
TN=True Negatives
n=Number of observations in test set
To find some of true positives and true negatives we have to find the sum of principal diagonal in confusion matrix. The confusion matrix is a matrix of n*n rows and columns that depend upon the elements in output class. In this case the confusion matrix is of 3*3 matrix.

2. Multiple Linear Regressions

It is augmentation of simple linear regression. It takes the attributes as input data sources and delivers a yield.
MLR examines the connection between at least two IVs and a solitary DV, where IV is an independent variable and DV is a dependent variable.

Y=x1+x2+...+xi

Where y is a dependent variable which depends upon x1,x2,x3……,xi which are independent variables.
TP+TN=1319



2.1 Confusion matrix of Multiple Linear Regressions

	0	1	2
0	2	19	18
1	0	1	82
2	0	2	1316

By using multi linear regression we can get the correctness of **91.59%**

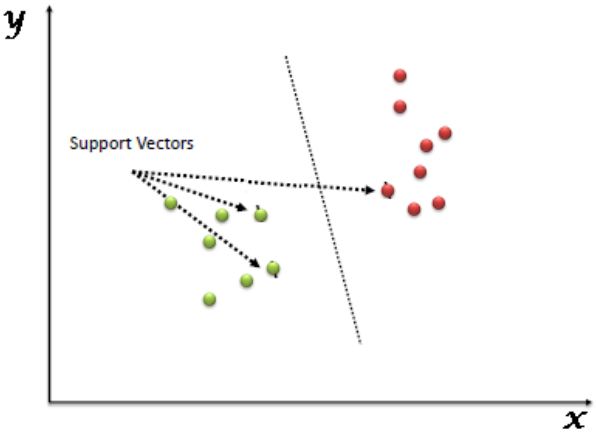
3. Svm (Support Vector Machine)

Support Vector Machine (SVM) is a managed machine learning count which can be used for both classification and regression issues. Regardless, it's usually used as a bit of arrangement problems. During this figuring, we have a tendency to plot every data point factor as some extent in n-dimensional area (where n is number of qualities you have) with the estimation of each half being the estimation of a selected organize. By then, we have a tendency to perform characterization by finding the hype-plane that completely different the two categories notably well.

Algorithm-I: SVM-RFE [22]

Input: Initial gene subset, $G = \{1, 2 \ldots n\}$
Output: Rank list according to smallest weight criterion, R.

Step 1: Set R= { }
Step 2: Repeat steps 3-8 until G is not empty
Step 3: Train the SVM using G.
Step 4: Compute the Weight Vector using eq (3)
Step 5: Compute the Ranking Criteria, $Rank = W^2$
Step 6: Rank the features as in sorted manner.
$New_{rank} = sort(Rank)$
Step 7: Update the Feature Rank list
$Update\ R = R + G(New_{rank})$
Step 8: Eliminate the feature with smallest rank
$Update\ G = G - G(New_{rank})$
Step 9: End



TP+TN=1383

2.1 Confusion matrix of SVM

	0	1	2
0	28	5	6
1	1	43	39
2	3	3	1312

By using Support vector machine we can get the accuracy of **96.04%**

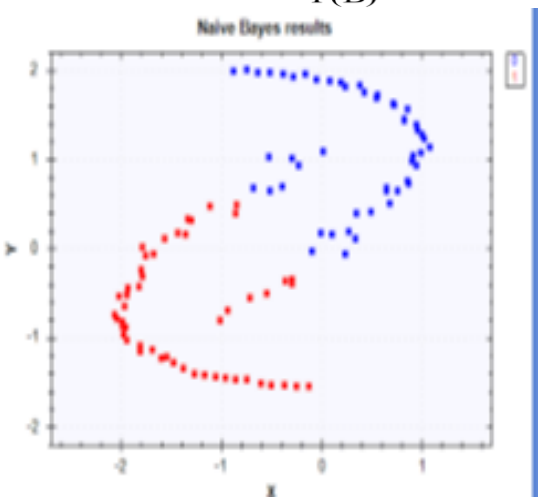
4. Naive Bayes

Naive Bayes classifiers are an accumulation of classification methods based on Bayes' Theorem. It isn't a solitary algorithms yet a group of algorithms where every one of them share a typical guideline, i.e. each combination of attributes being classified is autonomous of each other.
The dataset is divided into two different categories like **feature matrix** and **response vector.**
→The feature matrix consists each and every vector that is nothing but row of dataset in which every vector comprises of the estimate of dependent features.
→Response vector contains the esteem of class variable (prediction or yield) for each vector which is nothing but a row of the feature matrix.

4.1 Bayes Theorem

Bayes' Theorem finds the likelihood of an event happening given the likelihood of another event that has just happened. Bayes' hypothesis is expressed numerically as the following condition:

$$P(A \mid B) = \frac{P(B \mid A)P(A)}{P(B)}$$



Algorithm

Step 1: Convert the data set into a frequency table.
Step 2: Create Likelihood table by finding the probabilities.
Step 3: Now, use Naive Bayesian equation to calculate the posterior probability for each class. The class with the highest posterior probability is the outcome of prediction.

TP+TN=91

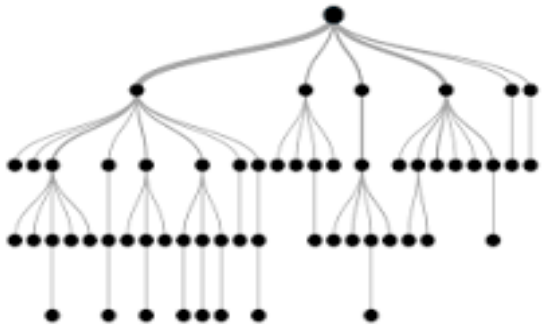
4.2 Confusion matrix of Naïve Bayes

	0	1	2
0	36	3	0
1	79	4	0
2	1036	231	51

By using Naïve Bayes algorithm we can get the exactness of **6.31%.** So Naïve Bayes has the least accuracy.

5. Decision Trees

The Decision tree is one of the classification methods. This learning calculation applies a separation and conquer methodology that can also be called as divide and conquer to build the tree. The arrangements of instances are related by an arrangement of attributes.
A Decision tree includes hubs and leaves, where hubs represent a test on the estimations of a trait and leaves represent the class of an instance that fulfills the conditions.
The result is "true" or "false" that is nothing but a categorical variable. Standards can be gotten from the way beginning from the root hub to the leaf and using the hubs on way as preconditions for the rule, to foresee the class at the leaf. The tree pruning must be done to expel pointless preconditions and duplications.



Decision Tree Algorithm Pseudo code

- Place the best attribute of the dataset at the root of the tree.
- Split the training set into subsets. ...
- Repeat step 1 and step 2 on each subset until you Find leaf nodes in all the branches of the tree.

TP+TN=1429

Confusion matrix of Decision trees

	0	1	2
0	36	0	3
1	0	81	2
2	4	2	1312

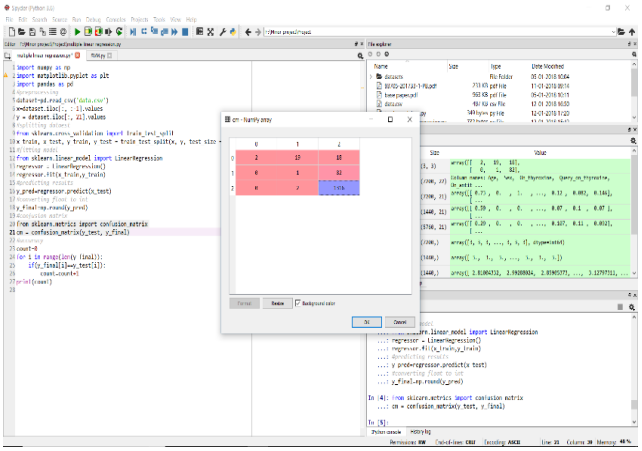
By using Decision tree algorithm we can get the highest correctness of **99.23%.**

5. Results

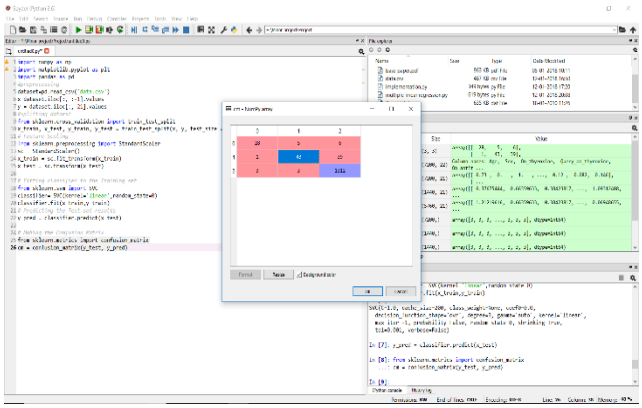
5.1 The comparison of Results

Algorithm	Accuracy
Multiple Linear Regression	91.59%
SVM	96.04%
Naïve Bayes	6.31%
Decision Trees	99.23%

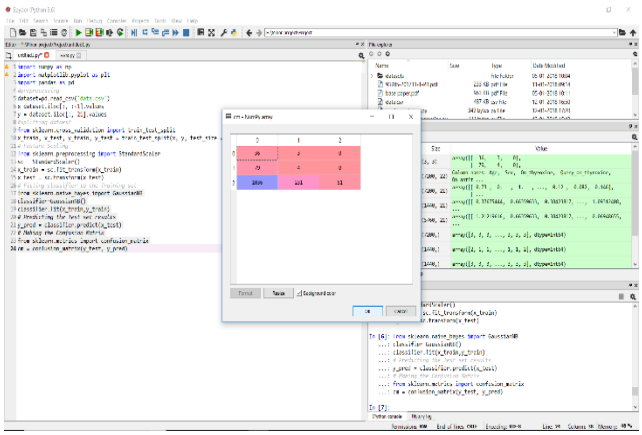
5.2 Multi Linear Regression output



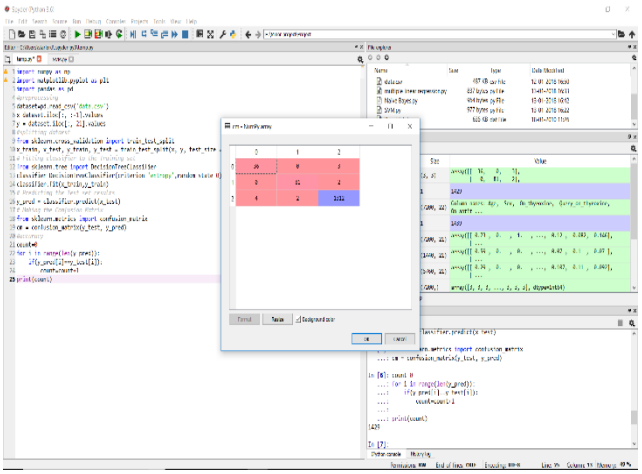
5.3 Support Vector Machine output



5.4 Naïve Bayes output



5.5 Decision Tree output



6. Conclusion

This paper presents a comparative study on thyroid disease diagnosis by using Support Vector Machine (SVM), Multiple Linear Regression, Naïve Bayes and Decision Trees. The results were compared and it was seen that Decision Trees could be successfully used to help the diagnosis of thyroid disease. It is observed that the Decision Trees outperformed the SVM, Multi linear regression, Naïve Bayes with respect to the accuracy of the network to diagnose the thyroid disease.

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