IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
Research paper **Volume 11, Iss 4 , 2022**

PREDICTION OF HYPERTENSION BY USING ARTIFICIAL NEURAL NETWORK SYSTEMS

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DOI : 10.48047/IJFANS/11/ISS4/123

Abstract

In Today's daily life people are facing diverse health issues, Hypertension is one of serious health issues which may cause heart problems. This paper is focus on prediction of hypertension by means of Artificial Neural Networks, which is a sub field of Artificial intelligence. Hypertension is one of the genetic problems which people are facing it is a sickness that ends in an excessive at the same time dangerous disease which includes coronary heart failure, inspissation of heart muscle, coronary artery disease, and other extreme situations.This paper is for identifying the occurrence of hypertension in various categories of persons, like people with or without hypertension, pregnant lady with or without hypertension, people with chronic kidney disease, adrenal and thyroid disorders. This is used to recognize the best solutions, challenges and chances in detecting hypertension. In upcoming it is used as a primary recognition system for hypertension. Artificial neural network, a subclass of Artificial intelligence, which is used to predict the solution, which is a best prediction algorithm to identify hypertension. Results of the proposed method compared with existing solutions. In This intern one can increase the accuracy of the system. In machine learning genetic algorithms and neural networks plays vital role for prediction. To predict hypertension logistic regression and boosting classifiers are used. Artificial neural networks result best accuracy for human biology system prediction. To assess the proposed model performance measurements are included to calculate precision, recall Accuracy and F1- Score. The proposed method results and exhibit superior results, when compared to the existing machine learning algorithms. Neurons within the brain bypass the indicators to carry out actions. So, artificial neurons are connected with neural networks to carry out duties. concept of artificial neural network was inspired by human biology and the way neurons of the human brain function together to understand inputs from human senses. The end results can be either patient with hypertension or without hypertension.

Keywords— Machine Learning (ML), Artificial Neural Network (ANN), Hypertension, Keras, Tensor Flow.

Introduction

Blood pressure generally increases and reduces during the day, can damage heart and cause health problem if it stays for a long time. Hypertension, also called high blood pressure, which is higher than the normal. Hypertension (HTN) is an excessive or higher blood pressure [1], with this condition the blood vessels constantly in high pressure. Blood passes from heart to all portions of frame in vessels. Respectively coronary heart beats [2], strain is created by the force of blood assertive in opposition to the walls of blood vessels (arteries) as its miles are propelled through the coronary heart. With higher strain, the more difficult to coronary heart to pump. Hypertension is a severe scientific situation [3-4], might raise the risk of heart, brain, kidneys and different illnesses [6]. It's by far a prime motive of untimely dying globally, for every four persons one men and one female in five ladies – concluded 1000000000 humans having the situation of Ease of Use. Hypertension is one of the primary health issues, without treatment may cause death by causing heart attack [10-11]. Due to Geographical conditions also, the hypertension may vary from place to place. Due to hypertension, one may get high blood pressure and having potential signs like headache, edema of extremities, impaired vision and epigastric pain [5]. As per the calculations of

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in the year 2020, more than 670,000 [https://www.cdc.gov/bloodpressure/facts.htm] deaths happened in the United States due to hypertension as a primary or contributing cause. Nearly 47% of Adults are facing hypertension health issue in united states [7-8].

In pregnant time women may suffer hyper tension disorder, which is one of the most causes for maternal and neonatal mortality. Due to this a long-term incident of cardiovascular diseases and preeclampsia may happen.

To Develop a version for predicting hypertension in numerous classes of individuals [9], here we are using machine learning Algorithms. Machine learning algorithms are mathematical model mapping techniques used to examine or find underlying styles embedded within the facts. Machine learning [13] incorporates a set of computational algorithms which can carry out pattern popularity, classification, and prediction on data via getting to know the present statistics (training set). Right here in thisusing the ANN algorithm for the proposed version. An artificial neural network (ANN) is to carry out duties like forecast, arrangement, decision making, and so forth. It includes artificial neurons. These artificial neurons are a replica of human brain neurons [12]. Neurons within the brain bypass indicators to carry out the actions. Further, artificial neurons connect in a neural network to carry out duties. End result can be acquired in two different forms i.e., either patient with hypertension or no hypertension. Data sets are collected from Kaggle repository, to get accurate and precision results. In the following sections 2 represents related work about literature survey. In Section 3 described proposed method and materials used to develop the system. Section 4 Describes the implementation of algorithms. Section 5 describes the results, the last section related to discussions, section 7 includes conclusion and last one is the reference section.

2. RELATED WORK:

R.C. Hermida et al [1] projected a system for hypertension this system includes both hardware and software modules which are used for measurement of blood pressure and blood pressure elevations. This system uses ABPM-630 Colin which is used for automatic monitoring of systolic and diastolic pressure and heart rates. In this, few values are maintained for calculating the tolerance limits. This system uses the bootstrap techniques, with the help of this software system it provides us with tolerance limits and timing of BP measures that means elevations. Maintaining the Integrity of the specifications. K.L. Fernando et al [2] proposed a system about the prediction of hypertension in pregnant women only with the help of coherent analysis. This system states that, according to previous studies the functional relations between maternal and fetal tissue are different in pregnant women. This states that according to previous studies the development of hypertension has become a riskfactor in pregnant women because of intrauterine growth in babies is at high risk. Aiguo Wang et al [3], proposed a system that deals with chronic disease prediction. This paper tells the importance of identifying hypertension-related risk factors in order to develop models, that can predict hypertension based on these risk factors since early detection, diagnosis, and screening can reduce the incidence of cardiovascular diseases and enhance the quality of life. The moto of this current study is to participate logistic regression analysis with Artificial Neural Networks (ANNs) models can predict risk factors and prediction of chronic diseases by analysing the cause of hypertension. This proposed system uses a logistic regression algorithm to know the relationship between the dependent and independent variables. Sinkuo Chao et al [4], proposed a system to predict HTN complications. The Taiwan administrator and ministry of health stated that hypertension causes major risk factors like heart diseases, strokes, kidney related diseases and many other diseases. It leads to severe complications when the complications of 6 people with hypertension are very high. So, to avoid the major complications this proposed system uses the one of the machine learning algorithms that is the decision tree and it collects the data about the patients with heart related diseases like stroke. This proposed model is the predictive model and this model uses the Bayesian calculation to predict hypertension. Guojun Zhang et al [5] proposed a system to predict hypertension based on support vector machine and Random Forest for this prediction they

ISSN PRINT 2319 1775 Online 2320 7876
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used the sample data which is established in three gorges part this data is gathered by Tongji Medical College of HUST. This feature spoils the calculation and classification data and it also reduces the actual time capacity of medical values. To reduce the complexity of data and number of attributes this model uses a rough set, SVM is used to train the data and predict hypertension. Daniel La Freniere et al [6], proposed a system that predicts hypertension from a clinical dataset an ANN is a powerful ML technique which permits the prediction of existence disease in susceptible populations although confiscating the potential for human error. In order to categorize hypertension back propagation, the neural network has 11 input nodes, 7 hidden nodes and 2 output nodes. The paper proposes a predictive ANN model which produced an accuracy of 82% when used with the large integrated CPCSSN data. Xiuying Dong et al [7], proposed a study of system on the causes of HTN with improved BP neural networks, the Neural Network based LM (Levenberg-Marquard) algorithm is applied. This network learning process is of two parts, namely positive communication and back-propagation. During the forward transmission, information from the input layer is sent to the output layer via hidden units.

Sundus Abrar et al [8], proposed a system. In order to predict real-time distributions of BP Gaussian mixture models and OIESGP are used. Framingham HTN risk estimator is used to estimate the risk score. The model is evaluated using Mean square error, mean absolute error and root mean square error. From computing missing values in time series, the user agent and data processing agent algorithms are used. Sirinat Wanriko et al [9], projected a system that uses machine learning as an approach to assess risk of pregnancy induced HTN. Pregnancy-induced Hypertension is among the top three killers in pregnant women. The on-target cause and treatment for it is still unknown. However, Earlier detection and medication can reduce the risk and severity.

3. PROPOSED SYSTEM

System Design

The projected system uses machine learning classifiers along with ANN to predict hypertension for distinct categories of people. This system predicts the person with hypertension or no longer. For this prediction Logistic regression, Random Forest, Gradient Boosting classifier, AdaBoost classifier and XG Boost classifier are used. Along with these classifiers, ANN algorithms are also used. The data is acquired from the Kaggle repository which is a CSV file. As a primary step we import the libraries. Afterward, the predictions are achieved for the given information and the usage of the above-mentioned classifiers where precision, recall and F1 score are obtained for the data which might be greater than existing systems. In the end, as an output the result is either an individual with high blood pressure or no high blood pressure.

Data set consists of fifteen columns namely Patient Number, Blood Pressure Abnormality, Level of Haemoglobin, Genetic Pedigree Coefficient, Age, BMI, Sex, Pregnancy, Smoking, Physical movement, salt content in the diet,alcoholconsumptionperday,LevelofStress,Chronickidneydisease,Adrenal_and_thyroid_disorders . This collected data is stored in one variable that is df with help of this dataset we will predict the hypertension by applying machine learningclassifiers. Applied below machine algorithms to get the comparison and also to acquire performance of the system. 1. Gradient Boosting Classifier 2. Ada Boost Classifier and ANN Algorithms. The Purpose of this Comparison is to acquire more Performance

Graphical representation of the System.

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Research paper Volume 11, Iss 4 , 2022

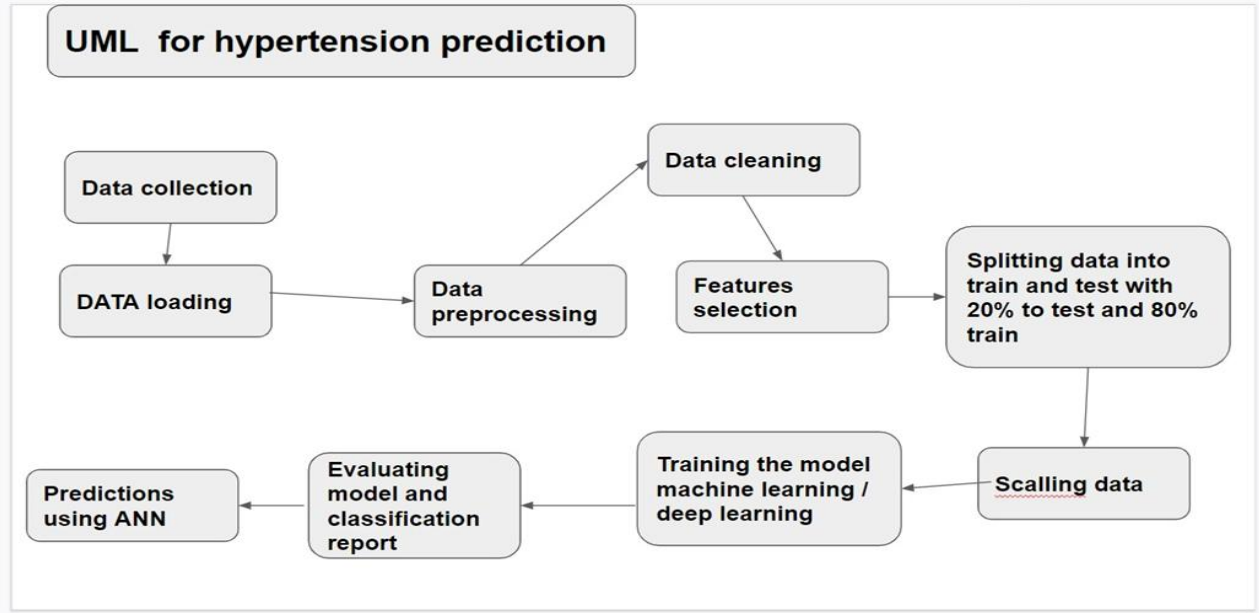

Fig 1: UML Diagram for Hypertension Prediction

LOGISTIC REGRESSION: It is one of the popular Supervised machine learning algorithms. This is used to solve the classification problems and also used for predicting the categorical dependent variable using a given set of independent variables. Generally, we have three types of logistic regression namely multinomial, binary and ordinal. Logistic Regression is used to predict the output.

The linear function can be $h\emptyset(x)=g(\emptyset Tx)$ where$0\leq h\emptyset\leq 1$

$g(z)=1/1+e-z$where$z=\emptyset^{T}x$ Here g is the sigmoid function.

RANDOM FOREST: Random Forest is also supervised machine learning like logistic regression. It mostly depends on both classification and regression problems. It uses several decision trees to calculate the data and it gives majority results on classification and average results on regression. Why it is called Random Forest means it randomly selects the data from a sample. Random Forest is used to predict the output.

BOOSTING CLASSIFIERS: In our proposed model we used the boosting classifiers, boosting algorithms grant superpower to machine learning algorithms to progress the accurateness of the prediction. So in this Gradient Boosting classifier, AdaBoost classifier, XG Boost classifier are applied implemented on data sets which are collected from Kaggle repository. With the help of this boosting classifiers, we can improve the results of our system to get the accurate one. It means that combines the data and converts the weaker ones into stronger ones. It improves the power of the machine learning algorithm we have used in our system.

ANN: ANN stands for artificial neural network. ANN is independent of other algorithms and it includes several processes to deliver the output units. ANN is the advanced machine learning algorithm where it is used to model data.

$$\sum_{i=1}^{n} Wi * Xi + b$$

Wi is the weights of the connection and xi is the input units and b is the bias.

Output of the artificial neural networks can be input is computed with weight having bias.

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4. IMPLEMENTATION:

We need to install Jupyter notebook which is one of the software requirements for our system

The data is acquired from the Kaggle repository which is a CSV file with fifteen attributes. As dataset is a collection of data which will be in the tabular form here, we used the dataset from open source which has all required categories to predict the hypertension, after importing all the required information, we will calculate the level of stress for the dataset entries because the nerves system will deliver a huge number of hormones that increase the blood pressure of the body. With the help of stress levels only we can easily predict the blood pressure, we will train and split the data for applying the classifiers. Here 80% of data get trained and the remaining 20% of data gets split. This training and splitting of data are done to check how our machine learning classifiers fit the model. Now we will apply some selected machine learning algorithms, like Logistic regression, Random Forest along with ANN to the dataset. We have used ANN for further development of the system. We also need the boosting classifiers like Gradient Boosting classifier, AdaBoost classifier and XG Boost classifier for the data which is used to increase the accuracy of the results. We get the classification report with precision, recall, f1-score for every classifier we have used and with this we can predict the people suffering from hypertension.

Developing, Training and Splitting a model:

Here the concept of machine learning has been used which is used to develop the model that are able to learn by using the algorithms. The system uses some machine learning classifiers along with ANN. We haveusedANNforfurtherdevelopmentofthesystem.WedevelopedamodelbyusingLogisticregression, RandomForest,GradientBoostingclassifier,AdaBoostclassifierandXG BoostclassifieralongwithANN. Here the boosting algorithm is developed to increase the accuracy of the proposedsystem

5. RESULTS

The model has been entrusted with considering 20 number of epochs and hereafter the replication values associated withtraining loss,precision,validationloss,andaccuracyofepoch respectivelyarepublicizedinTable. 1 The model accuracy graph represents change of loss and precision regarding epochs .The performance metrics associated to the model are exposed inTable 1**.** In this validation loss and validation accuracy are calculated. Test cases are used to check the working nature of the system, based on the test cases one can predict the result as patient with hypertension or no hypertension.

```
In [49]: result = model.predict(np.array([[Level_of_Hemoglobin,Genetic_Pedigree_Coefficient,Age,BMI,
               Sex, Pregnancy, Smoking, Physical_activity,
               salt_content_in_the_diet, alcohol_consumption_per_day,
               Level_of_Stress, Chronic_kidney_disease,
               Adrenal_and_thyroid_disorders]]))
         if result[0][0]==1:
             print("patient with Hypertension")
         else:
             print("No Hypertension")

         patient with Hypertension
```

```
In [50]: result = model.predict(np.array([[Level_of_Hemoglobin,Genetic_Pedigree_Coefficient,Age,BMI,
               Sex, Pregnancy, Smoking, Physical_activity,
               salt_content_in_the_diet, alcohol_consumption_per_day,
               Level_of_Stress, Chronic_kidney_disease,
               Adrenal_and_thyroid_disorders]]))
         if result[0][0]==0:
             print("patient with Hypertension")
         else:
             print("No Hypertension")

         No Hypertension
```

Fig 2: Results from Data set Patient with and Without Hypertension

ISSN PRINT 2319 1775 Online 2320 7876
Research paper Volume 11, Iss 4 , 2022

Epoch	Train loss	Train Accuracy	Validation loss	Validation Accuracy
I	.6931	.4994	.6912	.5300
II	.6875	.5863	.6754	.6700
III	.6525	.6500	.6026	.7375
IV	.6017	.6931	.5450	.7525
V	.5688	.7200	.5251	.7700
VI	.5713	.7194	.5213	.7625
VII	.5536	.7219	.5105	.7750
VIII	.5356	.7356	.5032	.7700
IX	.5402	.7437	.4991	.7800
X	.5392	.7475	.4952	.7725
XI	.5277	.7556	.4895	.7700
XII	.5297	.7437	.4874	.7750
XIII	.5083	.7588	.4797	.7850
XIV	.5166	.7544	.4754	.7900
XV	.4996	.7725	.4704	.7950
XVI	.4932	.7681	.4652	.8000
XVII	.4914	.7706	.4621	.7875
XVIII	.4934	.7694	.4555	.8000
XIX	.4948	.7719	.4551	.7950
XX	.4921	.7700	.4509	.8075

Table 1: Validation Loss and Validation Accuracy

	Precision	Recall	F1-Score	Support
0	.89	.92	.90	208
1	.91	.88	.89	192
Accuracy	.90			400
Macro avg	.90	.90	.90	400
Weighted avg	.90	.90	.90	400

Table 2: Results By applying the Gradient Boosting Classifier

	Precision	Recall	F1-Score	Support
0	.87	.90	.89	208
1	.89	.86	.88	192
Accuracy	.88			400
Macro avg	.88	.88	.88	400
Weighted avg	.88	.88	.88	400

Table 3: Results By applying the AdaBoostClassifier

ISSN PRINT 2319 1775 Online 2320 7876
Research paper Volume 11, Iss 4 , 2022

	Precision	Recall	F1-Score	Support
0	.87	.90	.89	208
1	.89	.86	.88	192
Accuracy		.88		400
Macro avg	.88	.88	.88	400
Weighted avg	.88	.88	.88	400

Table 4: Results By applying the XG BoostClassifier

	Precision	Recall	F1-Score	Support
0	.88	.85	.86	208
1	.84	.87	.85	192
Accuracy		.86		400
Macro avg	.86	.86	.86	400
Weighted avg	.86	.86	.86	400

Table 5: Results By applying the ANN

Model Accuracy

The performance metrics are considered for model accuracy they are Precision, Recall, F1-score, and accuracy. Accuracy is the proportion between number of correct predictions to the total number of predictions performed. Method used to calculate the accuracy is:

$$\text{accuracy} = \frac{\text{No: of predictions}}{\text{Total No: of predictions}}$$

Precision is the quantity between the number of correct positive predictions to the total number of positive predictions.

$$\text{Precision} = \frac{\text{No: of correct positive predictions}}{\text{Total No: of positive predictions}}$$

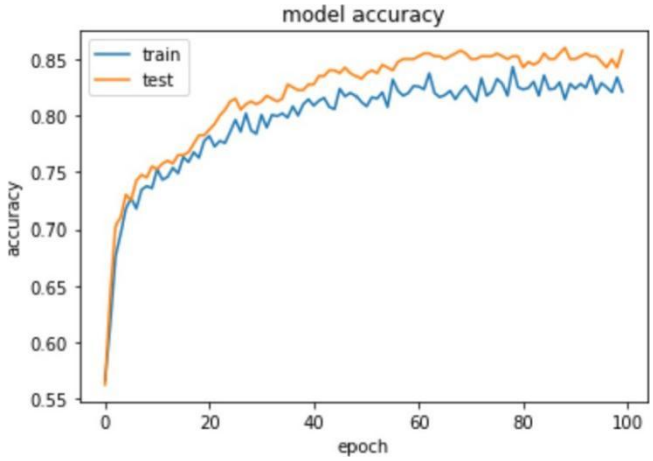
Recall is the proportion between the number of correct positive predictions to total number of values in positive class examples. The formula used to calculate recall is:

$$\text{Recall} = \frac{\text{No: of correct positive predictions}}{\text{Total No: of values in the positive class}}$$

Fig 3: Model Accuracy Graph

ISSN PRINT 2319 1775 Online 2320 7876
Research paper **Volume 11, Iss 4 , 2022**

F1-score is the average of precision and recall values. The formula used to calculate f1-score



$$F1 - score = \frac{precision + recall}{2}$$

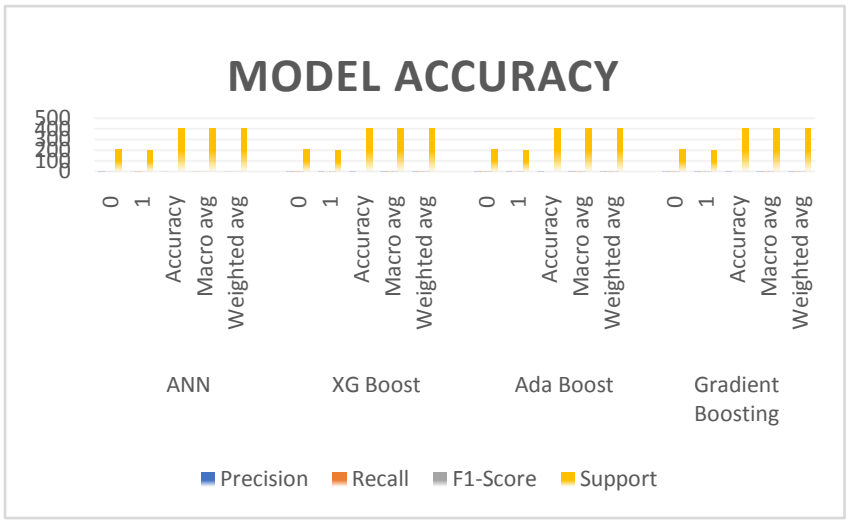


Fig: 4 Model Accuracy Graph for Precision, Recall, F1- Score, Support

6. DISCUSSIONS: Conducted experiment to evaluate the efficiency of algorithm and disseminated results. based on the results and model accuracy one can easily recognize the results, which one has hypertension and which one is not having hyper tension issues. The performance metrics related to the model are depicted in **table 1. In Table 2, and 3** results obtained by applying Gradient Boosting Classifier and Ada boosting Classifier. **In table 4** results are obtained by applying XG Boost classifiers. **In table 5** Results are obtained by Applying Artificial Neural Networks. Model Accuracy graph is obtained. By applying Gradient boosting classifier precision recall and accuracy are more when compared with the remaining.

7. CONCLUSION: Inthispaper,Authorsdevelopedasystemtopredict, thepersonsufferingfromhypertensionornot by applying machine learning algorithms with ANN. Also used boosting classifiers to improve the results of the system. The required dataset is collected from open source. The results displays that the accuracy of present system is greater than the existing system which is accurate andefficient. In future by using Genetic algorithms one can get more accurate results.

ISSN PRINT 2319 1775 Online 2320 7876
Research paper **Volume 11, Iss 4 , 2022**

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