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Smart Health Prediction System Using Machine Learning for Physiological Data

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Abstract The use of clinical healthcare programs has seen a large boom in attention in recent years. The development of an ailment tracking device that offers flexibility and mobility to track sufferers' fitness situations may be done the usage of a gadget, ideally an online system. The machine indicates the sickness to the consumer while the parameters' evaluation fee reaches a specific outcome. Massive volumes of facts are accrued by the healthcare region, some of that is hid facts that may be used to manual selections. In the healthcare structures, there is a lot of facts. Nonetheless, there are not many efficient analytic gear available to find traits and hidden links inside the statistics. For acquiring the intended outcomes and making defensible judgements based on records, several sophisticated data analysis methods are employed. In the present investigation, a health forecasting system (DPS) has been created using the Naive Bayes and decision Tree algorithms to predict the likelihood of illness in human bodies. The set of rules makes predictions the usage of 15 scientific characteristics, which include age, sex, blood strain, cholesterol, and weight problems. The DPS estimates the scenario whether that a patient gets a sickness or not and which one. It makes viable critical data. In this regard, it's crucial to recognize connections between trends and health factors associated to cardiovascular disease.

Keywords: Health Prediction, Decision Trees, KNN, Machine Learning, accuracy, efficiency, training, predictions, symptoms

Introduction

For applications connecting with the human body, sickness expectation innovation has seen an expansion in consideration throughout the course of recent years. Due to machine learning, there are now more people who need medical care—and they need it quickly and precisely—because the world's population has grown significantly over time. The standard patient monitoring systems are becoming less reliable because they use threshold levels of parameters to indicate a significant risk. A few measures are being utilized to examine worldwide gamble, and endeavors are being made to expand their precision. Other developers have put forth an effort to come up with a framework built upon the same concept that would have made an effort to provide a framework based on the same idea that would average the attributes of the system tree and compare them to a database of medical practitioners to monitor a particular parameter. We used a flexible framework in this study to analyze physiological data from patients in real time and monitor their health. Utilizing user-supplied and system-defined parameters, the system first measures the physiological data of the patient before providing us with the user's health status through analysis. The framework's continuous client input information and

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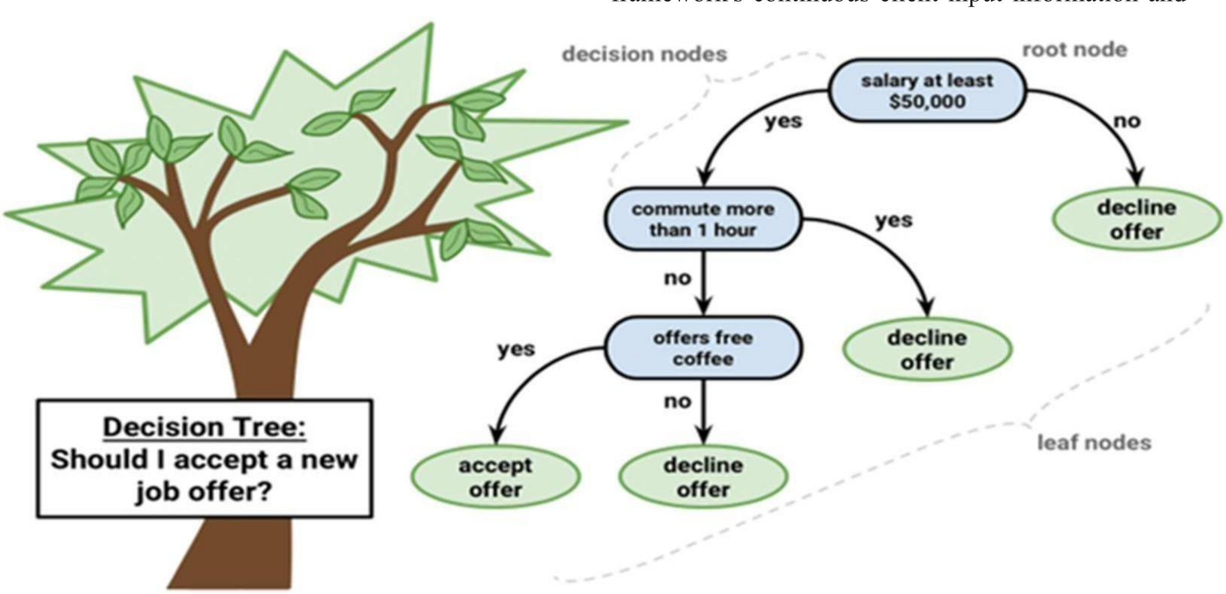


Fig 1.1: Description of the functioning of Decision Trees

history information are consolidated to make a data set that is utilized to dissect the patient's wellbeing. Prospective diagnostic neural network methods can better understand how to manage persistent illnesses and offer options for therapy that take a patient's demographic and surroundings into account by adding social aspects of health. An emerging strategy for enhancing patient outcomes is predictive analytics. By examining the data and results of previous patients, neural networks may be developed to give expertise concerning the sorts of remedies that might prove helpful for present patients. Predictive analytic methods vary from person to person, but they can be used to estimate the severity of COVID-19. Using predictive analytics, American Chemical Society researchers have just developed a blood test that can determine whether a person may have severe COVID19 symptoms. Predicting future trends and sorting utilizing data, the knowledge of the clever healthcare operation and analysis have become crucial to the sector's rapid growth. One of the most important topics that modern people pay attention to as they get older is how to live a healthy life. Medical guidance data is making healthcare smarter, which could also help patients deal with the problem of taking too much medication. The medical advice data service, which also enables clinicians to comprehend the patients' state of medical marketing agency, allows medical facility to transition from its traditional medical role to one of the advancement of wellbeing. In the era of big data in medicine, the use of intelligent healthcare equipment contributes to the improvement of service quality and medical efficacy. The healthcare system has been our society's most important pillar. The advice given by doctors in response to symptoms that patients confirm is absolutely necessary for the health care system. But what if there isn't a doctor on call? What might occur assuming that you really wanted clinics however they were protesting? What would you do if you got sick and couldn't get to the hospital because you were alone at home? What would you do about it? For the same issue, we present our project, "Smart Health Prediction system utilizing Machine Learning." End-user assistance is provided by the online Smart Health Prediction System.

This decision tree starts by asking whether the salary offer is above $50k. If the answer is yes, the next question is whether the company's reputation is rated above 8. If both conditions are met, the recommendation is to accept the job offer. If not, the tree asks whether the commute time to work would be more than an hour. If the answer is no, the recommendation is to accept the job offer. Otherwise, the recommendation is to reject the offer. Of course, this is just a simple example, and a real-world decision tree for job offer acceptance would likely consider additional factors such as job responsibilities, benefits, company culture, and career growth potential. Additionally, decision trees can be personalized to reflect an individual's unique preferences and circumstances. Nonetheless, this example illustrates how a decision tree can be employed to break down a difficult issue into an array of easier, attainable options.

As you can see from the image, A decision tree resembles an organizational chart. that starts at the top with a single node called the root node. The root node represents the initial decision that needs to be made, based on a set of available options or criteria. From the root node, the decision tree branches out into a series of interconnected nodes, with each node representing a specific decision point or criterion. Each branch represents a different possible outcome or decision that can be made based on the criteria represented by the node. The nodes that form leaves constitute the tree's last elements, and they represent the final decision or outcome of the decision-making process. Each leaf node corresponds to a particular decision or action that can be taken based on the preceding decisions or criteria. In a typical decision tree, the nodes are labeled with questions or criteria, and the branches are labeled with the possible outcomes or decisions that can be made based on those criteria. The labels on the branches and nodes are usually accompanied by probabilities or other numerical measures of uncertainty, which reflect the likelihood of each possible outcome or decision. Numerous industries, including the financial and business sectors, medical services, and science and technology, leverage decision chains. They are particularly useful in situations where there are multiple factors or criteria that need to be considered in making a decision, as they can help to simplify complex decision-making processes and enable users to visualize the trade-offs and consequences of different options. Fig 1.2: Example of the Decision Trees

RELATED WORK

Author Uses Naïve bayes algorithm for predicting the disease and for clustering knn algorithm in order to ease down the workload on the system for solving the problem Disease Prediction using Machine Learning ,2019 International Research Journal of Engineering & Technology. Kedar Pingale1, Sushant Surwase2 [1]
The machine learning approach utilized for precise illness prediction is discussed in this research. Here, a latent component model is employed to obtain the partial data. Large amounts of hospital data are clarified using the Naive Bayes technique, and subsequently Convolutional Neural Network Based Multimodal Disease Prediction (CNN-MDRP) algorithm aids in providing results, By Shraddha
Subhash Shirsath in the paper "Disease Prediction Using Machine Learning Over Big Data", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 7, Iss. 6, pp 6752-6757 [2].

A key goal is to assess data mining methods for clinical and healthcare applications to make informed judgements. Additionally, it provides a thorough analysis of medical data mining methods that can enhance several facets of clinical predictions.. It is a new powerful technology which is of high interest in computer world, Nikita Kamble, Manjiri Harmalkar, Manali Bhoir, Supriya Chaudhary, IJSRCSEIT, 2017. Smart Health Prediction System Using Data Mining [3] .

The project trains a neural network and than uses the trained neural network for detection of kidney disease in the human body. The back propagation algorithms presented here have capacity for distinguishing amongst infected patients or non-infected person Nilesh Borisagar, Dipa Barad, Priyanka Raval, Conference paper (PICCN), April 2017. Chronic Kidney Disease Prediction using Back Propagation Neural Network Algorithm[4] .

This study examines the forecasts for heart disease using several categorization systems. Here medical data mining techniques like Association Rule Mining, Clustering and Classification Algorithms such as Decision tree, C4.5 Algorithm are implemented to analyze the different kinds of heart based problems , A. Nishara Banu, B Gomathy, IJTRA, Dec 2013. Disease Prediction System Using Data Mining Techniques [5].

The proposed system has used Wireless Based sensor based network to monitor the patient's physiological data with increased mobility even in the ubiquitous environment. HR, SpO2 levels have ben monitored and assessed for the evaluation of final results from the research of Cluster-based real-time analysis of mobile healthcare applications for the prediction of physiological data [6] by Sagar B. Tambe and Suhas S. Gajre.

Prediction of heart disease has been done by using Logistic Regression and knn which have showd better accuracy than the previous ones used like that of the naive bayes classifiers , Heart disease prediction using machine learning algorithms Harshit Jindal1, Sarthak Agrawal1, Rishabh Khera1, Rachna Jain2 and Preeti Nagrath2[7].

The current work provides an approach that includes data preparation, a method for handling missing values, data aggregation, and feature extraction for predicting CKD status using clinical data. In this study, Comparative Analysis for Prediction of Kidney Disease Using Intelligent Machine Learning Methods, three different models for accurate prediction were trained using a variety of physiological variables and ML techniques like logistic regression (LR), decision tree (DT) classification, and -nearest neighbour (KNN). Mohammad Monirujjaman Khan [8], Tahia Tazin, Sami Bourouis, Gazi Mohammed Ifraz, Muhammad Hasnath Rashid [1, 2], and Sami Bourouis.

Machine Learning Approach for real time model For a scenario when the patient's medical history is unknown, the literal model's delicateness will be low. We require a real-time decision-making system that can immediately prognosticate the hazard in order to increase efficacy for comparable cases. In this study, the danger is predicted in real time using clustering and bracket techniques. Delicateness can therefore be improved by contrasting its outcome with that of a literal model for the same issue. This model may be used to cluster and categorize the unknown data. The proposed regulation more precisely classifies the incoming input signals. We may set up a comparison between the real-time model, which chooses the affair threat as the outside of both, and the literal model's (complaint-specific) conclusion. The literal model for advanced vaticination delicacy can employ the boobytrapped collection of cases' database. However, the database could not really include data on the freshly entered instances. This script calls for an entirely new design that can immediately assess threats using casespecific real-time data. This new model is expected to use real-time sluice data mining to cover the case's critical signal and forecast the health concern. The crucial information and proclamation that were transmitted in the event of an emergency belonged to croakers.

Decision Trees for real time evaluation

To solve classification and regression problems, a decision tree is a tree-based method. An inverted tree is built to provide the output, branching from a root node with a homogeneous probability distribution to leaf nodes with significant heterogeneity. Regression trees are used for dependent variables with continuous values, whereas classification trees are used for dependent variables with discrete values. A decision tree is built using the independent variables, with a condition over a feature at each node. The nodes decide which node to visit next based on the criteria. Once the leaf node is reached, an output is expected. When the requirements are in the right sequence, the tree works well. Entropy and information gain are the criteria for determining the node conditions in nodes. The method utilized to create the tree structure is greedy and recursive.

Proposed system

The proposed work focuses on outlining the disease that is being faced by the individual using machine learning , using classification and deciding on the factors provided to the decision tree algorithm. We have proposed a project which is based upon the finalization of the decision which would be undertaken on the basis of the parameters provided to the decision tree. The decision tree is being fed by the parameters in the form of symptoms. Each of the decision tree string that results in the different pathway is formed of a different kind of parameter/ symptom pathway. Each pathway responds to different evaluation by the decision tree. The user here needs to analyze and enter or provide the system which is being fed by the form of symptoms that he/she might be facing. The fed input is then classified by the decision tree, utilized into construction of the best possible branch that could lead the input values to the specific result. If the input results in some kind of disease that the person might be facing than, the system defines and alerts the person that he or she might be facing a specific disease, if the evaluation turns out to be that way. If the prediction by the tree does not result in any form of disease than the system result wont be the same as that of the previous one

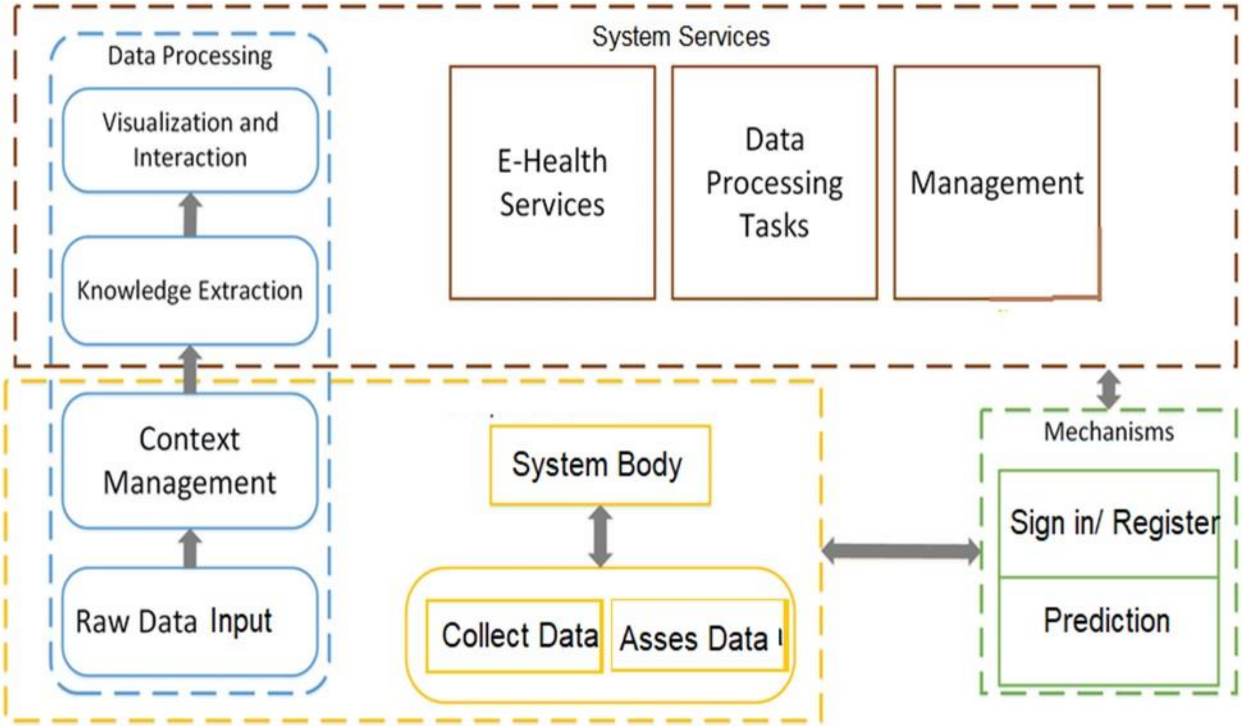
Name	Type	Description
Age	Continuous	Age in years
Sex	Discrete	1 = male 0 = female
Cp	Discrete	Chest pain type: 1 = typical angina 2 = atypical angina 3 = non-anginal pain 4 =asymptomatic
Trestbps	Continuous	Resting blood pressure (in mm Hg)
Chol	Continuous	Serum cholesterol in mg/dl

Steps involved in Decision Trees

Step 1: Begin your tree at the base nodes, that holds the entire dataset, according to S. All of the preparatory information that must be used by the system for evaluation is contained in this root. Step 2: To figure out the most significant attribute in the dataset, employ the Attribute Selection Measure (ASM). The procedure of choosing the best characteristic follows. Here, the best attribute for each disease or separate branch created for prediction is chosen. For instance, if the branch is responsible for predicting the outcomes of a minor cough and cold, the preliminary attributes chosen for those branches would be sneezing and coughing, respectively, which would form the root of the subsequent tree being created for the evaluation process.

Step 3: To incorporate possibilities for the most beneficial characteristics, subgroup the set S. According to the similarity and dissimilarity of the root parameters they possess for the assessment, the branches that have the same sort of root parameters are being separated and bifurcated from one another. Step 4: Create the decision tree node that has the best attribute in step four. In order to generate the pathway or branch to outline the whole analysis and the full prediction path for the disease, the best node among them all for the corresponding paths or branches is

Architecture of the system



chosen.

Step5: Use the selections of the dataset generated in step 3 to iteratively develop new decision trees in Step 6. Continue down this path until you reach a point when you can no longer categorize the nodes and you

Fig 1.3: Architecture diagram of the system Fig 1.3 explains the Architecture diagram of the system which depicts the system in different phases. Initially the system has been fed by the raw input that has been supplied in the form of the dataset. The dataset than has to be handled by the system. The system than is used up for knowledge extraction with the contextually useful data has been utilized and consumed for the prediction of the final result which then goes ahead for the final predictions. The system here provides three services including prediction service, the data processing task that is done internally, the data management where the data has been collected and assessed as well for all the functions and performance requirements of the system. The system simply runs for the user once he/she has signed in, registered for the system with giving him/her the access to gain access for the prediction facility of the system .

refer to the last node as a leaf node. This stage entails creating the trees repeatedly until we obtain a final output, a forecast, or even if we don't, we are guaranteed not to receive a result from a certain branch.

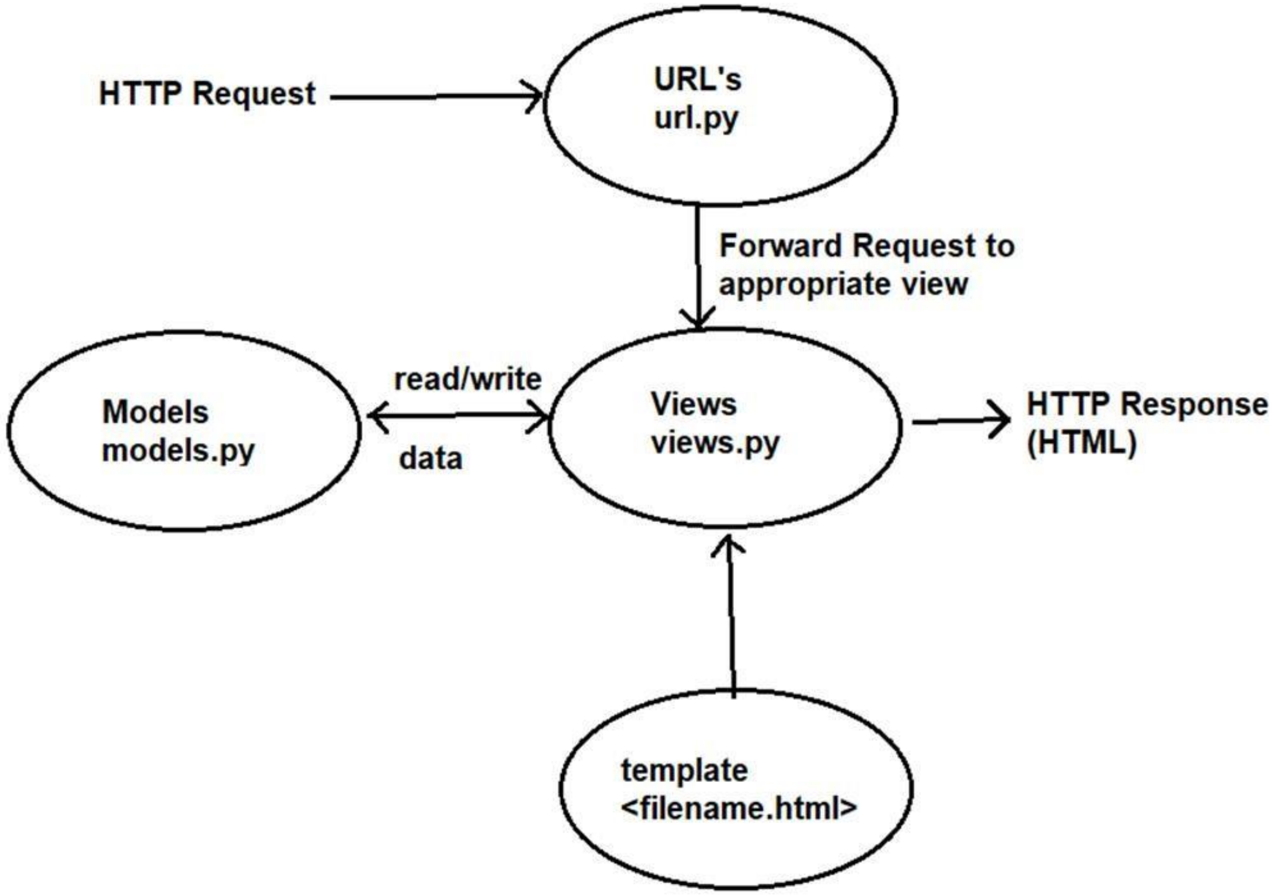


Fig 1.4: Model View Template of the System

Fig 1.4 explains the model-view-template being used in the system. We have utilized the model view template of the django framework . The model view template scenario of the web app defines the interaction of the user , the server and the data that has to be utilized by the system in order to fulfill the demands of the user . The user handles the view at first , where he comes in contact with the basic templates that have been designed and developed to be very attractive, easy to use and user friendly so that the user can be very easily seeing the user interface can interact and communicate with the system. The move then goes on for the models where all the data that has to be fetched and utilized is being used by the system. The model contains all the database related functionality with the register and signup sections' functionality being provided and utilized there

The work flow of the system is in such a way that the user interacts with the urls the first where the urls receive the http request from the user after they have been requested . the user request then goes to the urls section and according to the url that has been hit by the user, the urls page redirects the user to the respective view being asked for, the view provides the http response back to the html page and the system , once when the system has been confirmed with the correct path that has to be traversed , the system traverses to the respective area of the request.

The views than loads the specific template which is being assigned to it. Whenever any request is being made on the template again, the template goes back to the view, gets the respective functionality required to be performed as asked by the user, returns to the respective position and starts re-performing the job as being assigned to. The views when asked to handle the data or asked to fetch the data are being asked to move towards the models.py file where all the data related stuff that has to be processed or that has to be done in order to perform the specific tasks are done. The models file than redirects the system to go back to views file in order to resume the functionality being in work as normal after the updation , Fetching, insertion of the data through the user interface. Fig 1.4 represents the Django architecture of MVC model

Algorithm

Inputs: values from parameters
Ac: Accuracy
P: Precision
Fm: F-Measure
Si: Significant Features
Cl: Classification
Fe: Features
Output: prediction whether the person has or doesn't have disease and if has than which one Begin

1. Data Preprocessing : remove missing record, perform data normalization
2. Fe Selection :

a. Selecting a ⊆ ≤ 3 attributes (x,y,z) from the U of attributes
b. Cl: perform Cl of all the subsets like, which one is the best one and which suits the most paths, which could be the most attractive attribute for the classification.
c. Check the performance on the basis of Ac, P and Fm
d. Repeat steps a to c until all the subsets are used and utilized within the dataset
e. Performances are measured using Ac, P and Fm
f. Fe Selection :

i. If(all Fe selected):

1. Attribute selection = false
2. Proceed to step 3

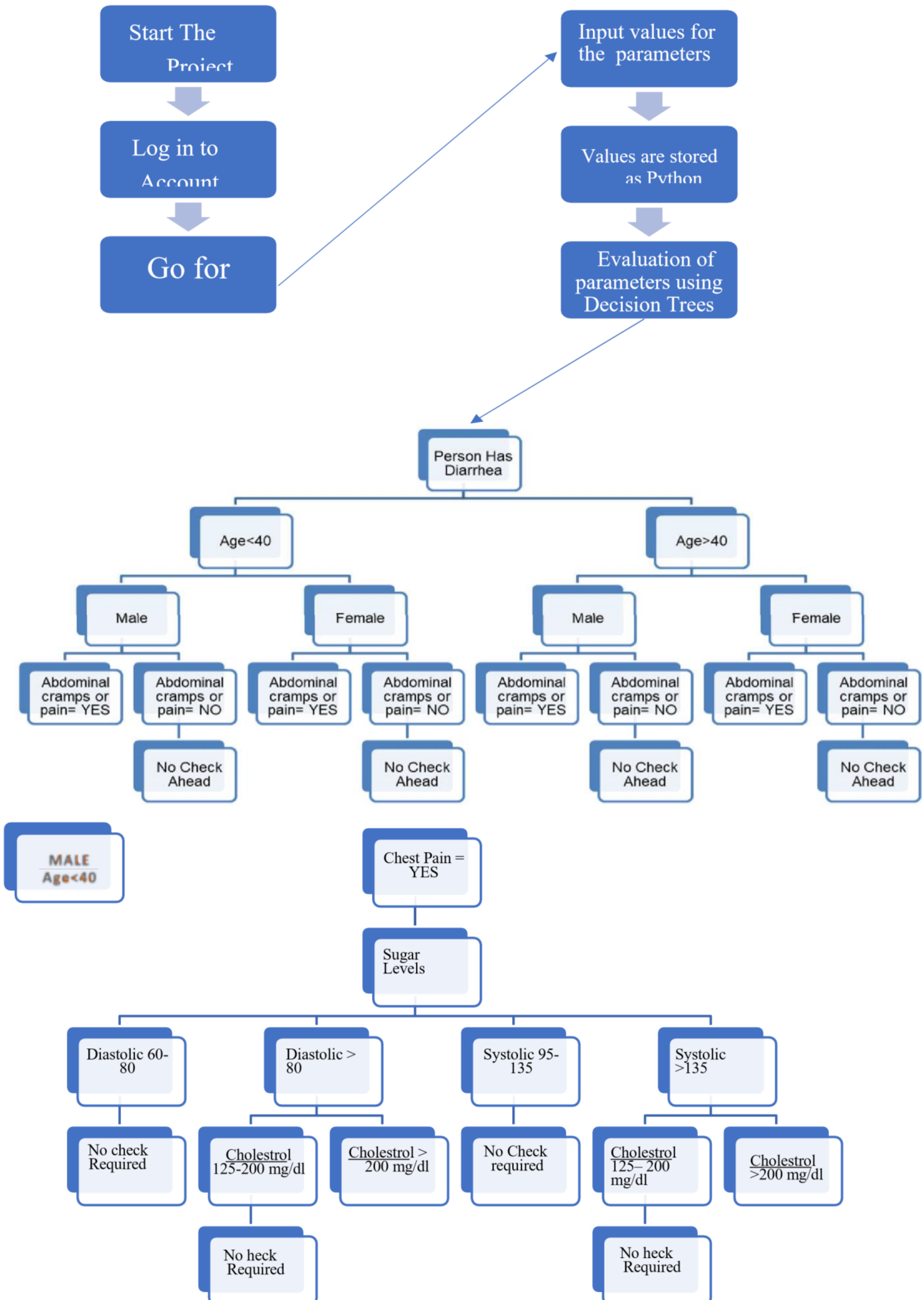
ii. If(Si are found):

1. Attribute selection = true
2. Select Fe that appear more than 10 times from the aggregated
results of the highest performance
3. Compute Fe Weights:
   a. Let r = {a1,a2,a3} and (a>0)
   b. W(n) should be calculated
   c. Calculate total Fe weight for a Fe
   d. Repeat step a to c until the Fe have been finalized
   e. If(attribute selection = false):
   Proceed to 2(f)
   Else End
4. Finalize the node attribute *j*
5. Start creating the decision tree
6. Frame the common attribute in a single path
7. Proceed with all the favorable attributes that could result in a disease until all possibilities are

checked

Flow Diagram of Proposed Approach

The Fig 1.5 in the form of below flow chart explains about the workflow of the actual system that currently system resides upon. Initially the user needs to access the system, work upon registering his profile in the system. Once he/she has registered in the system can get the login access and then being the user can access all the functionalities that are being currently provided in the system. There on he/she being the user of the system can go further to access the prediction page. The user then needs to enter input values as according to the parameters that have been assigned and defined in the form of dropdown menus. Once user has selected all the parameters, the system works using the decision tree algorithm and checks for the available paths/routes it has based on the parameters the user has entered. If the user has entered a path that leads to any of the defined output than the system predicts the possible output with the specific disease that he/she might be suffering through and if the case is on the other side and user does not seems being diseased or the diagnosis does not create any scenario for the algorithm in the form of any pre-defined result, then the result would be positive for the user with no further diagnosis required and no further checks needed


Start The Project
Log in to Account
Go for
Input values for the parameters
Values are stored as Python
Evaluation of parameters using Decision Trees
Person Has Diarrhea
Age<40
Age>40
Male
Female
Male
Female
Abdominal cramps or pain= YES
Abdominal cramps or pain= NO
Abdominal cramps or pain= YES
Abdominal cramps or pain= NO
Abdominal cramps or pain= YES
Abdominal cramps or pain= NO
Abdominal cramps or pain= YES
Abdominal cramps or pain= NO
No Check Ahead
No Check Ahead
No Check Ahead
No Check Ahead
MALE Age<40
Chest Pain = YES
Sugar Levels
Diastolic 60-80
Diastolic > 80
Systolic 95-135
Systolic >135
No check Required
Cholestrol 125-200 mg/dl
Cholestrol > 200 mg/dl
No Check required
Cholestrol 125– 200 mg/dl
Cholestrol >200 mg/dl
No heck Required
No heck Required

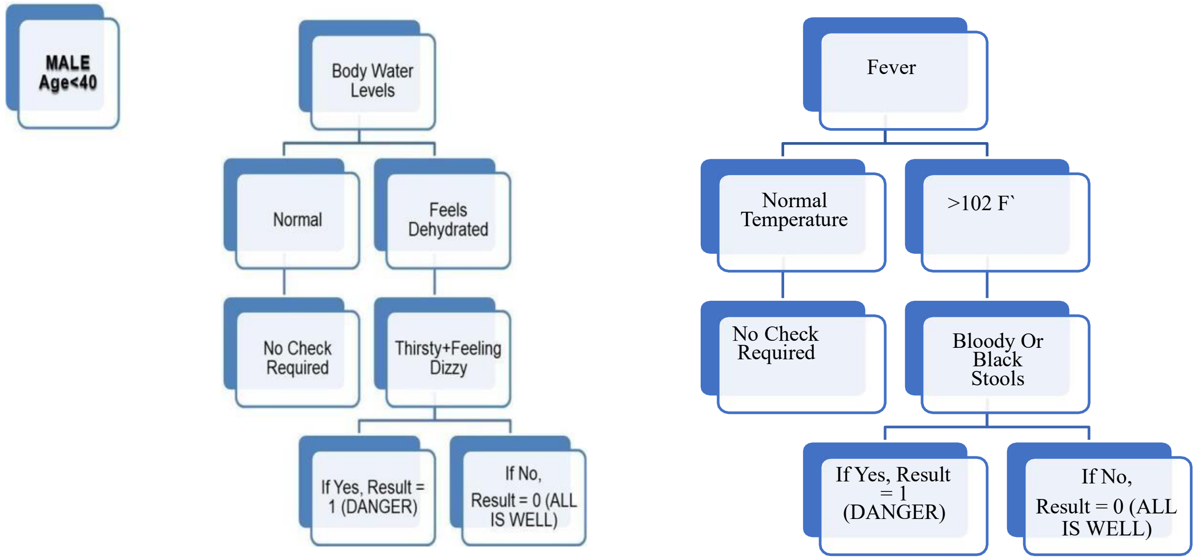


Fig 1.5: Flow chart of the proposed approach

Performance Analysis

Analysis of Algorithms

F-Measure

The balanced F-score (F1 score), often known as the traditional F-measure, is the harmonic mean of recall and accuracy.

$$F_1 = \frac{2}{\text{recall}^{-1} + \text{precision}^{-1}} = 2\frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}$$

F(Beta), a more broad F score An F score that is more broadly applicable and employs the factor Beta, where Beta is selected such that recall is seen as being Beta times as significant as precision:

$$F_\beta = (1+\beta^2) \cdot \frac{\text{precision} \cdot \text{recall}}{}$$

$$F_\beta = \frac{(1+\beta^2) \cdot \text{true positive}}{(1+\beta^2) \cdot \text{true positive} + \beta^2 \cdot \text{false negative} + \text{false positive}}$$

This becomes: When considering Type I and Type II mistakes.

Beta can be set to two different values: 2, which favors recall over accuracy, and 0.5, which favors recall over precision.

$$E = 1 - \left(\frac{\alpha}{p} + \frac{1-\alpha}{r}\right)^{-1}$$

The percentage of cases that were successfully categorised to all occurrences is used to define accuracy. Accuracy = (TP+TN)/(TP+TN+FP+FN). Precision is the percentage of correctly anticipated cases that actually occur out of all true instances.

The relationship established in the project for all of the chosen algorithms appears to prefer the Decision Trees method, which prompted us to continue using that algorithm and to improve our optimization utilizing all of the provided parameters and the scenario as The F1score assessment matrix takes the weighted

Precision is TP/(TP + FP) .Recall is the percentage of real genuine occurrences across all actual objects. Recall is TP/(TP+FN). The average harmonic value of recall and preciseness is commonly referred to as the F-measure. F_Measure is equal to 2*precision*recall/precision + recall.

arithmetic mean of the two matrices, both accuracy and recall, and combines them into a single metric. The weighted average mean of accuracy and sensitivity is, in essence, the f1 score. In order to get information, one uses the F1 score.

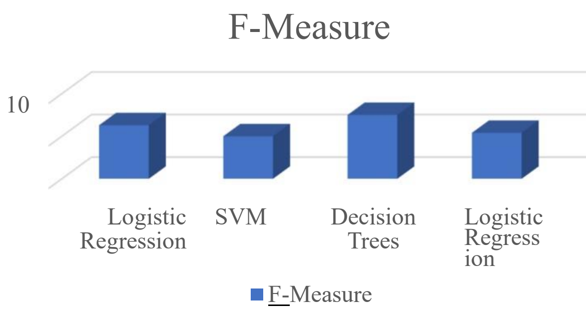


Fig 1.6: Depicts F-Measure of algorithms

Accuracy

The statistical measure of how well a binary classification test includes or excludes a condition is called accuracy. To put it another way, accuracy is the proportion of correctly predicted outcomes—both true positives and true negatives—among all the cases examined .Quantifying binary accuracy uses the following formula:

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

The analysis carrried out in the project for the calculation of accuracy turns out to be in the favour of Decision Trees with other algorithms being tested and analyzed are Logistic Regression, SVM and KNN where the accuracy of Logistic Regression terms out to be around 79%, the accuracy of svm terms out to be around 67%, the accuracy of knn terms out to be around 83% and largest of the lot, we got that of the decision trees where we received the accuracy status to be around 91% which has still and so far out performed all the other algorithms being tested and utilized by our project.

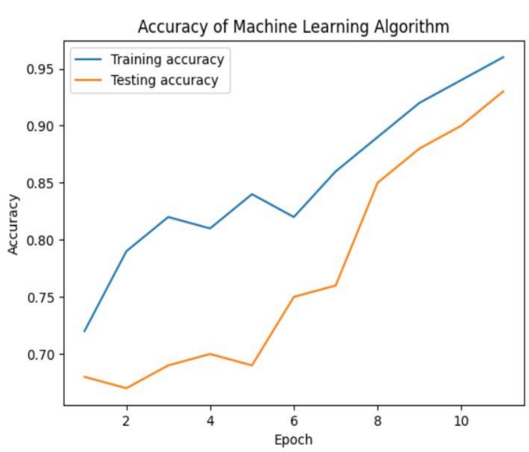


Fig 1.7: Depicts Accuracy testing of Decision tree algorithm

Precision: Precision (also referred to as positive predictive value) is the percentage of pertinent examples among the instances that were successfully recovered, whereas recall (also referred to as sensitivity) is the percentage of pertinent instances actually located.

$$\text{precision} = \frac{|\{\text{relevant documents}\} \cap \{\text{retrieved documents}\}|}{|\{\text{retrieved documents}\}|}$$

Recall: In information retrieval, recall is the proportion of successfully retrieved pertinent documents. In the case of a text search on a group of documents, recall is the proportion of accurate results to results that should have been returned. It might be interpreted as the probability that the query would return a relevant document. Precision and recall may be thought of as (estimated) conditional probabilities.

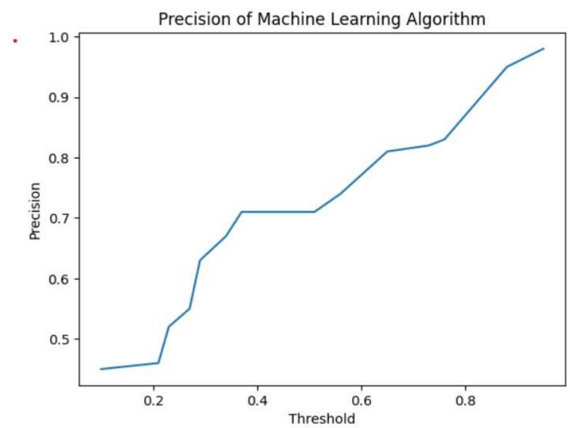


Fig 1.8: Depicts Precision for different thresholds of Decision tree algorithm

By organizing and grouping all the results that were achieved using the analysis of all the algorithms like that of decision trees , knn, svm and logistic regression , we get to know about the factors like precision at which the algorithm gives out the results where decision tree algorithm gave out precision on a scale of 5 of around 4, svm around 2, decision tree around 4.3 and logistic regression at around 3.2 on the scale of 5 , the accuracy at which the algorithm has given the results, the f1 score(within the range of 0 to 1) where we had the results like 6.3 for that of logistic regression, around 5 for svm, around 5.5 for knn and around 7.5 for decision trees and that meant that decision tree had more the number of better classification and that too a kind of accurate ones and about what we can conclude from the definition of f1 score that the more or the higher the f1 score is the greater the classification we have and lesser or closer the number towards zero we have our f1 score the lesser is the classification which wouldn't be a satisfactory scenario for our project, which had to be evaluated after the analysis of the algorithms which relates and concludes out about the prominence of the decision tree algorithm over all the other algorithms present in the analysis

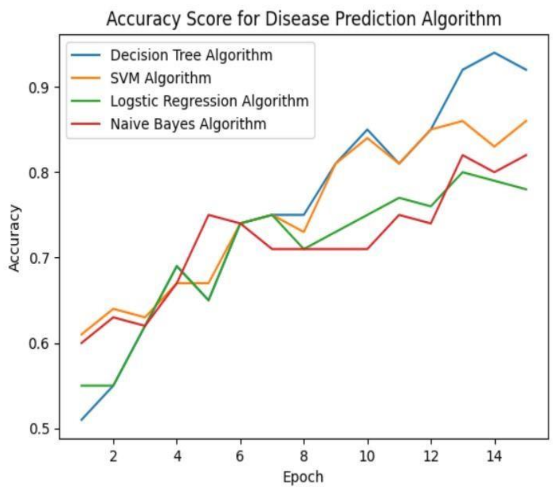


Fig 1.9: Depicts Accuracy Score at different epochs for different algorithms

FUTURE SCOPE

1) Improved accuracy: Disease prediction systems can become more accurate by incorporating new data sources and using advanced machine learning algorithms. This would enable medical professionals to make better judgements and give patients individualized treatment.
2) Personalized medicine: Based on the patients' unique health information, these prediction algorithms may be used to create individualized treatment regimens for them. This may lead to better medical outcomes and therapies.
3) Personalized Doctor Consultation: This System can be more effective when we can integrate actual doctors with the disease a person has to face which would help the patients to get a proper consultation and results quickly and effectively

CONCLUSION

We provided a thorough machine learning-based method for illness diagnostics utilising decision trees in this study. Our method used SVM, Naive Bayes, and Random Forest, three major machine learning classifiers, to identify illnesses using medical data. The data was subjected to significant preprocessing, divided into training and validation datasets, and the effectiveness of these classifiers was assessed using standard metrics including accuracy, sensitivity, specificity, and F1 score. The value of machine learning is highest in the fields of technological and medical sciences. In the area of medical research, machine learning has the potential to work marvels. Patients can easily receive a disease diagnosis and timely medicine delivery. Many illnesses have phases that may be accurately identified, and patients can be treated accordingly. By using the suggested system's knowledge, you may make informed judgements.

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