Recent Advances in Sentiment Analysis Technologies for Healthcare Applications using Machine Learning

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Abstract

Utilizing machine learning in the healthcare industry can assist in identifying patient risk and predicting cardiac disease. By collecting information on patient medical history, vital signs, and test results, a prediction model can be developed to identify those at risk of developing heart disease and forecast the likelihood of future heart problems. Machine learning algorithms can be employed to find hidden patterns in the data for more accurate predictions. The cross- and ramping approaches can be used to verify and test the accuracy of the model. This research study aims to modify a machine learning model that accurately predicts heart diseases in patients. The study uses a positivism and realism research approach, inductive research strategy, and quantitative research methods to identify risk factors and make precise predictions on a patient's likelihood of developing heart disease. The study consists of four stages, including data collection, data pre-processing, model development, and dataset evaluation. After analyzing the dataset, a software design using Python programming language and Google Colab platform was developed. The analysis involves exploring different types of data sources, including patient heart condition, sex, age, and other related sources, to recognize data patterns and correlations. The data is analyzed using data mining, feature analysis, supervised and unsupervised machine learning algorithms, and statistical methods. The results of the analysis include the prediction of heart rate in the healthcare system and the accuracy of the prediction. Implementing the dataset in the healthcare system can lead to improved heart rate prediction strategies and advancements in the deep learning process.

Keywords : Sentiment analysis, Machine learning, Patient risk, Healthcare, Predictive analytics
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1. Introduction

Machine learning may be utilized in the healthcare industry to determine patient risk and forecast cardiac disease. This include gathering information about the patient's history of illness, vital signs, and test findings. A prediction model may then be created using this data to pinpoint those who are at risk for developing heart disease. The likelihood that the individual would experience heart problems in the not-too-distant future may also be forecast using this approach. In order to make more precise predictions, algorithms for machine learning may be employed to find similarities in the data itself that are invisible to the naked eye. The process of cross- and ramping approaches may be used for verifying and testing the model to make sure it is accurate. In the context of healthcare, ML may be used to accurately predict patient risk and forecast cardiac disease.

The introduction of this research study analyses how to complete the sentiment analysis of patient risk identification and heart disease prediction that are related to healthcare using machine learning. This

research study also provides the title of a research project. This research study also includes the background, objective and discusses the scope of the research. The research structure can be outlined for this entire project. This analysis includes the increasing rate of heart diseases that become a major concern for the healthcare systems all over the world. The main goal of this research is to modify a machine learning model that can predict the heart diseases in patients. The data model that will be analyzed on the dataset. This dataset also included the record of patient heart rate. The positivism and realism research approach are used. The inductive research strategy is used to develop this strategy. The quantitive research methods are used to develop the health prediction data for heart diseases. The model means to recognize risk factors and make precise expectations about a patient's probability of creating health diseases. The scope of this project is to develop the machine learning model to recognize the risk factors and to predict the probability of a patient data for developing heart diseases. The data model is tested on the selected dataset of the records of the patient that is obtained from the hospital. The model will be analyzed and evaluated depending on the accuracy for predicting the heart disease of the patients. This research mainly includes the four stages such as data collection, data pre-processing, model development and the evaluation of the dataset. The process of data collection stage that can involve collecting the patient records from a hospital. The pre-processing stage of the data will include for cleaning the data and it is selected for relevant features and it is scaled for the data.

2. Research Method

This article focuses on the research methodology for patient risk identification and heart disease prediction using machine learning in healthcare.

1. Problem Statement: Defining the issue is the first stage in creating a study approach for heart disease forecasting and patient risk assessment using machine learning. The goal of the study and the problems that the researchers hope to answer should be clearly stated in the problem statement. The issue description can be something like "To develop an algorithmic model that is capable of predicting the risk of coronary heart disease in people and to detect major risk factors."

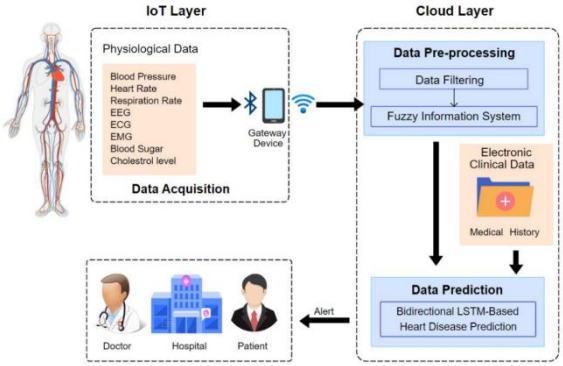

Figure 1: IoT and cloud layer

2. Data Collection: Gathering data is an essential first step in creating a machine learning-based prediction model. To guarantee that the model generates reliable results, the set of variables must be of good quality and contains pertinent data. The dataset could come from databases pertaining to medicine, health information systems, or other sources related to healthcare. The information gathered may include demographic data, medical history, lifestyle variables, lab evaluations, and outcomes from diagnostic procedures.

3. Data Preparation: Following data collection, the data must be preprocessed and made ready for analysis. Processing the data to remove mistakes and inconsistencies, addressing missing numbers, and converting the data into an arrangement that machine learning algorithms can utilize are all parts of the process of preparing the information. This information processing procedure is crucial since it makes sure the model generates

recommendations that are accurate and trustworthy.

4. Feature Selection: The fourth phase is choosing the right characteristics that may be incorporated into the artificial intelligence model. The chosen characteristics need to have a considerable effect on patient risk assessment and heart disease prognosis. The set's complexity is decreased through feature selection, which also contributes to the model's better precision.

5. Model Selection: Several machine learning methods, such as statistical regression analysis, decisions trees, randomized forests, as well as assistance vector machines, might be utilized to forecast cardiac disease and identify patient risk. The kind of problem at hand and the features of the dataset influence the algorithm of choice. Cross-validation might be used by researchers to compare the effectiveness of various algorithms and choose the one that performs the best.

In this section of this research method that can be identically analysed how the research is actually completed. The dastaset is collected that is relevant for the heart disease prediction rate. After collecting the data the dataset is properly analyzed and the dataset is properly evaluated. All characteristics of the dataset are properly analyzed. The dataset is imported properly. After importing the dataset the software is designed. After designing the software the proper algorithms are used to develop this report. The selected algorithm is mostly relevant for this heart rate prediction of the healthcare system. The machine learning approach is used to design the software of health care systems. In this machine learning approach the relevant algorithms are used (Kim, 2021).

3. Research Approach

The following steps make up the study methodology for applying machine learning to forecast cardiovascular disease and identify patient risk:

Step 1: Data gathering and pre-processing

The gathering and pre-processing of the data is the initial phase. This entails locating the pertinent data sources of information, such as clinical registries and medical record systems (EHRs), then extracting the required information from those sources. Demographic details, health information, test results from labs, and findings from imaging examinations might all appear in the data. To ensure the accuracy and completeness of the data, pre-processing is necessary after data collection. This include locating and dealing with missing data, getting rid of redundant information, and normalized the data to guarantee coherence.

Step 2: Choosing a feature

Selecting pertinent characteristics or characteristics from the data is the following stage. Finding the factors that are most indicative of patient risk or coronary artery bypass outcomes is necessary for this. The reliability of the ML models must be improved, and the amount of computational work must be decreased, through feature selection.

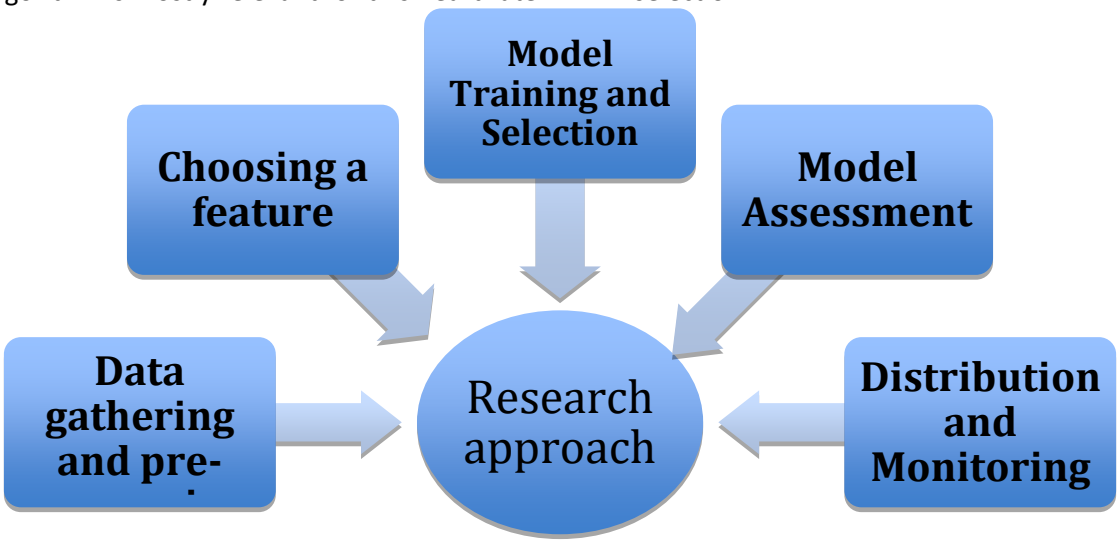

Figure 2: steps of approach

Step 3: Model Training and Selection

The next stage is to choose the best ML framework for forecasting patient risk and cardiovascular outcomes once the pertinent characteristics have been determined. Logistic regression, choice trees, supporting vector devices, and neural networks, among others, are a few examples of the several kinds of machine learning models that may be applied. The pre-processed data and the chosen features are then used to train the ML models. During training, the model is fed with data, and the model's parameters are optimized to reduce prediction error.

Step 4: Model Assessment

The next stage is to assess the ML models' performance after training. This entails evaluating the models' precision sensitivity, specificity, and other indicators of success using a different set of data, referred to as the validation set. By modifying the characteristics, the model parameters, or choosing a new model, the effectiveness of the models may be enhanced.

Step 5: Distribution and Monitoring

The deployment of the ML models into clinical practice and performance monitoring constitute the final phase. This entails supplying physicians with the forecasts and risk assessments and incorporating ML models throughout the clinical process. To guarantee the models' correctness and relevance, they should be frequently updated and retrained.

The research approach requires a thorough review of the prediction on the patient data that is relevant with the heart disease prediction that utilises AI in healthcare data. This empowers analysts to understand the state of the art in this area to identify key difficulties, and recognize the patient exploration data. The inductive and quantitative methodology gives programming structure to import the knowledge into the ongoing difficulties and potential answers programmed for heart rate prediction frameworks utilizing the health system to detect with the help of AI (Islam *et al.* 2019). An inductive methodology that can be utilized to accumulate information from patients, doctors, and analysts about their involvement in existing automated treatment frameworks and their perspectives on the expected qualities and shortcomings of these frameworks. Programming examination of existing automated medical data for frameworks can give significant knowledge into the effectiveness and potential for development of these frameworks (Ali *et al.* 2020). A quantitative methodology that can be taken to test the exhibition of computerized rating frameworks in true treatment situations. This permits researchers to survey framework precision and distinguish likely issues.

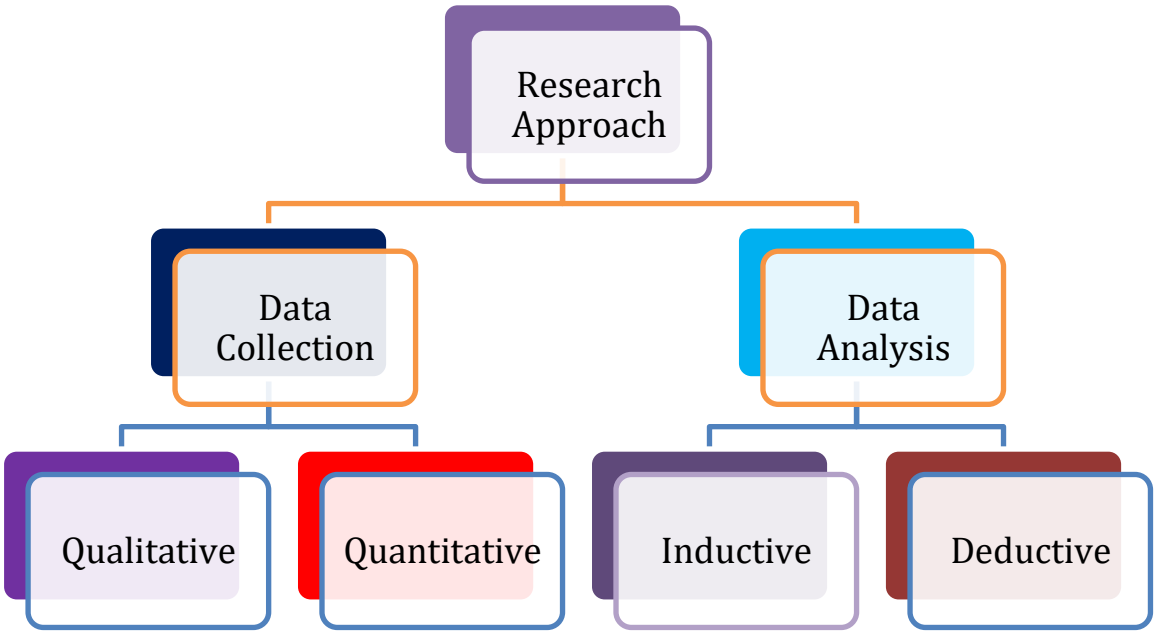

Figure 3: Research Approach

The quantitative methodology gathers information from existing techniques of the patients' treatment frameworks and utilises factual strategies to break down the information (Adler *et al.* 2020). This might remember gathering information for the precision of treatment frameworks, times of treatment, and the expense of the utilizing innovation. This approach assists researchers with better grasping the viability of the innovation and distinguishing regions that need improvement (Kumar *et al.* 2020). The inductive methodology includes investigation of existing writing and information on the treatment of programmed predict the treatments frameworks. This incorporates assessing existing innovation, testing the adequacy of existing rating frameworks, and meeting all the requirements, patient and doctor. Such a methodology can assist researchers with better figuring out the present status of patients of the data for frameworks and recognize expected issues and failures.

4. Algorithm

In the data analysis section includes the analysis two main algorithms which are relevant for this research such as LSTM as well as Bark algorithms. These two main algorithms are mainly used for machine learning technology that is relevant with the healthcare of used the "Long Short Term Memory" or "LSTM" and another one is bark algorithm. These two algorithms are mainly used to recognize the risk of patient and analysis the prediction of heart diseases. Both algorithms have their own advantage and disadvantages. This "Long Short Term Network" algorithms are mainly used a variation of "Recurrent Neural Network" or RNN technology which is actually used for a memory cell and it also remember that the information from the previous evaluation of this selected machine learning technology. This algorithms are used to create an identification the patient risk and the predicts the heart rate. The LSTM algorithms can also analyzed the dependences which are long term for analyzed the data this is also used to recognize the data patterns for overcome the many time steps. For example for using this algorithms used to recognize the structure of the medical history of patients and it also helps to recognize the higher risk of heart disease.

In this section the LSTM can make and analyzed that depends on the large amount of data and it also makes a most suitable applications of healthcare system. On the hand, the use of bark algorithms is a type to follow the decision tree algorithms. For using this algorithms, it is also helped for well suited for recognize the patient risk and predicts the

heart diseases that can analyzed to follow up the entire medical history of the patient.

For using the bark algorithms is can also manage the large amount of datasets and it can make particular for predicts the data when data is also missing. Both algorithms have their own advantages and disadvantages. The LSTM algorithm can take into account the long-term dependencies in the data, making it suitable for predicting heart disease. However, it can be computationally expensive and is difficult to interpret. The Bark algorithm, on the other hand, is computationally efficient and is easy to interpret. However, it may not be able to take into account the long-term dependencies in the data. In conclusion, both the LSTM and Bark algorithms are suitable for patient risk identification and heart disease prediction related to healthcare using machine learning. The LSTM algorithm is better suited for predicting heart disease while the Bark algorithm is better suited for identifying patient risk. For completing the sentiment analysis the researchers can used Random Forest Algorithm, Kneighbours Classifiers and SVM algorithm.

5. Data Analysis

The introduction of the data analysis research study that provides patient risk identification for detecting the heart rate for using a machine learning system for the healthcare system. Here it should be using the advanced machine learning algorithms that are used for designing the software part. The dataset is selected from Kaggle. The selected dataset is relevant for designing the software part. For designing the software the python programming language is used. This research study should also discuss and analyze the main objectives and research aim of this research. It should explain that it is the provided system that is important and discuss how it can modify the rate of heart disease that predicts the healthcare system. It should also provide an overview of the data analysis methods that will be used to modify the entire health care system that is involved the process of data collection, Cleaning the dataset and preprocessing of the dataset and it also analyzed the factors of the dataset and it also analyzed the platform of the software design that is used to develop the software and it helps to model build and evaluation. Additionally, the introduction research study should also discuss the expected results of the heart rate prediction of the healthcare system. And it also implemented the potential approaches for the patient and the treatment of the healthcare system. Finally the introduction research study should also discuss an overview of the structure of the system and the provided dataset that should also discuss the dataset and also analyse the dataset and the result that should be discussed properly in this section.

The dataset is selected from Kaggle. This is actually a CSV extension file. The entire dataset is included in one excel file. The dataset is related to heart rate prediction. With the help of these datasets the software is designed to compete with the help of "Python Programming language" (Rosano *et al.* 2021). The advanced machine learning algorithm is used for software design. In the selected dataset various factors are mentioned such as: "Age", "Sex", "Chest Pair", "BP", "Cholesterol", "FBS over 120", "EKG result", "Max HR", "Exercise angina", "ST depression", "Slope of ST", "Number of vessels fluro", "Thallium", "Heart Disease". The entire dataset includes 270 rows and 14 Columns. These are different types of factors that are used for a heart rate prediction of the healthcare system. This dataset also includes the heart rate prediction from the healthcare systems.

6. Result and Discussion

```
import pandas as pd #import alphanumeric values#
import numpy as np #import numeric value#
import matplotlib.pyplot as plt #import to plotting the graph values#
import seaborn as sns #import seaborn library#
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy_score
from sklearn.metrics import confusion_matrix
from sklearn.metrics import f1_score
from sklearn.model_selection import train_test_split
import warnings #import warning library#
warnings.filterwarnings('ignore')
import sklearn.neighbors
from sklearn.neighbors import KNeighborsClassifier #import KNeighborsClassifier Al
from sklearn.ensemble import RandomForestClassifier #import RandomForestClassifier
```

Figure 4: import various libraries

The provided figure represents different types of libraries that are used to develop this software. Here “pandas”, “numpy”, “matplotlib.pyplot”, “seaborn”, “sklearn.preprocessing”, “sklearn.metrics”, “sklearn.model_selection” libraries that are used. Here the “warnings” library is used. Here also define the “KNN Classifier”, “Random Forest Classifier”. It also defines the “accuracy of the score”, “confusion of the matrix”. The dataset is divided into two parts: train and test datasets (Niu *et al.* 2019). In this section “Numpy '' is an important library in Python that provides efficient and powerful operations on large datasets. It is the most important library for computing various kinds of numerical values. The “matplotlib” library is used for plotting the graph. This library also used to help the plotting of the “line graph”, “histograms”, “bar charts”, “scatter plot”. The library is most popular among the researchers and it helps to develop the performance and scalability.

```
sns.countplot(x='Heart Disease', data=df) #define the sns libraries #
```

```
<Axes: xlabel='Heart Disease', ylabel='count'>
```

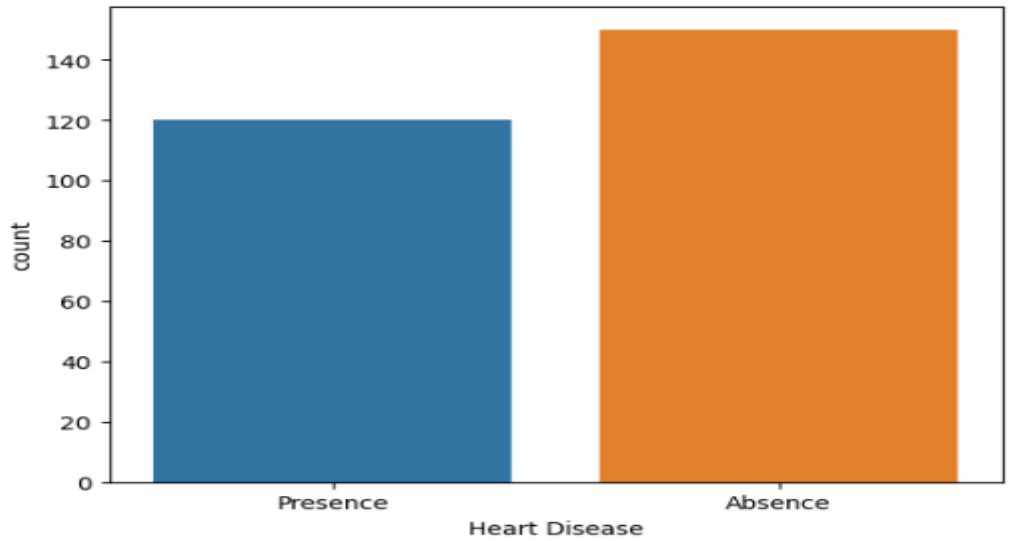

Figure 5: Use SNS Libraries

The following figure shows how to use the SNS libraries. In this graphical representation the X-axis represents the "Heart Disease" and the Y axis represents the "Count". The "sns" library is used to plot the statistical graph in Python.

```
[75] df= pd.read_csv ('/content/Heart_disease_prediction.csv') #load the dataset#
```

Figure 6: Load the dataset

The above picture represents how to load the selected dataset throughout the "Google Drive" link. The "read_csv" command is used to make a path to a CSV file and read the data into the Pandas dataframe (Jenča *et al.* 2021). It is a useful tool for importing these datasets. These data frames are relevant with the lines and variables of this process. This helps to create the data from a CSV file and it is starting to explore it.

```
df. corr () # check the correlations for any values#
```

	Age	Sex	Chest pain type	BP	Cholesterol	FBS over 120	EKG results	Max HR	Exercise angina	ST depression	Slope of ST	Number of vessels fluro	Thallium
Age	1.000000	-0.094401	0.096920	0.273053	0.220056	0.123458	0.128171	-0.402215	0.098297	0.194234	0.159774	0.356081	0.106100
Sex	-0.094401	1.000000	0.034636	-0.062693	-0.201647	0.042140	0.039253	-0.076101	0.180022	0.097412	0.050545	0.086830	0.391046
Chest pain type	0.096920	0.034636	1.000000	-0.043196	0.090465	-0.098537	0.074325	-0.317682	0.353160	0.167244	0.136900	0.225890	0.262659
BP	0.273053	-0.062693	-0.043196	1.000000	0.173019	0.155681	0.116157	-0.039136	0.082793	0.222800	0.142472	0.085697	0.132045
Cholesterol	0.220056	-0.201647	0.090465	0.173019	1.000000	0.025186	0.167652	-0.018739	0.078243	0.027709	-0.005755	0.126541	0.028836
FBS over 120	0.123458	0.042140	-0.098537	0.155681	0.025186	1.000000	0.053499	0.022494	-0.004107	-0.025538	0.044076	0.123774	0.049237
EKG results	0.128171	0.039253	0.074325	0.116157	0.167652	0.053499	1.000000	-0.074628	0.095098	0.120034	0.160614	0.114368	0.007337
Max HR	-0.402215	-0.076101	-0.317682	-0.039136	-0.018739	0.022494	-0.074628	1.000000	-0.380719	-0.349045	-0.386847	-0.265333	-0.253397
Exercise angina	0.098297	0.180022	0.353160	0.082793	0.078243	-0.004107	0.095098	-0.380719	1.000000	0.274672	0.255908	0.153347	0.321449
ST depression	0.194234	0.097412	0.167244	0.222800	0.027709	-0.025538	0.120034	-0.349045	0.274672	1.000000	0.609712	0.255005	0.324333
Slope of ST	0.159774	0.050545	0.136900	0.142472	-0.005755	0.044076	0.160614	-0.386847	0.255908	0.609712	1.000000	0.109498	0.283678
Number of vessels fluro	0.356081	0.086830	0.225890	0.085697	0.126541	0.123774	0.114368	-0.265333	0.153347	0.255005	0.109498	1.000000	0.255648

Figure 7: Define the correlation of any values

(Source: Self-Created)

The provided images found the correlations of any values with the help of "df. corr()" command in the use of Python programming language. This command is also used to find out the correlations of any values. This also helps to calculate the pairwise correlation of all columns of the dataset (Ali *et al.* 2021). This value is returned with the correlation values to find out each pair of columns in the dataframe. This is an important tool for the data analysis section that helps to recognize the relationships between the variables in the dataset and it can be used to recognize that the variables might not be imported for a particular analysis part.


```
x = df.iloc[:, :-2]
y = df.iloc[:, -1]
x_train, x_test, y_train, y_test = train_test_split(x, y, random_state = 0, test_s
#split the dataset into trraining and testing datasets#
#use k-nearest neighbours#
```

Figure 8: use k-nearest neighbours

The provided figure represents how to split the dataset into two parts. The dataset is used to train and test the dataset in both values Such as "X and Y" (Mullens *et al.* 2020). Here the "KNN" algorithms are used for this kind of dataset. The value of "random_state" is 0.

```
88] classifier = KNeighborsClassifier(n_neighbors = 9, p = 2, metric = 'euclidean')
    classifier.fit(x_train,y_train)
    #make a KNN model#
```

```
KNeighborsClassifier
KNeighborsClassifier(metric='euclidean', n_neighbors=9)
```

Figure 9: use KNeighbours Classifier

The above provided figure shows how to make a model using "KNN". This is a supervised machine learning algorithm that can be used for both models of classification and the regression task. It is used to refer to a machine learning algorithm that does not

attempt to construct a general data model (Alotaibi, 2019). This algorithm is advantageous because it is simple to understand and implement and is robust to noisy training data. It is also effective when the classes are non-linear and when the number of dimensions is large. Additionally, it can easily be updated with new data without needing to retrain the entire model.

```
data['Age'].hist(figsize=(5,5))
plt.show()
```

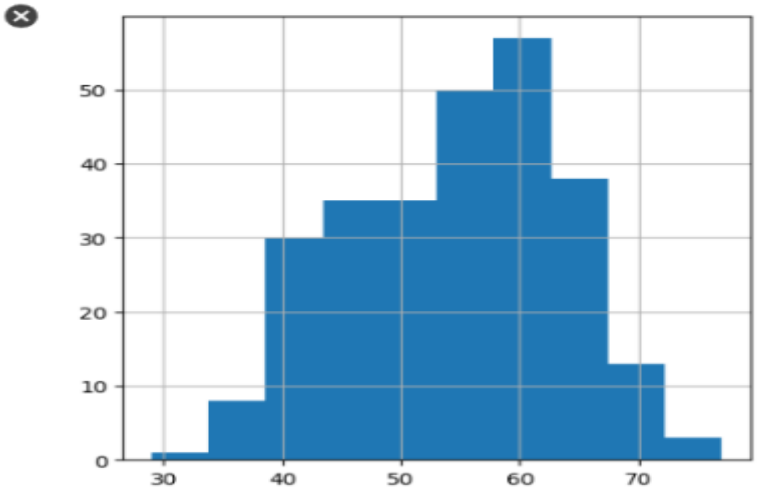

Figure 10: bar graph of age

(Source: Self-Created)

This is the above pictures shown the graphical image of bar graph. This is created with the help of Google Colab.

```
plt.figure(figsize=(12,8))

total = float(len(data["Age"]) )

ax = sns.countplot(x="Sex", data=data)
for p in ax.patches:
    height = p.get_height()
    ax.text(p.get_x()+p.get_width()/2.,
            height + 3,
            '{:1.2f}'.format((height/total)*100),
            ha="center")
plt.show()
```

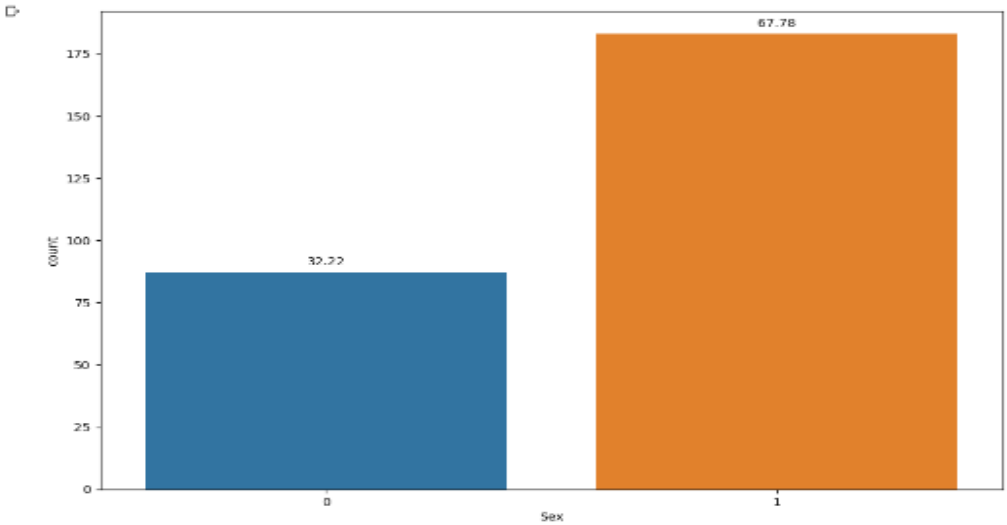

Figure 11: Image of age vs sex graph

(Source: Self-Created)

This is the above pictures shown the graphical image of age vs sex graph. This is created with the help of Google Colab. For this graph count value is needed.

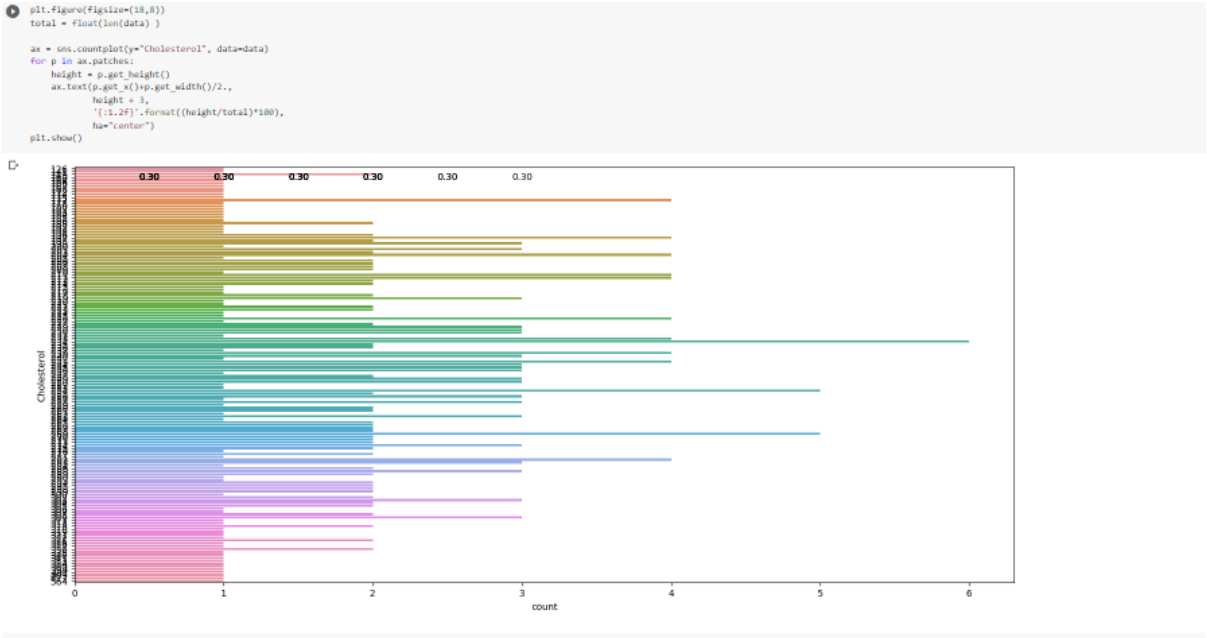

Figure 12: Image for graph of cholesterol

The provided image represent the cholesterol graph with the help of count value. This is created with the help of Google Colab.

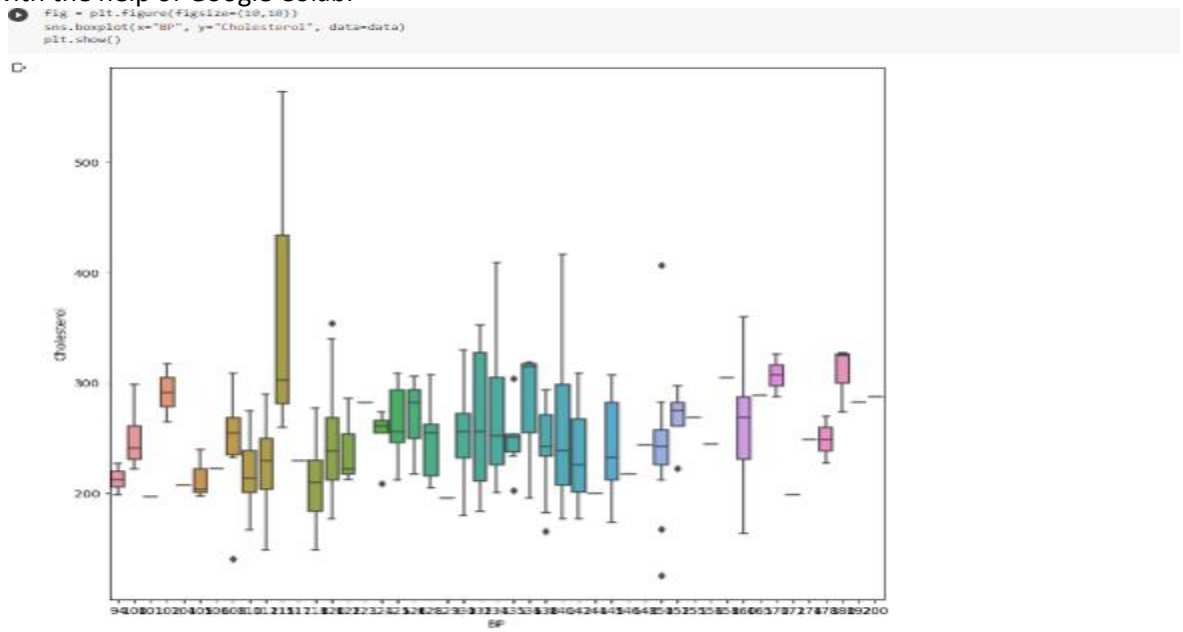

Figure 13: cholesterol vs BP graph

The above image shows the cholesterol vs BP graph. This is created with the help of Google colab.

```
sns.countplot(x="Heart Disease", data=df, palette="bwr")
plt.show()
```

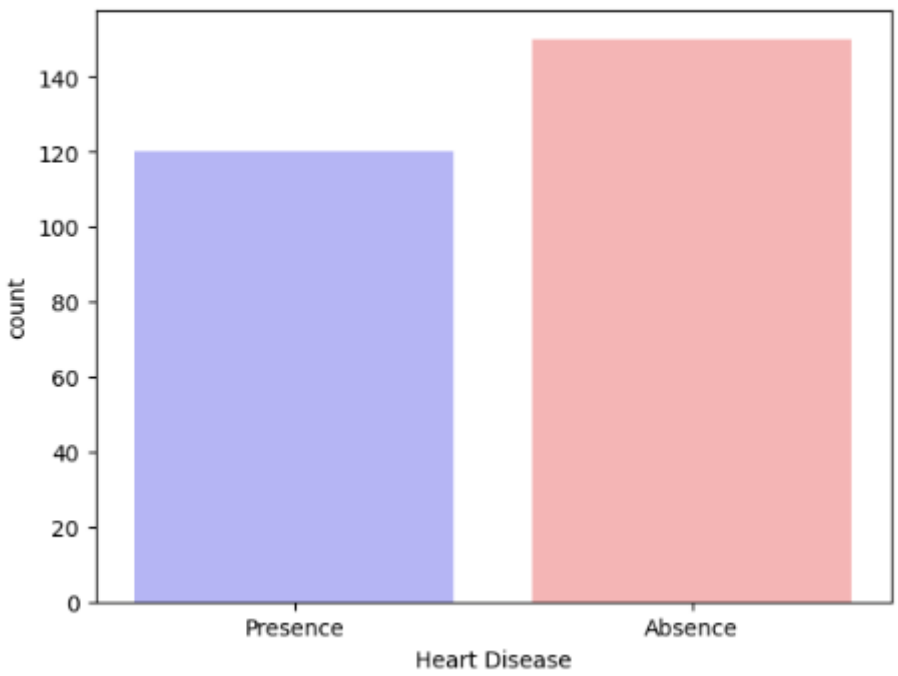

Figure 14: graph of heart diseases

The above figure shows the graph of heart diseases. This is self-created by using Google Colab.

```
[41] word_cloud=WordCloud().generate(corpus)

[42] img=word_cloud.to_image()

     img
```

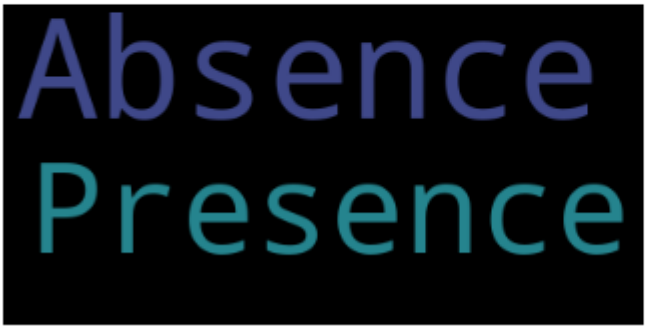

Figure 15: graph of word cloud

The above figure shows the graph of world cloud. This is self-created by using Google Colab.

```
sns.countplot(x="ST depression", data=df, palette="bwr")
plt.show()
```

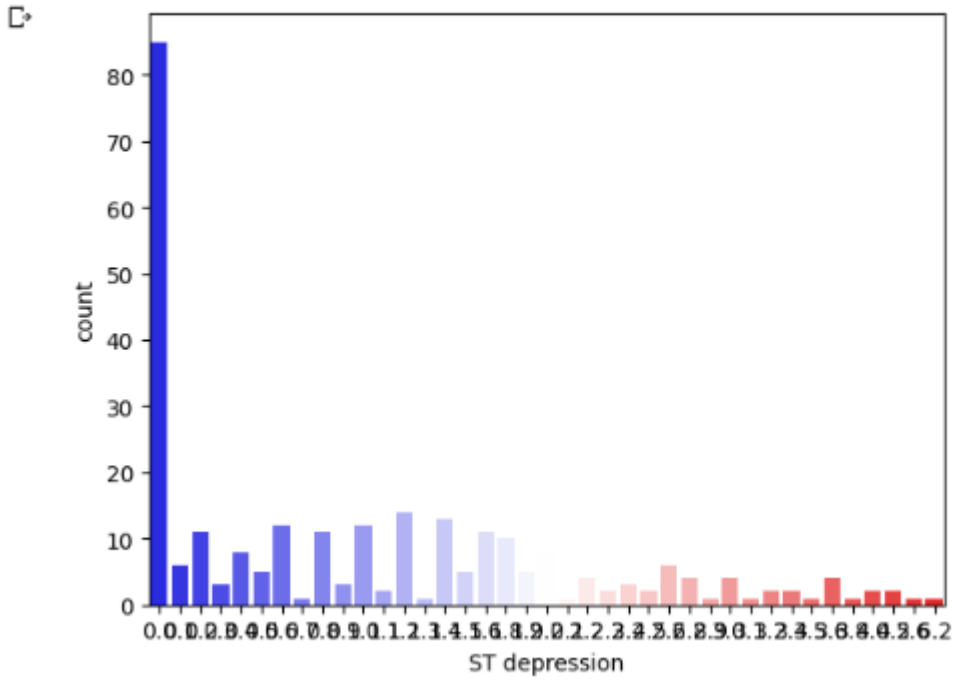

Figure 16: graph for ST depression

The above figure shows the graph of ST depression. This is self-created by using Google Colab.

```
[49] sns.countplot(x="EKG results", data=df, palette="bwr")
plt.show()
```

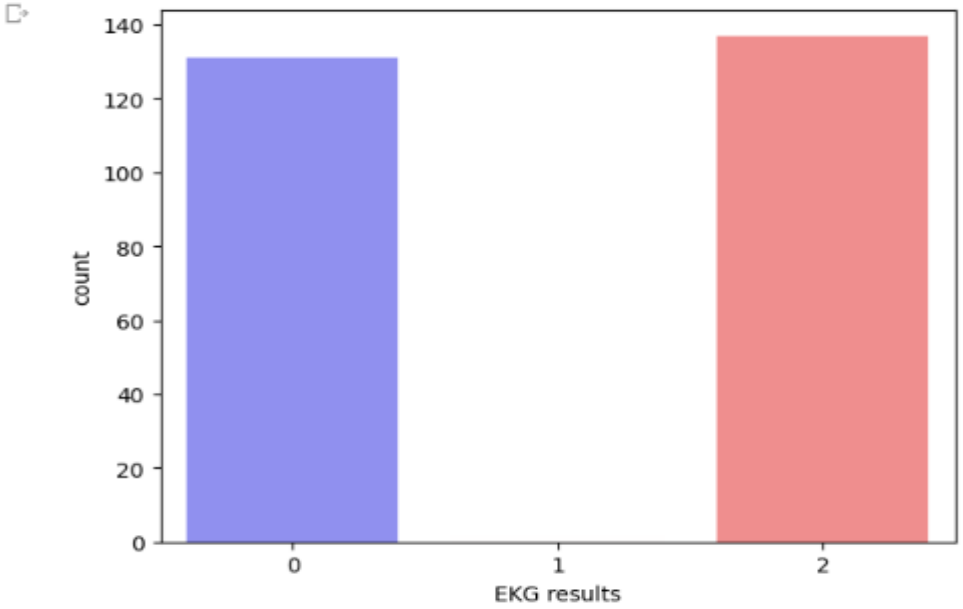

Figure 17: graph for EKG vs count

The above figure shows the graph for EKG versus Count. This is self-created by using Google Colab.

```
[54] sns.countplot(x="Thallium", data=df, palette="bwr")
     plt.show()
```

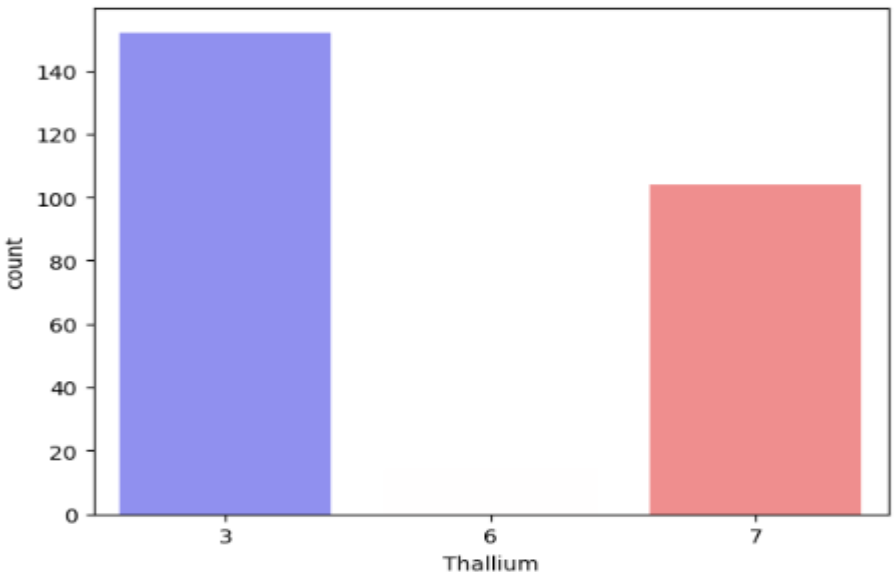

Figure 18: graph for Thallium vs count

The above figure shows the graph for Thallium versus Count. This is self-created by using Google Colab.

7. Conclusion

In summary, this research has properly analyzed the dataset and designed the software using the Python programming language and the Google Colab platform. The coding section has been thoroughly discussed and evaluated. The analysis focused on predicting the heart rate of patients in a healthcare system using advanced machine learning algorithms. The process involved exploring different data sources, analyzing the data, and recognizing data patterns, correlations, and trends. The data sources included the patient's heart condition, age, sex, and other relevant information. The analysis methods included data mining, feature analysis, supervised and unsupervised machine learning algorithms, and statistical methods. The results of the analysis discussed the accuracy of the heart rate prediction and how the dataset could be implemented to improve the healthcare system's effectiveness. By using deep learning processes, this healthcare system can continuously learn from its previous performance and make advancements towards a more accurate and effective healthcare system.

8. Reference

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