A Project Report on

CHRONIC KIDNEY DISEASE PREDICTION MODEL USING MACHINE LEARNING

Submitted in partial fulfilment for the award of the degree of

B.Tech (Branch)
By

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ABSTRACT

Chronic kidney disease (CKD) is an important public health issue because CKD patients have an increased risk of end-stage renal disease (ESRD). Dialysis has charged the national health insurance system billions of dollars in recent years, and the costs are rising. We will develop a system by using artificial neural networks, and other data mining algorithms that could predict the disease at early stages. Chronic kidney disease (CKD) is common. Kidney disease severity can be classified by estimated glomerular filtration rate (GFR) and albuminuria, but more accurate information regarding risk for progression to kidney failure is required for clinical decisions about testing, treatment, and referral.

ACKNOWLEDGEMENT

I take immense pleasure in thanking **Dr. G. Viswanathan**, my beloved **Chancellor**, VIT University and respected **Dean, Dr. Saravanan R, SCHOOLOF COMPUTER SCIENCE AND ENGINEERING**, for having permitted meto carry out the project.

I express gratitude to my guide, **SWETA BHATTACHARYA.**, for guidance and suggestions that helped me to complete the project on time. Words are inadequate to express my gratitude to the faculty and staff members who encouraged and supported me during the project. Finally, I would like to thank my ever-loving parents for their blessings and my friends for their timely help and support.

INTRODUCTION

Chronic Kidney Disease (CKD) is a major public health concern with rising prevalence. Kidney disease is when the kidneys are damaged and could not filter the blood properly. This damage could cause the wastes to build up in the body. There are five stages of CKD, the most serious one is stage 5 because, at this stage, the kidneys are unable to do most of their functions. It is difficult to pinpoint the CKD stage of each patient especially at the early-stages. It also causes a high possibility of death within a short period of time, a patient must be hospitalized and appropriately cured. The most common causes of kidney disease are diabetes and high blood pressure.

Machine learning is a field of computer science that gives the ability of machines to learn without being explicitly programmed. By using computational methods, machine learning has shown success in providing solutions for earlystage diagnosis in a variety of medical domains. These methods are used to find hidden patterns from data and mine these data for decision- makers.

Motivation

Chronic kidney disease (CKD) affects 8–16% of the populationworldwide and is associated with an increased risk of cardio-vascular disease (CVD), muscle wasting, decreased phys-ical function and overall poorer quality of life (QOL). Exercise is being increasingly recognized for its therapeuticbenefits in patients with CKD, which include improved physicalfitness, cardiovascular health and better QOL. Most of theresearch regarding such benefits has been conducted in dialysispatients but the potential of exercise to modulate a num-ber of factors related to disease progression, as well as addressco-morbidities, makes it a particularly interesting and theoret-ically important treatment for all patients with CKD. Current international guidelines recommend that CKD pa-tients should engage in an exercise programme that is compat-ible with cardiovascular health for 30 min, 5 days of the week. Despite this, CKD patients are known to lead insufficientlyactive lifestyles. Identifying barriers and asking participants to strategizeways to overcome them is a popular technique used in behav-iour change interventions.

AIM OF THE PROPOSED WORK

The proposed work operates on three stages: pre-processing, implementation and conclusion. The pre-processing stage is the primary process since the database may contain redundant and noise data. By examining the data, different processes take place such as data cleaning, filling missing values, removing excessive data because the missing values and excessive data degrade the performance. For the implementation stage we will work with three most common neural network algorithms (Probabilistic Neural Networks, Multilayer Perceptron algorithm, Support vector machine algorithm) and visualization tools to map the results, in conclusion stage by analysing the graphs various results could be drawn.

OBJECTIVE(S) OF THE PROPOSED WORK

Chronic kidney disease (CKD) is common, and associated with increased risk of cardiovascular disease and end-stage renal disease, which are potentially preventable through early identification and treatment of individuals at risk, this product will develop models that can help in the prediction of the disease at an early stage so that sufficient health facilities could be provided to the patients.

Literature Survey

Survey of the Existing Models/Work

The following are some of the earlier works in the field of using machine-learning algorithms to diagnose CKD. They used the same dataset from UCI Machine Learning Repository with different machine learning algorithms. The dataset has been collected from Apollo hospital (Tamilandu) [6]. It has 25 attributes and 400 total instances, out of which 250 instances are classified as CKD and 150 instances as nonCKD [6]. Jena and Kamila proposed a method for predicting chronic kidney disease using SVM, Naïve Bayes, Multilayer Perceptron, J48 (a type of decision tree), Conjunctive Rule and Decision Table. From the experimental result, the Multilayer Perception algorithm gives a better classification accuracy of 99.7%. The performance of these algorithms was measured by classification accuracy, the time taken to build the model, the time taken to test the model, and the mean absolute error [7]. In another related work, Manish Kumar has made some research on other authors' studies and reported that SVM performed best compared to other classifiers. The authors used six machine learning algorithms namely: Random Forest (RF), Naïve Bayes, Sequential Minimum Optimization (SMO), Radial Basis Function (RBFClassifier), Multilayer Perceptron Classifier (MLPC) and Simple Logistic (SLG). The author compared the performance of the six classifiers with SVM. The results showed that RF achieved a performance of 100% classification accuracy, while SMO and RBF achieved a lower classification accuracy [8].

Summary/Gaps identified in the Survey

A. Artificial Neural Network Artificial neural networks (ANNs) are a branch of machine learning that are statistical-based learning algorithms which were designed to simulate the properties of the biological neural networks [13]. One of the most widely used neural network is Multilayer Perceptron (MLP). MLP consists mainly of three types of layers made up of artificial neurons and connected by weighted links as shown in figure 1 [14]. Depending on the weights and a specific value called the activation value, some neurons will be activated to some value and others will not. The activation pattern of a layer affects that of the next layer [15].

B. Support Vector Machine The original Support Vector Machine (SVM) algorithm was first introduced by Russian mathematicians Vladimir Vapnik and Alexey Chervonenkis based on decades of research in computational learning theory [16]. SVM is a supervised machine learning algorithm used in both classification and regression problems [17]. Focusing on classification problems, SVM became a popular choice among many researchers, since it often outperforms other classification algorithms [17]. Moreover, SVM performs well even when the number of samples is low [17]. SVM has been used in many fields such as optical character recognition [18], email spam detection [19] , and medical diagnosis [20]. For further details readers should refer to [16], [21], [22].

C. K-Nearest Neighbors K-NN is a simple classifier which increasingly became a popular choice in practice. The idea of K-NN was first introduced by Fix and Hodges in 1951 as a non-parametric method for pattern classification [24]. It is considered a lazy classifier as it does not require building a training model, instead, for each query, the k nearest neighbors are located from the training database regardless of their class label, then the majority vote predicts the class label of the instance [25].

PROPOSED SYSTEM REQUIREMENTS ANALYSIS AND DESIGN

INTRODUCTION

Purpose

This project will help doctors and other users to predict whether the patient has a kidney failure. The CKD model is made using python and machine learning to detect the kidney failure.

Document Conventions

DS = Dataset
UI = User Interface
CKD = Chronic Kidney Disease
ANN = Artificial Neural Network

Intended Audience and Reading Suggestions

This document is meant to be read by anyone who is working on this project as well as for the people who would like to refer this project for future work.

Product Scope

Chronic kidney disease (CKD) is common, and associated with increased risk of cardiovascular disease and end- stage renal disease, which are potentially preventable through early identification and treatment of individuals at risk, this product will develop models that can help in the prediction of the disease at an early stage so that sufficient health facilities could be provided to the patients.

Features:

- Commenting and interacting between other users.
- Uploading files, documents, datasets and relevant information.
- Validation of expert users and normal users.

Milestones:

- Designing CKD models and relationships.
- Designing the UI/UX and its webpage layout

Deliverables:

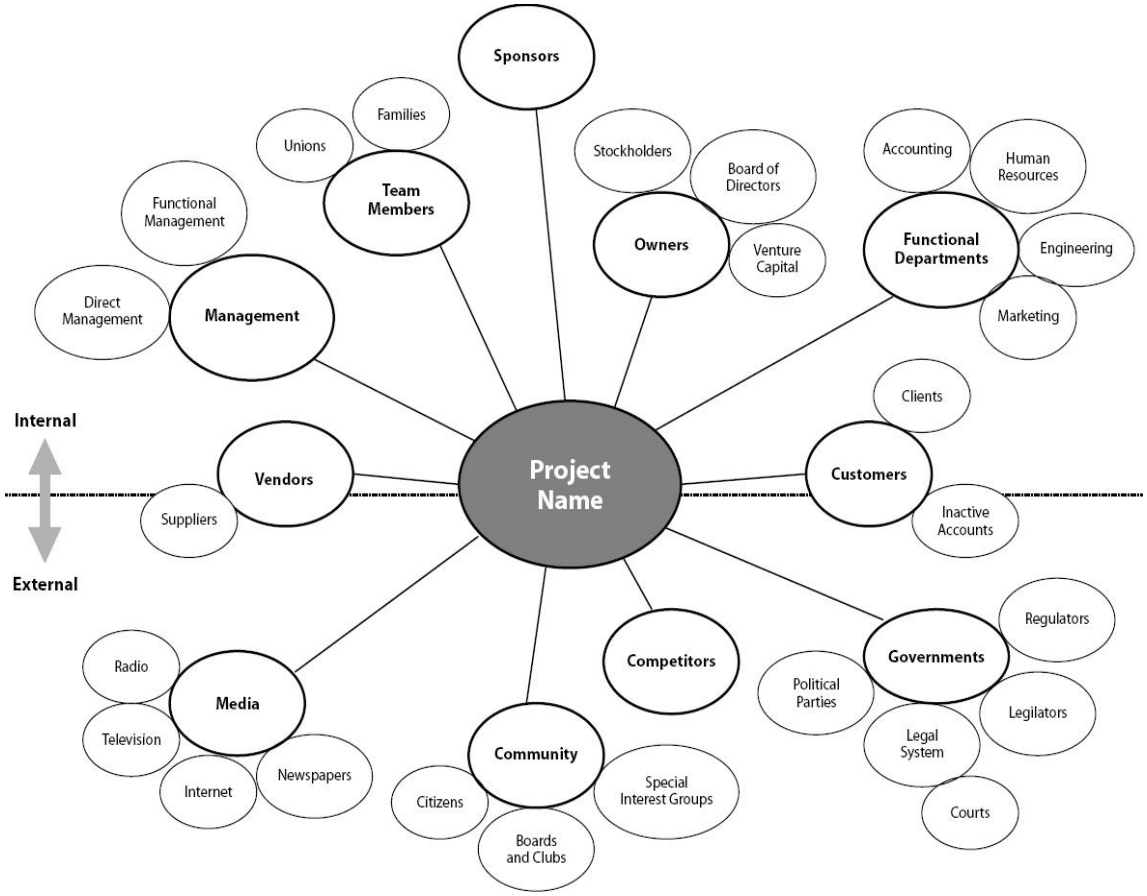
- Basic API for interaction.
- Fully fledged model with many features.

Technical Requirements:

- Responsive UI
- Should be a scalable model that is able to handle a large dataset.
- Should facilitate to interaction with users.

REQUIREMENT ANALYSIS

STAKEHOLDER IDENTIFICATION



STAKEHOLDERS	INTERESTS	ESTIMATED PRIORITY
OWNER	• Achieve targets • Liability • Increase sales margin	1
SPONSOR	• Sucessfully addresses needs of adjunct customers • Appears competent among peers • Provides new market to expand ventures	3
TEAM MEMEBERS OR DEVELOPERS	• New product excitement • Retain and expand skill level • Keep bringing new changes and updates to the product	2
CUSTOMERS	• Tests and uses the product • Check for feasibility and usability	3

FUNCTIONAL REQUIREMENTS

Product Perspective

The proposed project operates on three stages: pre-processing, implementation and conclusion. The pre-processing stage is the primary process since the database may contain redundant and noise data. By examining the data, different processes take place such as data cleaning, filling missing values, removing excessive data because the missing values and excessive data degrade the performance. For the implementation stage we will work with three most common neural network algorithms (Probabilistic Neural Networks, Multilayer Perceptron algorithm, Support vector machine algorithm) and visualization tools to map the results, in conclusion stage by analysing the graphs various results could be drawn.

Product Functions

- Predict kidney failure.
- Show a comparison study between all the patients.
- Shows how accurate the model is.
- Graphical visualization of the model and the results.

User Classes and Characteristics

- Scientists
- Engineers
- Doctors
- Entrepreneurs
- Innovative/Curious folk
- Students

Operating Environment

This product will be launched for Window, Linux and Mac operating systems.
The basic hardware required to support these operating systems are (4GB ram,4core processor), (1GB ram, 2core processor) and 2GB ram,4 core processor) respectively.

Design and Implementation Constraints

- The algorithms used should be able to train the model properly to increase the accuracy of model.
- The dataset used should be extensive enough to train the model properly.
- Data Cleaning should be done properly to get proper results.

NON FUNCTIONAL REQUIREMENTS

Performance Requirements

The website should be fully functional even when scaled to 1000's of users. The latency periods for retrieving data should be under 1ms per 1000 queries. 48 threads should be running on the Jupyter Notebook server.

The model should be properly fitted and accurate to avoid large size that increases latency.

Safety Requirements

There are no safety compromises in this project.

Security Requirements

Sufficient measures should be taken to avoid the following security attacks:

- Cross site request Forgery
- XML scripting
- SQL injections
- Dataset checking

Software Quality Attributes

This project aims to be easy to use for end users and also aims to attract experts on to the site. For an overall better experience.

The main focus is to increase the accuracy of the model to get better results.

SYSTEM REQUIREMENTS

H/W Requirements(details about Application-Specific Hardware)

The website can be accessed through any of computers with a proper internet connection. Preferred configuration is i7 intel processor, 8gb Ram, 2 Gb Graphics card.

S/W Requirements(details about Application-Specific Software)

The website can be accessed through any of the common browsers such as mozilla Firefox, Google Chrome, Microsoft edge, Safari etc. Additional softwares Anaconda, Python, Jupyter Notebook also had to be installed for the model to work.

If the User is not logged in through proper channel, then the screen will appear for which the user can be authenticated and then directed to the main page.

The main page will contain the users feed or relevant posts or projects on which the user can comment and interact. The main page will also contain links to the logout page, documentation page FAQ page. The user will also be able to request help from one of the experts in the site.

The interface works using machine learning libraries and runs on Jupyter Notebook.

SOFTWARE REQUIREMENT SPECIFICATION DOCUMENT

1. Introduction

1.1 Purpose

This project will help doctors and other users to predict whether the patient has a kidney failure. The CKD model is made using python and machine learning to detect the kidney failure.

1.2 Document Conventions

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UI = User Interface
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1.4 Product Scope

Chronic kidney disease (CKD) is common, and associated with increased risk of cardiovascular disease and end-stage renal disease, which are potentially preventable through early identification and treatment of individuals at risk, this product will develop models that can help in the prediction of the disease at an early stage so that sufficient health facilities could be provided to the patients.

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Deliverables:

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- Fully fledged model with many features.

Technical Requirements:

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1.5 References

1. https://thesai.org/Downloads/Volume10No8/Paper_1Detection_of_Chronic_Kidney_Disease.pdf

2. https://medium.com/@randerson112358/chronic-kidney-disease-prediction-detection-using-machine-learning-29cc7e3eba96

3. https://wonderfulengineering.com/this-artificial-kidney-eliminates-the-need-for-kidney-ialysis/?fbclid=IwAR19Olftqa9vr0HEhwl51c89OPN6RGsxPNDDJB2rzhqdKkIVGYYXeGCF1Ds

2. Overall Description

2.1 Product Perspective

The proposed project operates on three stages: pre-processing, implementation and conclusion. The pre-processing stage is the primary process since the database may contain redundant and noise data. By examining the data, different processes take place such as data cleaning, filling missing values, removing excessive data because the missing values and excessive data degrade the performance. For the implementation stage we will work with three most common neural network algorithms (Probabilistic Neural Networks, Multilayer Perceptron algorithm, Support vector machine algorithm) and visualization tools to map the results, in conclusion stage by analysing the graphs various results could be drawn.

2.2 Product Functions

- Predict kidney failure.
- Show a comparison study between all the patients.
- Shows how accurate the model is.
- Graphical visualization of the model and the results.

2.3 User Classes and Characteristics

- Scientists
- Engineers
- Doctors

- Entrepreneurs
- Innovative/Curious folk
- Students

2.4 Operating Environment

This product will be launched for Window, Linux and Mac operating systems. The basic hardware required to support these operating systems are (4GB ram,4core processor), (1GB ram, 2core processor) and 2GB ram,4 core processor) respectively.

2.5 Design and Implementation Constraints

- The algorithms used should be able to train the model properly to increase the accuracy of model.
- The dataset used should be extensive enough to train the model properly.
- Data Cleaning should be done properly to get proper results.

2.6 User Documentation

Please refer section 3.1 for user interfaces.

2.7 Assumptions and Dependencies

It is assumed that the hardware designed will work correctly with the third-party operating system Windows 10 and other Operating Systems and the developed software.

3. External Interface Requirements

3.1 User Interfaces

If the User is not logged in through proper channel, then the screen will appear for which the user can be authenticated and then directed to the main page.

The main page will contain the users feed or relevant posts or projects on which the user can comment and interact. The main page will also contain links to the logout page, documentation page FAQ page. The user will also be able to request help from one of the experts in the site.

The interface works using machine learning libraries and runs on Jupyter Notebook.

3.2 Hardware Interfaces

The website can be accessed through any of computers with a proper internet connection. Preferred configuration is i7 intel processor, 8gb Ram, 2 Gb Graphics card.

3.3 Software Interfaces

The website can be accessed through any of the common browsers such as mozilla Firefox, Google Chrome, Microsoft edge, Safari etc. Additional softwares Anaconda, Python, Jupyter Notebook also had to be installed for the model to work.

3.4 Communications Interfaces

This software will make use of HTTP connections for website access and will use SMTP for email related functionality. It will also use Jupyter Notebook and various machine learning libraries to work properly.

4. System Features

4.1 Upload Project Content

4.1.1 Description and Priority

This allows the users to predict whether the patient is suffering from kidney failure or not using various attributes and medical terms.

Priority:

This is the main priority of the whole project and crucial to implement.

4.1.2 Stimulus/Response Sequences

1) User inputs the dataset
2) User enters his requirements.
3) User enters related documents and clicks run.

4.1.3 Functional Requirements

1) The system should provide the option of an upload to upload the dataset.
2) User needs to be authenticated before uploading.
3) The system should support all file type uploads relevant to the project.
4) There should be a UI for writing descriptions in the website itself.

4.2 Expert help

4.1.1 Description and Priority

Experts are people who are well versed in the subjects and can help the other users on the platform.

Priority:

This is a medium priority feature.

4.1.2 Stimulus/Response Sequences

1) User presses the help button
2) User browses all experts presently available to help.

3) User can then interact with the expert and ask for help.

4.1.3 Functional Requirements

1) The system should provide the option of a help button.
2) Experts have to be certified and verified before becoming an authenticated expert on the website.
3) The system should support all communicating factors such as file sharing or image sharing.
4) There should be a UI for interacting with experts in the website itself.

5. Other Non-functional Requirements

5.1 Performance Requirements

The website should be fully functional even when scaled to 1000's of users. The latency periods for retrieving data should be under 1ms per 1000 queries. 48 threads should be running on the Jupyter Notebook server.

The model should be properly fitted and accurate to avoid large size that increases latency.

5.2 Safety Requirements

There are no safety compromises in this project.

5.3 Security Requirements

Sufficient measures should be taken to avoid the following security attacks:

- Cross site request Forgery
- XML scripting
- SQL injections
- Dataset checking

5.4 Software Quality Attributes

This project aims to be easy to use for end users and also aims to attract experts on to the site. For an overall better experience.

The main focus is to increase the accuracy of the model to get better result

6. Other Requirements

Cloud storage for faster access to data and easy to maintain server

Appendix A:

Glossary

Appendix B:

Analysis

Models

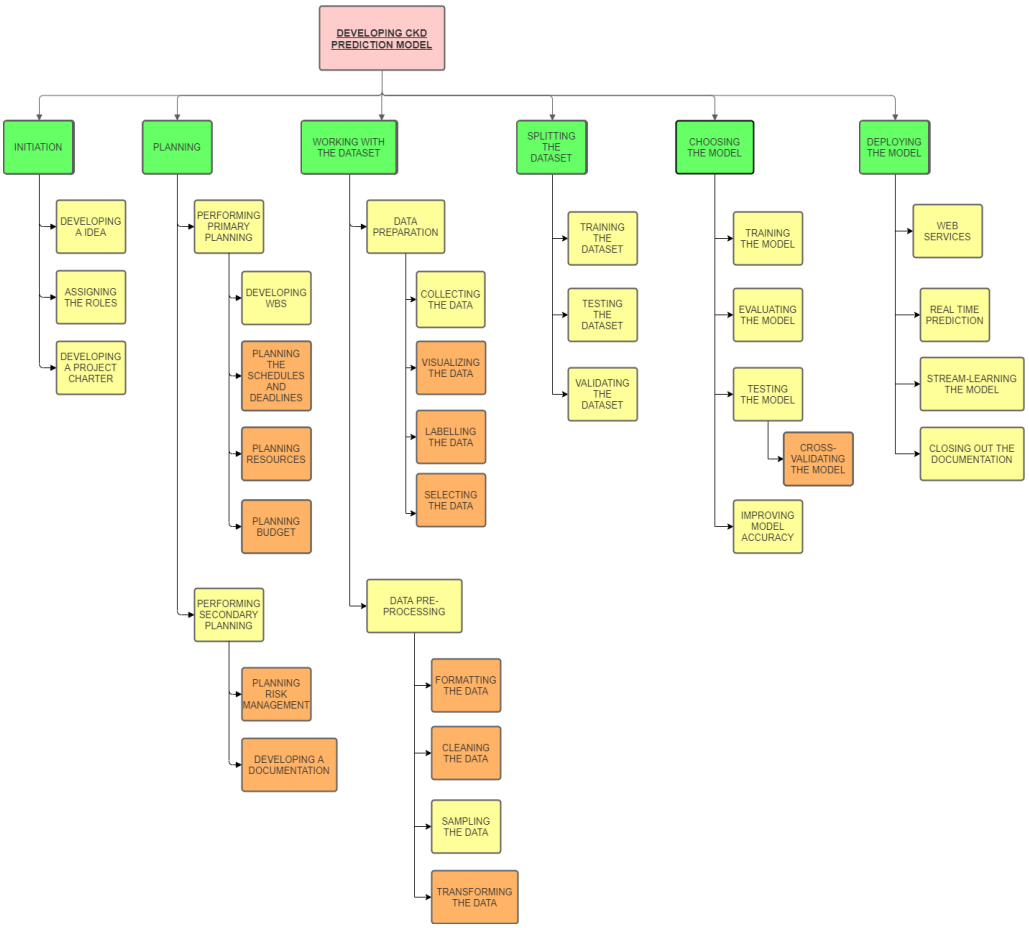
Refer the Graphical representations below.

Appendix C: To Be Determined List

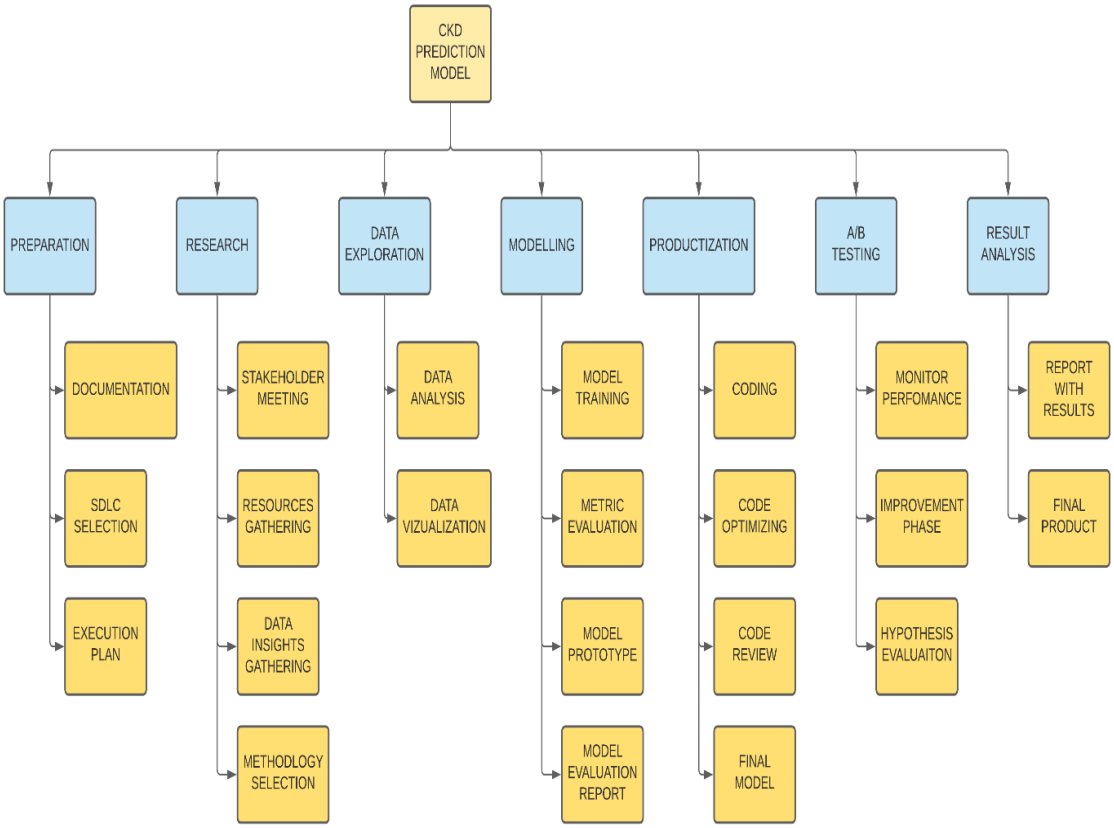
- internet assistant.
- Recommendation algorithms for users.

WORK BREAKDOWN STRUCTURE

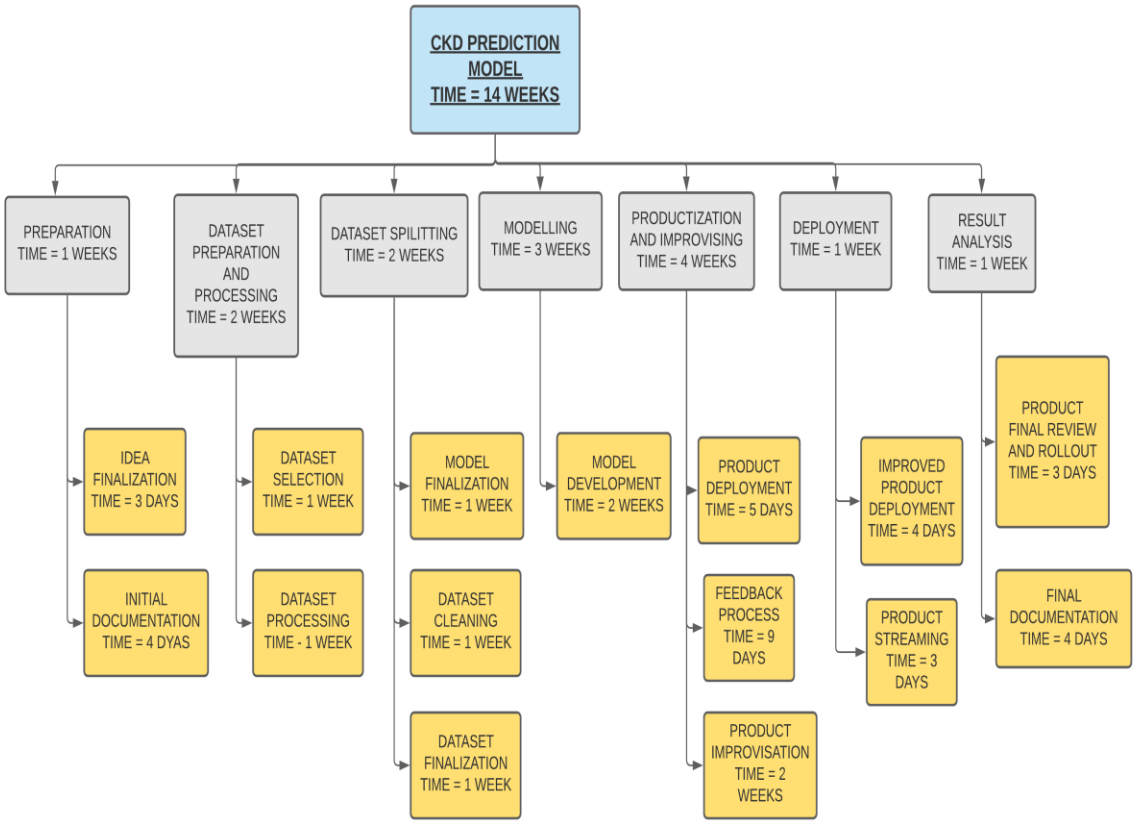
VERB BASED



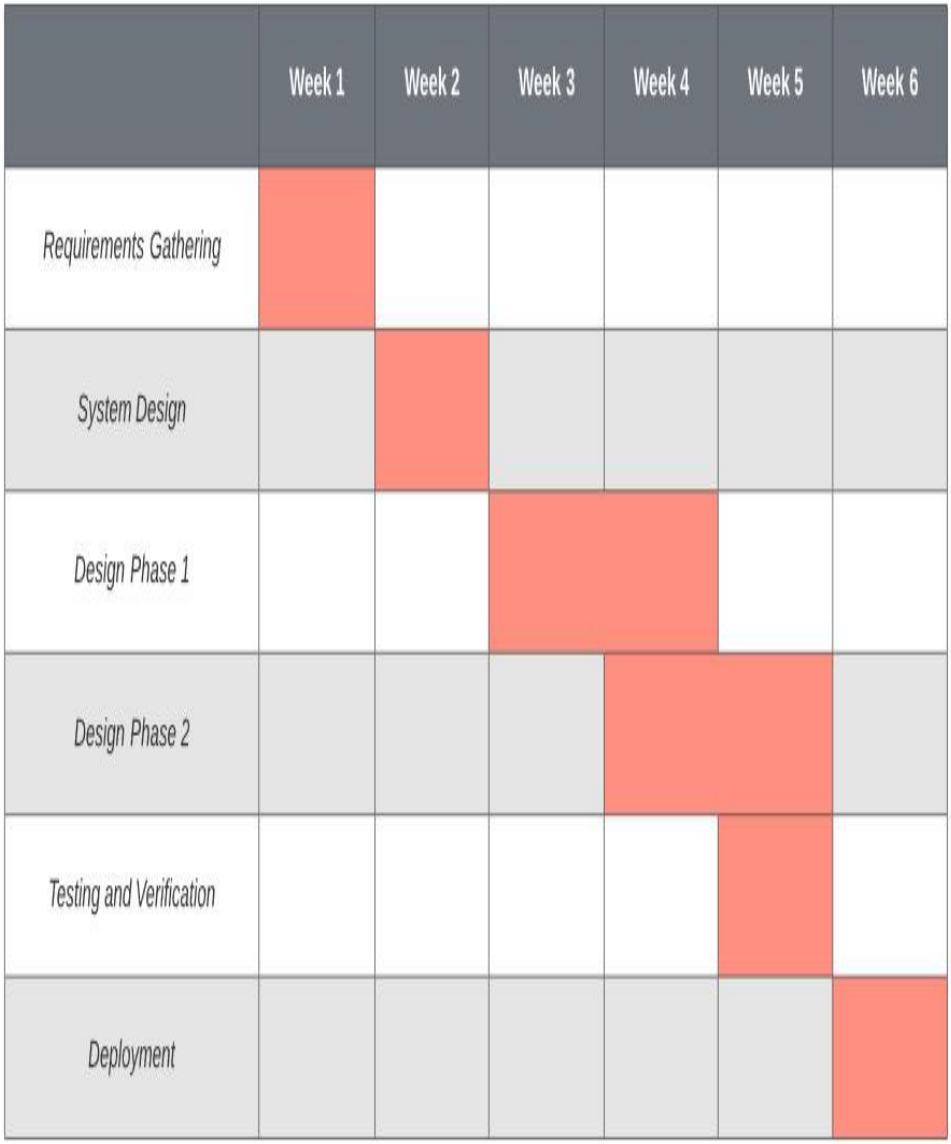
NOUN BASED


CKD PREDICTION MODEL
PREPARATION
RESEARCH
DATA EXPLORATION
MODELLING
PRODUCTIZATION
A/B TESTING
RESULT ANALYSIS
DOCUMENTATION
SDLC SELECTION
EXECUTION PLAN
STAKEHOLDER MEETING
RESOURCES GATHERING
DATA INSIGHTS GATHERING
METHODLOGY SELECTION
DATA ANALYSIS
DATA VIZUALIZATION
MODEL TRAINING
METRIC EVALUATION
MODEL PROTOTYPE
MODEL EVALUATION REPORT
CODING
CODE OPTIMIZING
CODE REVIEW
FINAL MODEL
MONITOR PERFOMANCE
IMPROVEMENT PHASE
HYPOTHESIS EVALUAITON
REPORT WITH RESULTS
FINAL PRODUCT

TIME BASED


CKD PREDICTION MODEL
TIME = 14 WEEKS
PREPARATION
TIME = 1 WEEKS
DATASET PREPARATION AND PROCESSING
TIME = 2 WEEKS
DATASET SPILITTING
TIME = 2 WEEKS
MODELLING
TIME = 3 WEEKS
PRODUCTIZATION AND IMPROVISING
TIME = 4 WEEKS
DEPLOYMENT
TIME = 1 WEEK
RESULT ANALYSIS
TIME = 1 WEEK
IDEA FINALIZATION
TIME = 3 DAYS
INITIAL DOCUMENTATION
TIME = 4 DYAS
DATASET SELECTION
TIME = 1 WEEK
DATASET PROCESSING
TIME - 1 WEEK
MODEL FINALIZATION
TIME = 1 WEEK
DATASET CLEANING
TIME = 1 WEEK
DATASET FINALIZATION
TIME = 1 WEEK
MODEL DEVELOPMENT
TIME = 2 WEEKS
PRODUCT DEPLOYMENT
TIME = 5 DAYS
FEEDBACK PROCESS
TIME = 9 DAYS
PRODUCT IMPROVISATION
TIME = 2 WEEKS
IMPROVED PRODUCT DEPLOYMENT
TIME = 4 DAYS
PRODUCT STREAMING
TIME = 3 DAYS
PRODUCT FINAL REVIEW AND ROLLOUT
TIME = 3 DAYS
FINAL DOCUMENTATION
TIME = 4 DAYS

GANTT CHART


Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Requirements Gathering
System Design
Design Phase 1
Design Phase 2
Testing and Verification
Deployment

DESIGN OF THE PROPOSED SYSTEM

INTRODUCTION

We will be using **RAPID APPLICATION DEVELOPEMNT MODEL (RAD)**

The **RAD (Rapid Application Development)** model is based on prototyping and iterative development with no specific planning involved. The process of writing the software itself involves the planning required for developing the product.

Rapid Application Development focuses on gathering customer requirements through workshops or focus groups, early testing of the prototypes by the customer using iterative concept, reuse of the existing prototypes (components), continuous integration and rapid delivery.

Rapid application development is a software development methodology that uses minimal planning in favour of rapid prototyping. A prototype is a working model that is functionally equivalent to a component of the product.

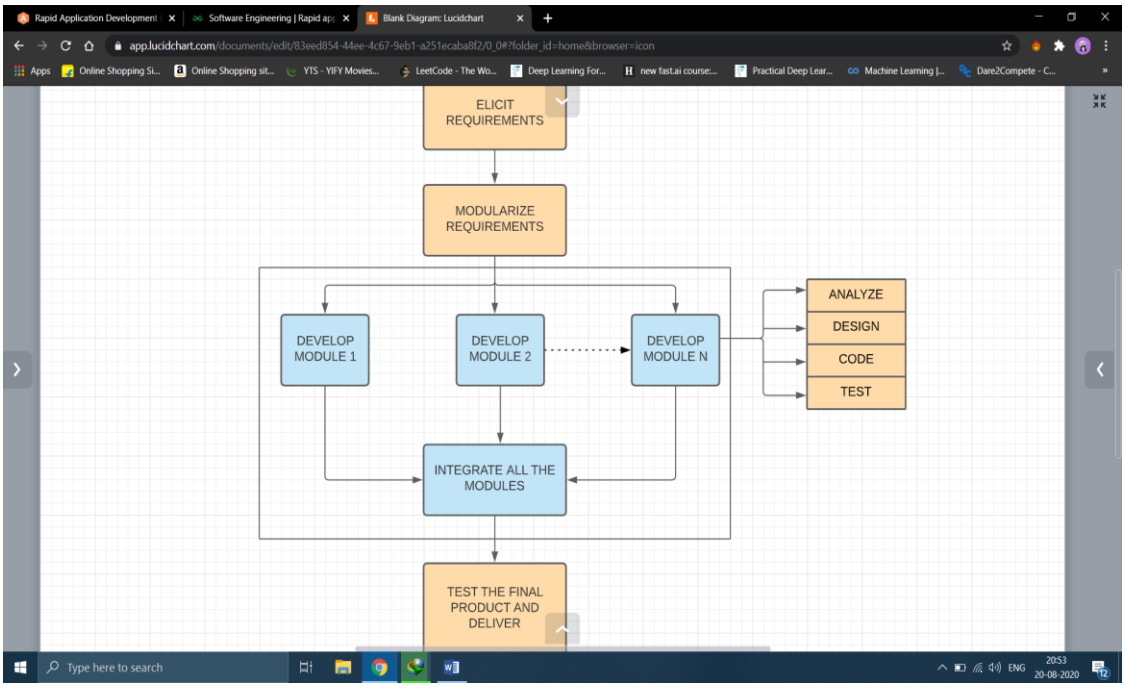
In the RAD model, the functional modules are developed in parallel as prototypes and are integrated to make the complete product for faster product delivery. Since there is no detailed preplanning, it makes it easier to incorporate the changes within the development process.

RAD projects follow iterative and incremental model and have small teams comprising of developers, domain experts, customer representatives and other IT resources working progressively on their component or prototype.

The most important aspect for this model to be successful is to make sure that the prototypes developed are reusable.

HIGH LEVEL DESIGN (FRAMEWORK, ARCHITECTURE OR MODULE FOR THE PROPOSED SYSTEM(WITH EXPLANATION))

ARCHITECTURE DESIGN (CHOOSE THE APPROPRIATE PATTERN WITH JUSTIFICATION)

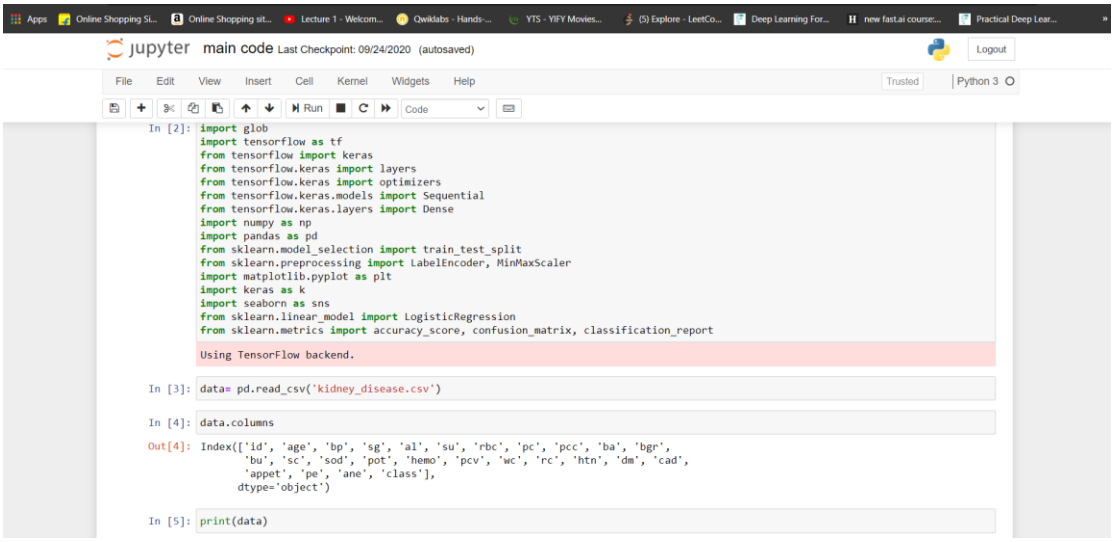


ARCHITECTURE DIAGRAM (EXPLANATION)

JUSTIFICATION FOR USING RAD MODEL

1. We use RAD model because there is a need to create a system that can be modularized in 2-3 months of time.
2. Also it increases the reusability of components and review of our work can be done quickly.
3. The other main purpose of using this model is because it allows integration from very beginning which solves a lot of integration issues.
4. Due to limited amount of time and man power, this will allow us to deliver our project in small pieces,that is whole project can be divided into number of smaller components.
5. The technical risks are low and also the requirements of the product are known well beforehand.
6. Also there is a good scope of getting reliable feedback on our deliverables for further improvement.

UI DESIGN



Detailed Design (ER Diagram/UML Diagram/Mathematical Modeling)

ER Diagram

Logistic regression algorithm

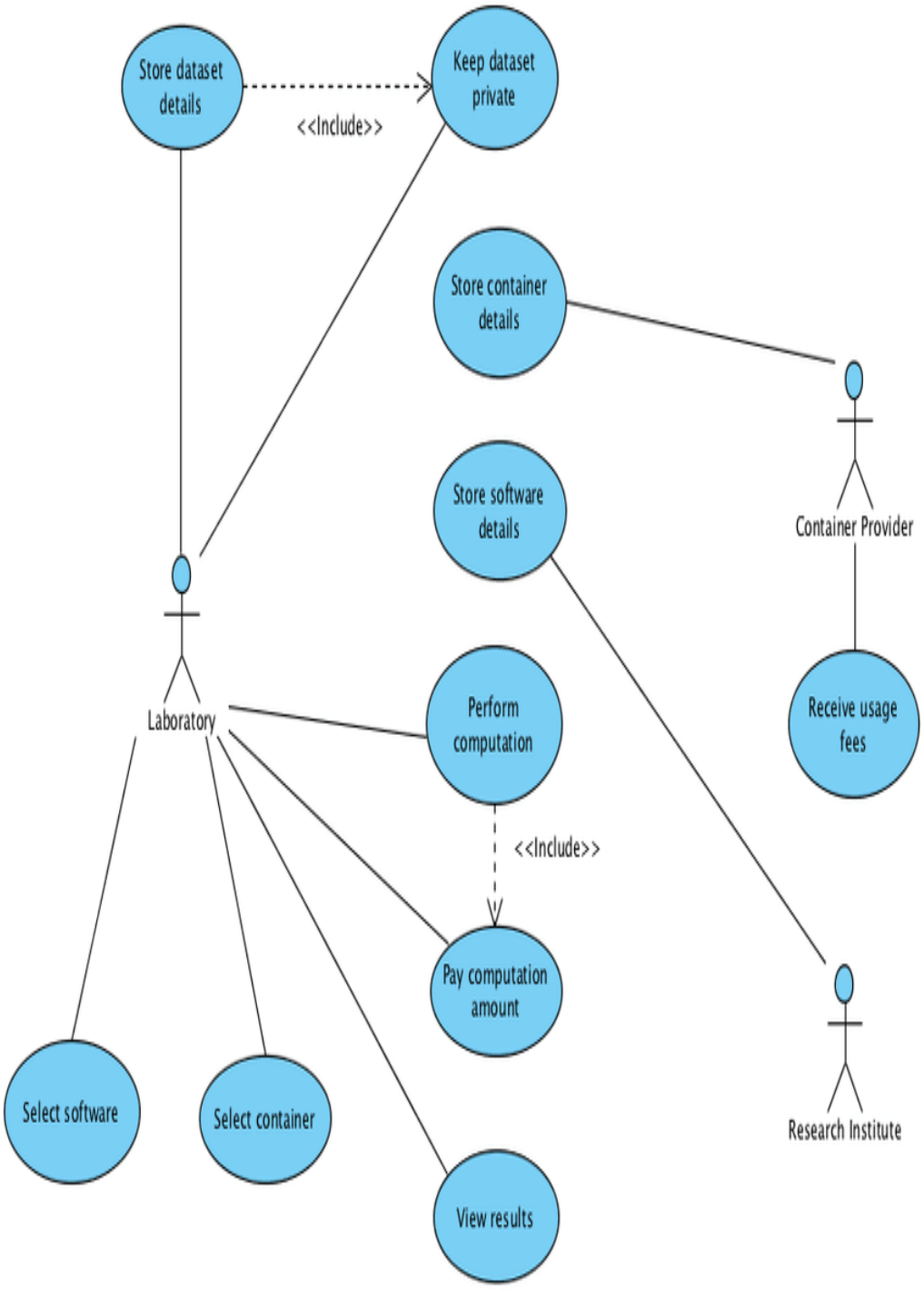
```
X = data.iloc[:,:-1]
y = data['class']
logreg = LogisticRegression(max_iter = 10000)
X_train, X_test, y_train, y_test = train_test_split(X,y, stratify = y, shuffle = True)
logreg.fit(X_train,y_train)
test_pred = logreg.predict(X_test)
train_pred = logreg.predict(X_train)
print('Train Accuracy: ', accuracy_score(y_train, train_pred))
print('Test Accuracy: ', accuracy_score(y_test, test_pred))
```

Ann algorithm

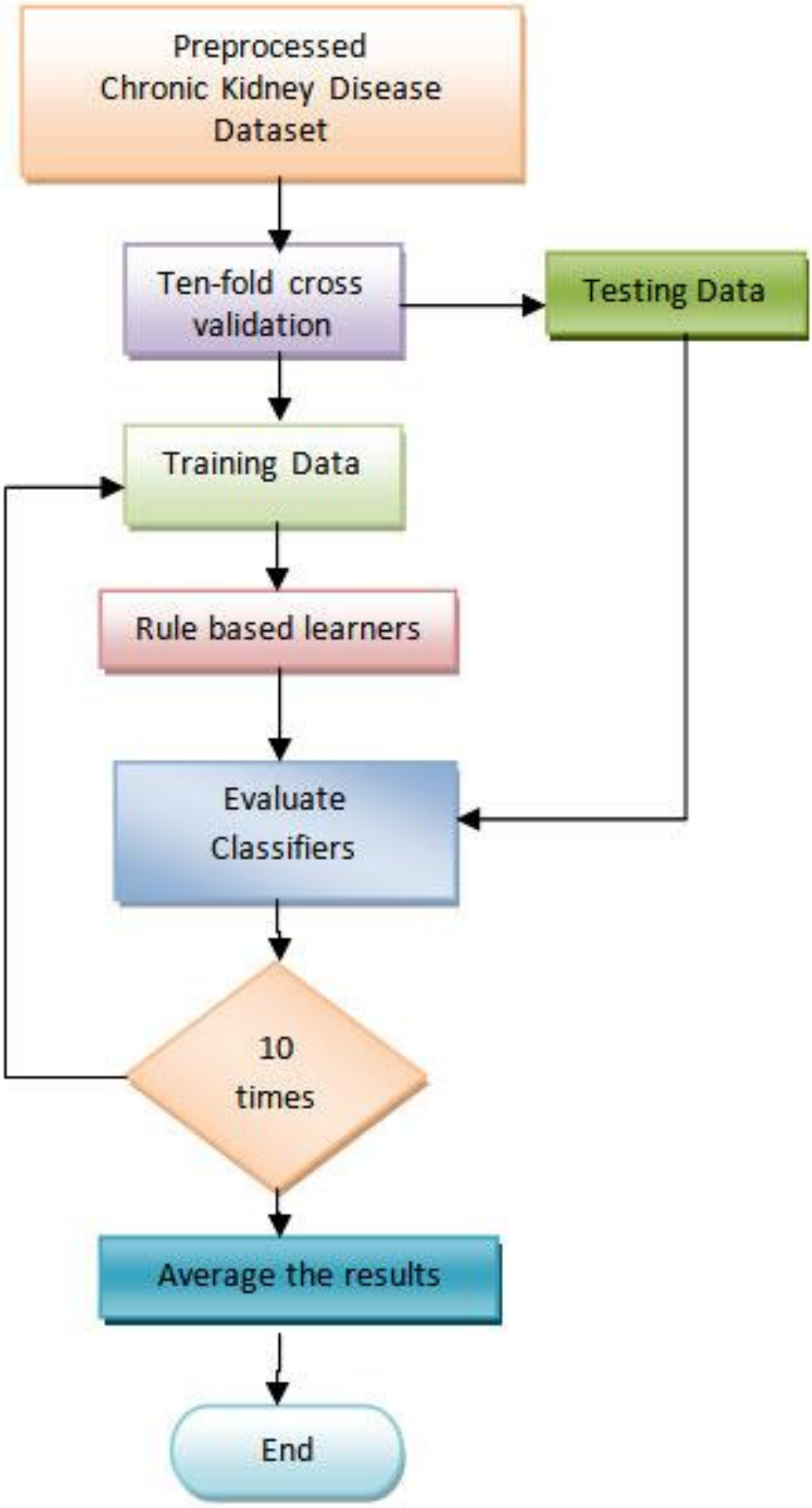
```
#build model
model = Sequential()
#first layer
model.add(Dense(256,input_dim= len(X.columns),kernel_initializer= k.initializers.random_normal(seed= 13),activation= 'relu'))
#second layer
model.add(Dense (1, activation = 'hard_sigmoid'))
#compiling the model
#opt = adam(lr=0.001, decay=1e-6)
model.compile(loss = 'binary_crossentropy', optimizer = 'adam', metrics = ['accuracy'])
```

UML DIAGRAM (USE CASE, CLASS, STATECHART, ACTIVITY AND INTERACTION DIAGRAMS)

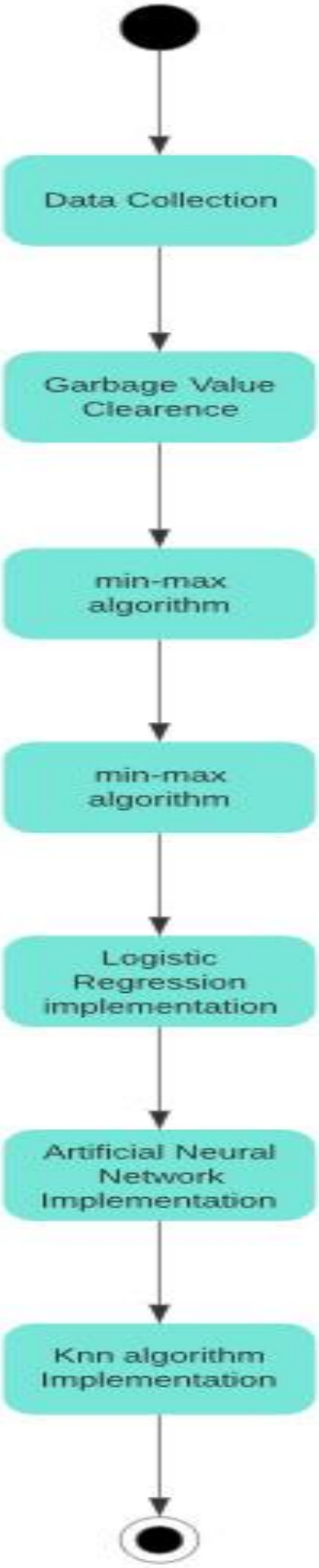
USE CASE



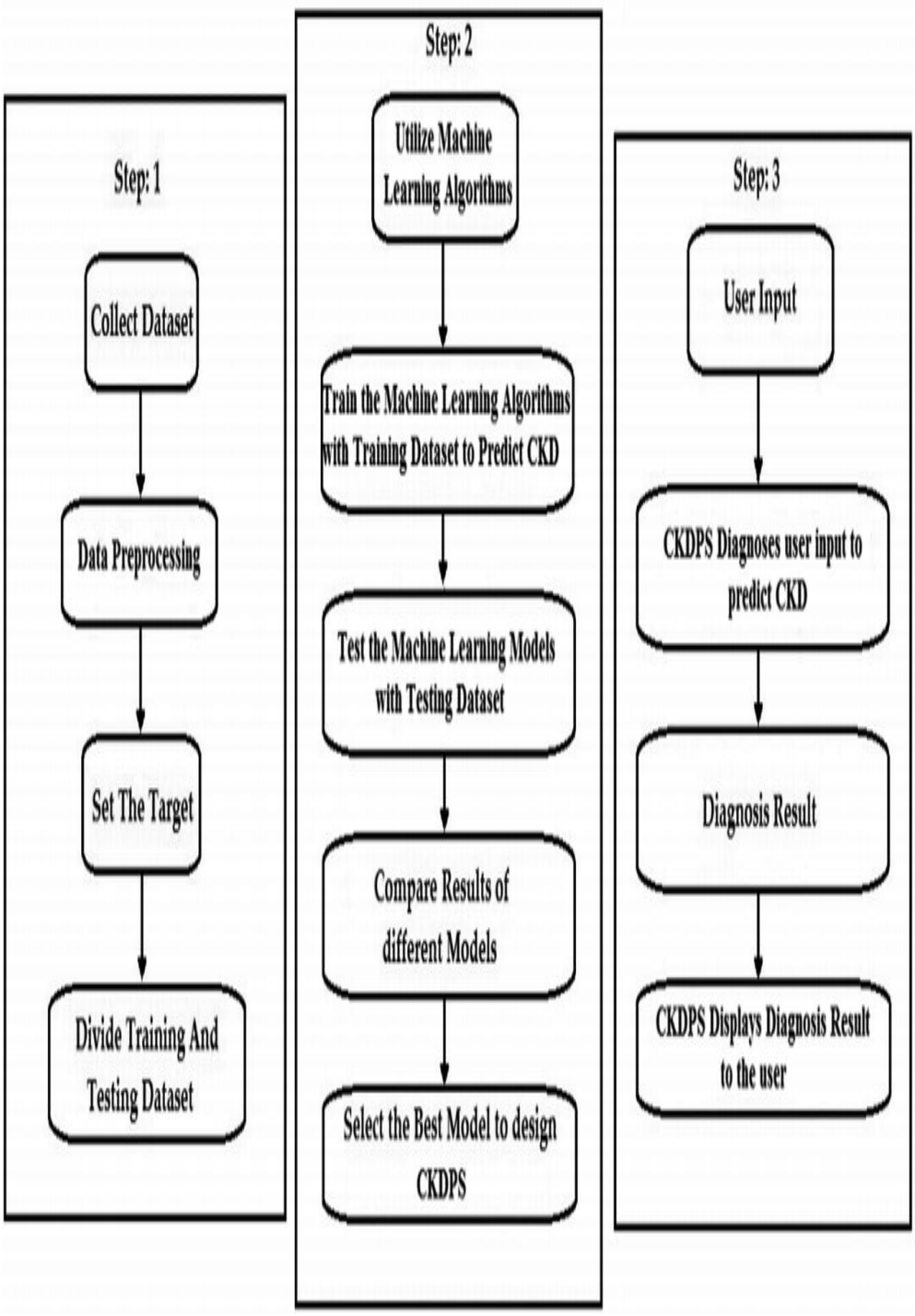
STATESCHART



ACTIVITY DIAGRAM



INTERACTION DIAGRAM



IMPLEMENTATION AND TESTING (SNAP SHOTS WITH DESCRIPTION)

IMPLEMENTATION DETAILS (SNAPSHOTS)

jupyter main code Last Checkpoint: 13 hours ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help

Trusted | Python 3

Run Code

In [1]:
```
# Description: Program to classify patients having chronic kidney disease or not using Artificial Neural Network and LR
```

In [2]:
```
import glob
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
from tensorflow.keras import optimizers
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder, MinMaxScaler
import matplotlib.pyplot as plt
import keras as k
import seaborn as sns
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report
```

```
Using TensorFlow backend.
```

In [3]:
```
data= pd.read_csv('kidney_disease.csv')
```

In [4]:
```
data.columns
```

Out[4]:
```
Index(['id', 'age', 'bp', 'sg', 'al', 'su', 'rbc', 'pc', 'pcc', 'ba', 'bgr',
       'bu', 'sc', 'sod', 'pot', 'hemo', 'pcv', 'wc', 'rc', 'htn', 'dm', 'cad',
       'appet', 'pe', 'ane', 'class'],
      dtype='object')
```

Run Code

In [5]:
```
data.head()
```

Out[5]:

	id	age	bp	sg	al	su	rbc	pc	pcc	ba	...	pcv	wc	rc	htn	dm	cad	appet	pe	ane	class
0	0	48.0	80.0	1.020	1.0	0.0	NaN	normal	notpresent	notpresent	...	44	7800	5.2	yes	yes	no	good	no	no	ckd
1	1	7.0	50.0	1.020	4.0	0.0	NaN	normal	notpresent	notpresent	...	38	6000	NaN	no	no	no	good	no	no	ckd
2	2	62.0	80.0	1.010	2.0	3.0	normal	normal	notpresent	notpresent	...	31	7500	NaN	no	yes	no	poor	no	yes	ckd
3	3	48.0	70.0	1.005	4.0	0.0	normal	abnormal	present	notpresent	...	32	6700	3.9	yes	no	no	poor	yes	yes	ckd
4	4	51.0	80.0	1.010	2.0	0.0	normal	normal	notpresent	notpresent	...	35	7300	4.6	no	no	no	good	no	no	ckd

5 rows × 26 columns

In [6]:
```
print(data.shape)
print(data.ndim)
```

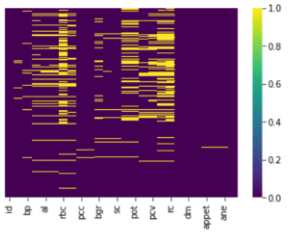
```
(400, 26)
2
```

In [7]:
```
print(data.describe())
```

```
               id         age          bp          sg          al          su  \
count  400.000000  391.000000  388.000000  353.000000  354.000000  351.000000
mean   199.500000   51.483376   76.469072    1.017408    1.016949    0.450142
std    115.614301   17.169714   13.683637    0.005717    1.352679    1.099191
min      0.000000    2.000000   50.000000    1.005000    0.000000    0.000000
25%     99.750000   42.000000   70.000000    1.010000    0.000000    0.000000
50%    199.500000   55.000000   80.000000    1.020000    0.000000    0.000000
75%    299.250000   64.500000   80.000000    1.020000    2.000000    0.000000
```

Run Code

In [8]:
```
sns.heatmap(data.isnull(),yticklabels = False, cmap='viridis');
```



In [9]:
```
data = data.dropna(axis = 0)
```

In [10]:
```
print(data.shape)
```

```
(158, 26)
```

In [11]:
```
for column in data.columns:
    if data[column].dtype == np.number:
        continue
    data[column] = LabelEncoder().fit_transform(data[column])
```

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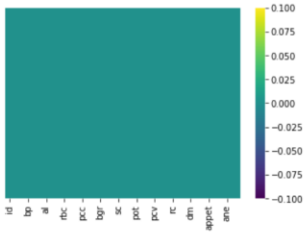
Run Code

In [14]:
```
sns.heatmap(data.isnull(),yticklabels = False, cmap='viridis');
```



In [15]:
```
# splitting dataset into dependent and independent

X = data.drop(['class'],axis=1)
Y = data['class']
```

In [16]:
```
#Feature Scaling
#min-max scaler method scales the data set so that all the input features lie between 0 and 1
x_scaler = MinMaxScaler()
x_scaler.fit(X)
column_names = X.columns
X[column_names] = x_scaler.transform(X)
```

File Edit View Insert Cell Kernel Widgets Help Trusted | Python 3

Run Code

In [17]:
```
X.head()
```

Out[17]:

	id	age	bp	sg	al	su	rbc	pc	pcc	ba	...	hemo	pcv	wc	rc	htn	dm	cad	appet	pe	ane
3	0.000000	0.545455	0.333333	0.00	1.00	0.0	1.0	0.0	1.0	0.0	...	0.551020	0.333333	0.600000	0.350	1.0	0.0	0.0	1.0	1.0	1.0
9	0.006369	0.610390	0.666667	0.75	0.50	0.0	0.0	0.0	1.0	0.0	...	0.435374	0.242424	0.157143	0.300	1.0	1.0	0.0	1.0	0.0	1.0
11	0.012739	0.740260	0.333333	0.25	0.75	0.0	0.0	0.0	1.0	0.0	...	0.523810	0.333333	0.357143	0.325	1.0	1.0	0.0	1.0	1.0	0.0
14	0.019108	0.805195	0.500000	0.25	0.75	0.4	1.0	0.0	1.0	1.0	...	0.170068	0.000000	0.114286	0.050	1.0	1.0	1.0	1.0	1.0	0.0
20	0.025478	0.714286	0.500000	0.50	0.50	0.0	0.0	0.0	0.0	0.0	...	0.312925	0.121212	0.900000	0.175	1.0	1.0	1.0	1.0	1.0	1.0

5 rows × 25 columns

In [18]:
```
#split the data into 80% training and 20% testing and shuffle

X_train, X_test, Y_train, Y_test = train_test_split(X,Y, test_size = 0.2 ,shuffle = True)
```

Aritificial Neural Network ¶

In [19]:
```
#build model

model = Sequential()

#first layer
model.add(Dense(256,input_dim= len(X.columns),kernel_initializer= k.initializers.random_normal(seed= 13),activation= 'relu'))

#second layer
model.add(Dense (1, activation = 'hard_sigmoid'))
```

Run Code

In [20]:
```
#compiling the model
#opt = adam(lr=0.001, decay=1e-6)

model.compile(loss = 'binary_crossentropy', optimizer = 'adam', metrics = ['accuracy'])
```

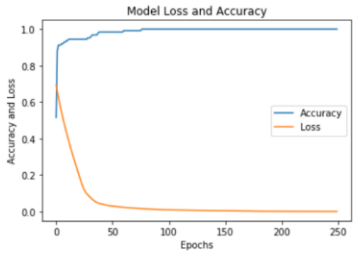
In [21]:
```
#train the model

history = model.fit(X_train, Y_train, epochs = 250, batch_size = X_train.shape[0])
```

```
Epoch 1/250
1/1 [==============================] - 0s 998us/step - loss: 0.6915 - accuracy: 0.5159
Epoch 2/250
1/1 [==============================] - 0s 2ms/step - loss: 0.6581 - accuracy: 0.8810
Epoch 3/250
1/1 [==============================] - 0s 979us/step - loss: 0.6261 - accuracy: 0.9127
Epoch 4/250
1/1 [==============================] - 0s 2ms/step - loss: 0.5956 - accuracy: 0.9127
Epoch 5/250
1/1 [==============================] - 0s 987us/step - loss: 0.5665 - accuracy: 0.9127
Epoch 6/250
```

```
In [23]: #visualie model loss and accuracy

plt.plot(history.history['accuracy'],label='Accuracy')
plt.plot(history.history['loss'],label='Loss')
plt.title('Model Loss and Accuracy')
plt.ylabel('Accuracy and Loss')
plt.xlabel('Epochs')
plt.legend();
```




```
In [24]: print("shape of training data: ",X_train.shape)
         print("shape of test data: ",X_test.shape)

         shape of training data:  (126, 25)
         shape of test data:  (32, 25)
```

```
In [25]: #show actual and predicted value
         pred = model.predict(X_test)
         pred = [1 if y>=0.5 else 0 for y in pred]

         print('Original:  {0}'.format(",".join(str(x) for x in Y_test)))
         print('Predicted: {0}'.format(",".join(str(x) for x in pred)))

         Original:  0,1,0,1,0,1,1,1,1,0,1,0,1,0,1,1,1,1,0,0,1,1,1,1,1,1,1,0,1,1,1,1,1,0,1,1
         Predicted: 0,1,0,1,0,1,1,1,1,0,1,0,1,0,1,1,1,1,0,0,1,1,1,1,1,1,1,0,1,1,1,1,1,0,1,1
```

Logistic Regression

```
In [26]: X = data.iloc[:,:-1]
         y = data['class']

         logreg = LogisticRegression(max_iter = 10000)

In [27]: X_train, X_test, y_train, y_test = train_test_split(X,y, stratify = y, shuffle = True)

In [28]: logreg.fit(X_train,y_train)

Out[28]: LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                            intercept_scaling=1, l1_ratio=None, max_iter=10000,
                            multi_class='auto', n_jobs=None, penalty='l2',
                            random_state=None, solver='lbfgs', tol=0.0001, verbose=0,
                            warm_start=False)

In [29]: test_pred = logreg.predict(X_test)
         train_pred = logreg.predict(X_train)
```

```
In [28]: logreg.fit(X_train,y_train)

Out[28]: LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                            intercept_scaling=1, l1_ratio=None, max_iter=10000,
                            multi_class='auto', n_jobs=None, penalty='l2',
                            random_state=None, solver='lbfgs', tol=0.0001, verbose=0,
                            warm_start=False)

In [29]: test_pred = logreg.predict(X_test)
         train_pred = logreg.predict(X_train)

         print('Train Accuracy: ', accuracy_score(y_train, train_pred))
         print('Test Accuracy: ', accuracy_score(y_test, test_pred))

         Train Accuracy:  1.0
         Test Accuracy:  1.0

In [30]: tn, fp, fn, tp = confusion_matrix(y_test, test_pred).ravel()

         print(f'True Neg: {tn}')
         print(f'False Pos: {fp}')
         print(f'False Neg: {fn}')
         print(f'True Pos: {tp}')

         True Neg: 11
         False Pos: 0
         False Neg: 0
         True Pos: 29

In [31]: print(classification_report(y_test,test_pred))
```

```
train_pred = logreg.predict(X_train)

print('Train Accuracy: ', accuracy_score(y_train, train_pred))
print('Test Accuracy: ', accuracy_score(y_test, test_pred))
```

```
Train Accuracy:  1.0
Test Accuracy:  1.0
```

In [30]:
```
tn, fp, fn, tp = confusion_matrix(y_test, test_pred).ravel()

print(f'True Neg: {tn}')
print(f'False Pos: {fp}')
print(f'False Neg: {fn}')
print(f'True Pos: {tp}')
```

```
True Neg: 11
False Pos: 0
False Neg: 0
True Pos: 29
```

In [31]:
```
print(classification_report(y_test,test_pred))
```

```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        11
           1       1.00      1.00      1.00        29

    accuracy                           1.00        40
   macro avg       1.00      1.00      1.00        40
weighted avg       1.00      1.00      1.00        40
```

TESTING

TESTCASES (FOR ALL MODULES AS PER THE TEMPLATE)

ORIGINAL DATA

```
id,age,bp,sg,al,su,rbc,pc,pcc,ba,bgr,bu,sc,sod,pot,hemo,pcv,wc,rc,htn,dm,cad,appet,pe,ane,class
0,48,80,1.02,1,0,,normal,notpresent,notpresent,121,36,1.2,,,15.4,44,7800,5.2,yes,yes,no,good,no,no,ckd
1,7,50,1.02,4,0,,normal,notpresent,notpresent,,18,0.8,,,11.3,38,6000,,no,no,no,good,no,no,ckd
2,62,80,1.01,2,3,normal,normal,notpresent,notpresent,423,53,1.8,,,9.6,31,7500,,no,yes,no,poor,no,yes,ckd
3,48,70,1.005,4,0,normal,abnormal,present,notpresent,117,56,3.8,111,2.5,11.2,32,6700,3.9,yes,no,no,poor,yes,yes,ckd
4,51,80,1.01,2,0,normal,normal,notpresent,notpresent,106,26,1.4,,,11.6,35,7300,4.6,no,no,no,good,no,no,ckd
5,60,90,1.015,3,0,,,notpresent,notpresent,74,25,1.1,142,3.2,12.2,39,7800,4.4,yes,yes,no,good,yes,no,ckd
6,68,70,1.01,0,0,,normal,notpresent,notpresent,100,54,24,104,4,12.4,36,,,no,no,no,good,no,no,ckd
7,24,,1.015,2,4,normal,abnormal,notpresent,notpresent,410,31,1.1,,,12.4,44,6900,5,no,yes,no,good,yes,no,ckd
8,52,100,1.015,3,0,normal,abnormal,present,notpresent,138,60,1.9,,,10.8,33,9600,4,yes,yes,no,good,no,yes,ckd
9,53,90,1.02,2,0,abnormal,abnormal,present,notpresent,70,107,7.2,114,3.7,9.5,29,12100,3.7,yes,yes,no,poor,no,yes,ckd
10,50,60,1.01,2,4,,abnormal,present,notpresent,490,55,4,,,9.4,28,,,yes,yes,no,good,no,yes,ckd
11,63,70,1.01,3,0,abnormal,abnormal,present,notpresent,380,60,2.7,131,4.2,10.8,32,4500,3.8,yes,yes,no,poor,yes,no,ckd
12,68,70,1.015,3,1,,normal,present,notpresent,208,72,2.1,138,5.8,9.7,28,12200,3.4,yes,yes,yes,poor,yes,no,ckd
13,68,70,,,,,notpresent,notpresent,98,86,4.6,135,3.4,9.8,,,,yes,yes,yes,poor,yes,no,ckd
14,68,80,1.01,3,2,normal,abnormal,present,present,157,90,4.1,130,6.4,5.6,16,11000,2.6,yes,yes,yes,poor,yes,no,ckd
15,40,80,1.015,3,0,,normal,notpresent,notpresent,76,162,9.6,141,4.9,7.6,24,3800,2.8,yes,no,no,good,no,yes,ckd
16,47,70,1.015,2,0,,normal,notpresent,notpresent,99,46,2.2,138,4.1,12.6,,,,no,no,no,good,no,no,ckd
17,47,80,,,,,notpresent,notpresent,114,87,5.2,139,3.7,12.1,,,,yes,no,no,poor,no,no,ckd
18,60,100,1.025,0,3,,normal,notpresent,notpresent,263,27,1.3,135,4.3,12.7,37,11400,4.3,yes,yes,yes,good,no,no,ckd
19,62,60,1.015,1,0,,abnormal,present,notpresent,100,31,1.6,,,10.3,30,5300,3.7,yes,no,yes,good,no,no,ckd
20,61,80,1.015,2,0,abnormal,abnormal,notpresent,notpresent,173,148,3.9,135,5.2,7.7,24,9200,3.2,yes,yes,yes,poor,yes,yes,ckd
21,60,90,,,,,notpresent,notpresent,,180,76,4.5,,10.9,32,6200,3.6,yes,yes,yes,good,no,no,ckd
22,48,80,1.025,4,0,normal,abnormal,notpresent,notpresent,95,163,7.7,136,3.8,9.8,32,6900,3.4,yes,no,no,good,no,yes,ckd
23,21,70,1.01,0,0,,normal,notpresent,notpresent,,,,,,,,,no,no,no,poor,no,yes,ckd
24,42,100,1.015,4,0,normal,abnormal,notpresent,present,,50,1.4,129,4,11.1,39,8300,4.6,yes,no,no,poor,no,no,ckd
25,61,60,1.025,0,0,,normal,notpresent,notpresent,108,75,1.9,141,5.2,9.9,29,8400,3.7,yes,yes,no,good,no,yes,ckd
26,75,80,1.015,0,0,,normal,notpresent,notpresent,156,45,2.4,140,3.4,11.6,35,10300,4,yes,yes,no,poor,no,no,ckd
27,69,70,1.01,3,4,normal,abnormal,notpresent,notpresent,264,87,2.7,130,4,12.5,37,9600,4.1,yes,yes,yes,good,yes,no,ckd
28,75,70,,1,3,,,notpresent,notpresent,123,31,1.4,,,,,,no,yes,no,good,no,no,ckd
29,68,70,1.005,1,0,abnormal,abnormal,present,notpresent,,28,1.4,,,12.9,38,,,no,no,yes,good,no,no,ckd
30,,70,,,,,,notpresent,notpresent,93,155,7.3,132,4.9,,,,yes, yes,no,good,no,no,ckd
```

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```
37,72,80,,,,,,notpresent,notpresent,137,65,3.4,141,4.7,9.7,28,6900,2.5,yes,yes,no,poor,no,yes,"ckd	"
38,69,80,1.02,3,0,abnormal,normal,notpresent,notpresent,,103,4.1,132,5.9,12.5,,,,yes,no,no,good,no,no,ckd
39,82,80,1.01,2,2,normal,,notpresent,notpresent,140,70,3.4,136,4.2,13,40,9800,4.2,yes,yes,no,good,no,no,ckd
40,46,90,1.01,2,0,normal,abnormal,notpresent,notpresent,99,80,2.1,,,11.1,32,9100,4.1,yes,no,"	no",good,no,no,ckd
41,45,70,1.01,0,0,,normal,notpresent,notpresent,,20,0.7,,,,,,,no,no,no,good,yes,no,ckd
42,47,100,1.01,0,0,,normal,notpresent,notpresent,204,29,1,139,4.2,9.7,33,9200,4.5,yes,no,no,good,no,yes,ckd
43,35,80,1.01,1,0,abnormal,,notpresent,notpresent,79,202,10.8,134,3.4,7.9,24,7900,3.1,no,yes,no,good,no,no,ckd
44,54,80,1.01,3,0,abnormal,abnormal,notpresent,notpresent,207,77,6.3,134,4.8,9.7,28,,,yes,yes,no,poor,yes,no,ckd
45,54,80,1.02,3,0,,abnormal,notpresent,notpresent,208,89,5.9,130,4.9,9.3,,,,yes,yes,no,poor,yes,no,ckd
46,48,70,1.015,0,0,,normal,notpresent,notpresent,124,24,1.2,142,4.2,12.4,37,6400,4.7,no,yes,no,good,no,no,ckd
47,11,80,1.01,3,0,,normal,notpresent,notpresent,,17,0.8,,,15,45,8600,,no,no,no,good,no,no,ckd
48,73,70,1.005,0,0,normal,normal,notpresent,notpresent,70,32,0.9,125,4,10,29,18900,3.5,yes,yes,no,good,yes,no,ckd
49,60,70,1.01,2,0,normal,abnormal,present,notpresent,144,72,3,,,9.7,29,21600,3.5,yes,yes,no,poor,no,yes,ckd
50,53,60,,,,,,notpresent,notpresent,91,114,3.25,142,4.3,8.6,28,11000,3.8,yes,yes,no,poor,yes,yes,ckd
51,54,100,1.015,3,0,,normal,present,notpresent,162,66,1.6,136,4.4,10.3,33,,,yes,yes,no,poor,yes,no,ckd
52,53,90,1.015,0,0,,normal,notpresent,notpresent,,38,2.2,,,10.9,34,4300,3.7,no,no,no,poor,no,yes,ckd
53,62,80,1.015,0,5,,,notpresent,notpresent,246,24,1,,,13.6,40,8500,4.7,yes,yes,no,good,no,no,ckd
54,63,80,1.01,2,2,normal,,notpresent,notpresent,,,3.4,136,4.2,13,40,9800,4.2,yes,no,yes,good,no,no,ckd
55,35,80,1.005,3,0,abnormal,normal,notpresent,notpresent,,,,,,9.5,28,,,no,no,no,good,yes,no,ckd
56,76,70,1.015,3,4,normal,abnormal,present,notpresent,,164,9.7,131,4.4,10.2,30,11300,3.4,yes,yes,yes,poor,yes,no,ckd
57,76,90,,,,,normal,notpresent,notpresent,93,155,7.3,132,4.9,,,,,yes,yes,yes,poor,no,no,ckd
58,73,80,1.02,2,0,abnormal,abnormal,notpresent,notpresent,253,142,4.6,138,5.8,10.5,33,7200,4.3,yes,yes,yes,good,no,no,ckd
59,59,100,,,,,,notpresent,notpresent,,96,6.4,,,6.6,,,,yes,yes,no,good,no,yes,ckd
60,67,90,1.02,1,0,,abnormal,present,notpresent,141,66,3.2,138,6.6,,,,,yes,no,no,good,no,no,ckd
61,67,80,1.01,1,3,normal,abnormal,notpresent,notpresent,182,391,32,163,39,,,,,no,no,no,good,yes,no,ckd
62,15,60,1.02,3,0,,normal,notpresent,notpresent,86,15,0.6,138,4,11,33,7700,3.8,yes,yes,no,good,no,no,ckd
63,46,70,1.015,1,0,abnormal,normal,notpresent,notpresent,150,111,6.1,131,3.7,7.5,27,,,no,no,no,good,no,yes,ckd
64,55,80,1.01,0,0,,normal,notpresent,notpresent,146,,,,,9.8,,,,no,no,"	no",good,no,no,ckd
65,44,90,1.01,1,0,,normal,notpresent,notpresent,,,20,1.1,,,15,48,,,no,"	no",no,good,no,no,ckd
66,67,70,1.02,2,0,abnormal,normal,notpresent,notpresent,150,55,1.6,131,4.8,,"	?",,,yes,yes,no,good,yes,no,ckd
67,45,80,1.02,3,0,normal,abnormal,notpresent,notpresent,425,,,,,,,,,no,no,no,poor,no,no,ckd
68,65,70,1.01,2,0,,normal,present,notpresent,112,73,3.3,,,10.9,37,,,no,no,no,good,no,no,ckd
```

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```
69,26,70,1.015,0,4,,normal,notpresent,notpresent,250,20,1.1,,,15.6,52,6900,6,no,yes,no,good,no,no,ckd
70,61,80,1.015,0,4,,normal,notpresent,notpresent,360,19,0.7,137,4.4,15.2,44,8300,5.2,yes,yes,no,good,no,no,ckd
71,46,60,1.01,1,0,normal,normal,notpresent,notpresent,163,92,3.3,141,4,9.8,28,14600,3.2,yes,yes,no,good,no,no,ckd
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File Edit View Language current mode

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219,68,90,1.01,0,0,,normal,notpresent,notpresent,238,57,2.5,,,9.8,28,8000,3.3,yes,yes,no,poor,no,no,ckd
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222,74,60,,,,,,notpresent,notpresent,108,68,1.8,,,,,,yes,yes,no,good,no,no,ckd
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300,45,60,1.02,0,0,normal,normal,,,114,26,0.7,141,4.2,15,43,9200,5.8,no,no,no,good,no,no,notckd
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328,28,70,1.02,0,0,normal,normal,,,131,29,0.6,145,4.9,,45,8600,6.5,no,no,no,good,no,no,notckd
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345,22,60,1.025,0,0,normal,normal,notpresent,notpresent,97,18,1.2,138,4.3,13.5,42,7900,6.4,no,no,no,good,no,no,notckd
346,33,60,,,,normal,normal,notpresent,notpresent,130,41,0.9,141,4.4,15.5,52,4300,5.8,no,no,no,good,no,no,notckd
347,43,60,1.025,0,0,normal,normal,notpresent,notpresent,108,25,1,144,5,17.8,43,7200,5.5,no,no,no,good,no,no,notckd
348,38,80,1.02,0,0,normal,normal,notpresent,notpresent,99,19,0.5,147,3.5,13.6,44,7300,6.4,no,no,no,good,no,no,notckd
349,35,70,1.025,0,0,,,notpresent,notpresent,82,36,1.1,150,3.5,14.5,52,9400,6.1,no,no,no,good,no,no,notckd
350,65,70,1.025,0,0,,,notpresent,notpresent,85,20,1,142,4.8,16.1,43,9600,4.5,no,no,no,good,no,no,notckd
351,29,80,1.02,0,0,normal,normal,notpresent,notpresent,83,49,0.9,139,3.3,17.5,40,9900,4.7,no,no,no,good,no,no,notckd
352,37,60,1.02,0,0,normal,normal,notpresent,notpresent,109,47,1.1,141,4.9,15,48,7000,5.2,no,no,no,good,no,no,notckd
353,39,60,1.02,0,0,normal,normal,notpresent,notpresent,86,37,0.6,150,5,13.6,51,5800,4.5,no,no,no,good,no,no,notckd
354,32,60,1.025,0,0,normal,normal,notpresent,notpresent,102,17,0.4,147,4.7,14.6,41,6800,5.1,no,no,no,good,no,no,notckd
355,23,60,1.02,0,0,normal,normal,notpresent,notpresent,95,24,0.8,145,5,15,52,6300,4.6,no,no,no,good,no,no,notckd
356,34,70,1.025,0,0,normal,normal,notpresent,notpresent,87,38,0.5,144,4.8,17.1,47,7400,6.1,no,no,no,good,no,no,notckd
357,66,70,1.025,0,0,normal,normal,notpresent,notpresent,107,16,1.1,140,3.6,13.6,42,11000,4.9,no,no,no,good,no,no,notckd
358,47,60,1.02,0,0,normal,normal,notpresent,notpresent,117,22,1.2,138,3.5,13,45,5200,5.6,no,no,no,good,no,no,notckd
359,74,60,1.02,0,0,normal,normal,notpresent,notpresent,88,50,0.6,147,3.7,17.2,53,6000,4.5,no,no,no,good,no,no,notckd
360,35,60,1.025,0,0,normal,normal,notpresent,notpresent,105,39,0.5,135,3.9,14.7,43,5800,6.2,no,no,no,good,no,no,notckd
361,29,80,1.02,0,0,normal,normal,notpresent,notpresent,70,16,0.7,138,3.5,13.7,54,5400,5.8,no,no,no,good,no,no,notckd
362,33,80,1.025,0,0,normal,normal,notpresent,notpresent,89,19,1.1,144,5,15,40,10300,4.8,no,no,no,good,no,no,notckd
363,67,80,1.025,0,0,normal,normal,notpresent,notpresent,99,40,0.5,,,17.8,44,5900,5.2,no,no,no,good,no,no,notckd
364,73,80,1.025,0,0,normal,normal,notpresent,notpresent,118,44,0.7,137,3.5,14.8,45,9300,4.7,no,no,no,good,no,no,notckd
365,24,80,1.02,0,0,normal,normal,notpresent,notpresent,93,46,1,145,3.5,,,10700,6.3,no,no,no,good,no,no,notckd
366,60,80,1.025,0,0,normal,normal,notpresent,notpresent,81,15,0.5,141,3.6,15,46,10500,5.3,no,no,no,good,no,no,notckd
367,68,60,1.025,0,0,normal,normal,notpresent,notpresent,125,41,1.1,139,3.8,17.4,50,6700,6.1,no,no,no,good,no,no,notckd
368,30,80,1.025,0,0,normal,normal,notpresent,notpresent,82,42,0.7,146,5,14.9,45,9400,5.9,no,no,no,good,no,no,notckd
```

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369,75,70,1.02,0,0,normal,normal,notpresent,notpresent,107,48,0.8,144,3.5,13.6,46,10300,4.8,no,no,no,good,no,no,notckd
370,69,70,1.02,0,0,normal,normal,notpresent,notpresent,83,42,1.2,139,3.7,16.2,50,9300,5.4,no,no,no,good,no,no,notckd
371,28,60,1.025,0,0,normal,normal,notpresent,notpresent,79,50,0.5,145,5,17.6,51,6500,5,no,no,no,good,no,no,notckd
372,72,60,1.02,0,0,normal,normal,notpresent,notpresent,109,26,0.9,150,4.9,15,52,10500,5.5,no,no,no,good,no,no,notckd
373,61,70,1.025,0,0,normal,normal,notpresent,notpresent,133,38,1,142,3.6,13.7,47,9200,4.9,no,no,no,good,no,no,notckd
374,79,80,1.025,0,0,normal,normal,notpresent,notpresent,111,44,1.2,146,3.6,16.3,40,8000,6.4,no,no,no,good,no,no,notckd
375,70,80,1.02,0,0,normal,normal,notpresent,notpresent,74,41,0.5,143,4.5,15.1,48,9700,5.6,no,no,no,good,no,no,notckd
376,58,70,1.025,0,0,normal,normal,notpresent,notpresent,88,16,1.1,147,3.5,16.4,53,9100,5.2,no,no,no,good,no,no,notckd
377,64,70,1.02,0,0,normal,normal,notpresent,notpresent,97,27,0.7,145,4.8,13.8,49,6400,4.8,no,no,no,good,no,no,notckd
378,71,60,1.025,0,0,normal,normal,notpresent,notpresent,,,0.9,140,4.8,15.2,42,7700,5.5,no,no,no,good,no,no,notckd
379,62,80,1.025,0,0,normal,normal,notpresent,notpresent,78,45,0.6,138,3.5,16.1,50,5400,5.7,no,no,no,good,no,no,notckd
380,59,60,1.02,0,0,normal,normal,notpresent,notpresent,113,23,1.1,139,3.5,15.3,54,6500,4.9,no,no,no,good,no,no,notckd
381,71,70,1.025,0,0,,,notpresent,notpresent,79,47,0.5,142,4.8,16.6,40,5800,5.9,no,no,no,good,no,no,notckd
382,48,80,1.025,0,0,normal,normal,notpresent,notpresent,75,22,0.8,137,5,16.8,51,6000,6.5,no,no,no,good,no,no,notckd
383,80,80,1.025,0,0,normal,normal,notpresent,notpresent,119,46,0.7,141,4.9,13.9,49,5100,5,no,no,no,good,no,no,notckd
384,57,60,1.02,0,0,normal,normal,notpresent,notpresent,132,18,1.1,150,4.7,15.4,42,11000,4.5,no,no,no,good,no,no,notckd
385,63,70,1.02,0,0,normal,normal,notpresent,notpresent,113,25,0.6,146,4.9,16.5,52,8000,5.1,no,no,no,good,no,no,notckd
386,46,70,1.025,0,0,normal,normal,notpresent,notpresent,100,47,0.5,142,3.5,16.4,43,5700,6.5,no,no,no,good,no,no,notckd
387,15,80,1.025,0,0,normal,normal,notpresent,notpresent,93,17,0.9,136,3.9,16.7,50,6200,5.2,no,no,no,good,no,no,notckd
388,51,80,1.02,0,0,normal,normal,notpresent,notpresent,94,15,1.2,144,3.7,15.5,46,9500,6.4,no,no,no,good,no,no,notckd
389,41,80,1.025,0,0,normal,normal,notpresent,notpresent,112,48,0.7,140,5,17,52,7200,5.8,no,no,no,good,no,no,notckd
390,52,80,1.025,0,0,normal,normal,notpresent,notpresent,99,25,0.8,135,3.7,15,52,6300,5.3,no,no,no,good,no,no,notckd
391,36,80,1.025,0,0,normal,normal,notpresent,notpresent,85,16,1.1,142,4.1,15.6,44,5800,6.3,no,no,no,good,no,no,notckd
392,57,80,1.02,0,0,normal,normal,notpresent,notpresent,133,48,1.2,147,4.3,14.8,46,6600,5.5,no,no,no,good,no,no,notckd
393,43,60,1.025,0,0,normal,normal,notpresent,notpresent,117,45,0.7,141,4.4,13,54,7400,5.4,no,no,no,good,no,no,notckd
394,50,80,1.02,0,0,normal,normal,notpresent,notpresent,137,46,0.8,139,5,14.1,45,9500,4.6,no,no,no,good,no,no,notckd
395,55,80,1.02,0,0,normal,normal,notpresent,notpresent,140,49,0.5,150,4.9,15.7,47,6700,4.9,no,no,no,good,no,no,notckd
396,42,70,1.025,0,0,normal,normal,notpresent,notpresent,75,31,1.2,141,3.5,16.5,54,7800,6.2,no,no,no,good,no,no,notckd
397,12,80,1.02,0,0,normal,normal,notpresent,notpresent,100,26,0.6,137,4.4,15.8,49,6600,5.4,no,no,no,good,no,no,notckd
398,17,60,1.025,0,0,normal,normal,notpresent,notpresent,114,50,1,135,4.9,14.2,51,7200,5.9,no,no,no,good,no,no,notckd
399,58,80,1.025,0,0,normal,normal,notpresent,notpresent,131,18,1.1,141,3.5,15.8,53,6800,6.1,no,no,no,good,no,no,notckd
402
```

DATA AFTER PREPROCESSING

Data is cleaned and scaled using drop axis method, then min-max scaler.

In [17]:
```
print(X)
```

```
           id       age        bp    sg    al   su  rbc   pc  pcc   ba  ...  \
3    0.000000  0.545455  0.333333  0.00  1.00  0.0  1.0  0.0  1.0  0.0  ...
9    0.006369  0.610390  0.666667  0.75  0.50  0.0  0.0  0.0  1.0  0.0  ...
11   0.012739  0.740260  0.333333  0.25  0.75  0.0  0.0  0.0  1.0  0.0  ...
14   0.019108  0.805195  0.500000  0.25  0.75  0.4  1.0  0.0  1.0  1.0  ...
20   0.025478  0.714286  0.500000  0.50  0.50  0.0  0.0  0.0  0.0  0.0  ...
..        ...       ...       ...   ...   ...  ...  ...  ...  ...  ...  ...
395  0.974522  0.636364  0.500000  0.75  0.00  0.0  1.0  1.0  0.0  0.0  ...
396  0.980892  0.467532  0.333333  1.00  0.00  0.0  1.0  1.0  0.0  0.0  ...
397  0.987261  0.077922  0.500000  0.75  0.00  0.0  1.0  1.0  0.0  0.0  ...
398  0.993631  0.142857  0.166667  1.00  0.00  0.0  1.0  1.0  0.0  0.0  ...
399  1.000000  0.675325  0.500000  1.00  0.00  0.0  1.0  1.0  0.0  0.0  ...

         hemo       pcv        wc     rc  htn   dm  cad  appet   pe  ane
3    0.551020  0.333333  0.600000  0.350  1.0  0.0  0.0    1.0  1.0  1.0
9    0.435374  0.242424  0.157143  0.300  1.0  1.0  0.0    1.0  0.0  1.0
11   0.523810  0.333333  0.357143  0.325  1.0  1.0  0.0    1.0  1.0  0.0
14   0.170068  0.000000  0.114286  0.050  1.0  1.0  1.0    1.0  1.0  0.0
20   0.312925  0.121212  0.900000  0.175  1.0  1.0  1.0    1.0  1.0  1.0
..        ...       ...       ...    ...  ...  ...  ...    ...  ...  ...
395  0.857143  0.757576  0.600000  0.575  0.0  0.0  0.0    0.0  0.0  0.0
396  0.911565  0.969697  0.742857  0.900  0.0  0.0  0.0    0.0  0.0  0.0
397  0.863946  0.818182  0.585714  0.700  0.0  0.0  0.0    0.0  0.0  0.0
398  0.755102  0.878788  0.671429  0.825  0.0  0.0  0.0    0.0  0.0  0.0
399  0.863946  0.939394  0.614286  0.875  0.0  0.0  0.0    0.0  0.0  0.0

[158 rows x 25 columns]
```

In [18]:
```
#split the data into 80% training and 20% testing and shuffle
```

CONCLUSION, LIMITATIONS AND SCOPE FOR FUTURE WORK

The first time in the process of diagnosing CKD using machine learning techniques. \ Then, four classification algorithms were explored, namely: ANN, SVM, Naïve Bayes, and k-NN. The performance of each of these classifiers was examined by the classification accuracy, precision, recall, and f-measure achieved by the classifier. ANN, SVM, and NB all achieved an accuracy of 98% while k-NN achieved an accuracy of 93.9%. Further research can be done to exceed the classification accuracy currently achieved, by using different classifiers or feature selection methods.
This project can be used as a prototype to develop a healthcare system for CKD patients. To further assess the performance of the model, testing the model with large number of data will help to analyze the accuracy levels of the current model with more accuracy.

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