ICU PATIENT RISK LEVEL MONITORING SYSTEM USING SUPERVISED LEARNING APPROACHES

A PROJECT REPORT

Submitted by

HARESH KUMAR P (211420104088)
ELANGO K (211420104071)
EMMANUEL JONATHAN E (211420104073)

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BONAFIDE CERTIFICATE

Certified that this project report **"ICU PATIENT RISK LEVEL MONITORING SYSTEM USING SUPERVISED LEARNING APPROACHES"** is the bonafide work of "HARESH KUMAR P (211420104088), ELANGO K (211420104071), EMMANUEL JONATHAN E (211420104073)" who carried out the project work under my supervision.

SIGNATURE

DR. L JABASHEELA M.E., Ph.D.,
HEAD OF THE DEPARTMENT
DEPARTMENT OF CSE,
PANIMALAR ENGINEERING COLLEGE,
POONAMALLEE,
CHENNAI-600 123

SIGNATURE

MRS.V.SATHYAPREIYA, M.E., Ph.D.,
ASSOCIATE PROFESSOR
DEPARTMENT OF CSE,
PANIMALAR ENGINEERING COLLEGE,
POONAMALLEE,
CHENNAI-600 123

Certified that the above candidate(s) was/were examined in the Anna University Project Viva-Voce Examination held on.....

INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION BY THE STUDENT

We **"HARESH KUMAR P (211420104088), ELANGO K (211420104071), EMMANUEL JONATHAN E (211420104073)"** hereby declare that this project report titled "**ICU PATIENT RISK LEVEL MONITORING SYSTEM USING SUPERVISED LEARNING APPROACHES** ", under the guidance of **MRS. V.SATHIYA PREIYA, M.E., Ph.D., ASSOCIATE PROFESSOR** is the original work done by us and we have not plagiarized or submitted to any other degree in any university by us.

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Haresh Kumar P

Elango K

Emmanuel Jonathan E

ABSTRACT

Modern Intensive Care Units (ICUs) provide continuous monitoring of critically ill patients susceptible to many complications affecting morbidity and mortality. ICU settings require a high staff-to-patient ratio and generates a sheer volume of data. For clinicians, the real-time interpretation of data and decision-making is a challenging task. Machine Learning (ML) techniques in ICUs are making headway in the early detection of high-risk events due to increased processing power and freely available datasets such as the Medical Information Mart for Intensive Care (MIMIC). Techniques in ICU settings using MIMIC data. We assembled the qualified articles to provide insights into the areas of application, clinical variables used, and treatment outcomes that can pave the way for further adoption of this promising technology and possible use in routine clinical decision-making. The lessons learned from our review can provide guidance to researchers on application of ML techniques to increase their rate of adoption in healthcare. The ICU patient risk level monitoring system plays a crucial role in improving patient safety, optimizing resource allocation, and enhancing clinical decision-making in intensive care settings. By continuously monitoring and analyzing patient data, it provides valuable insights that help healthcare providers intervene promptly and prevent adverse outcomes.

Keywords: intensive care unit, critical care, MIMIC, machine learning.

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CHAPTER-1
INTRODUCTION

1.1 OVERVIEW

Data science is Associate in Nursing knowledge base field that uses scientific strategies, processes, algorithms and systems to extract data and insights from structured and unstructured information, and apply data and unjust insights from information across a broad vary of application domains.

The term "data science" has been copied back to 1974, once Peter Naur projected it as another name for applied science. In 1996, the International Federation of Classification Societies became the primary conference to specifically feature information science as a subject. However, the definition was still in flux.

The term “data science” was 1st coined in 2008 by D.J. Patil, and Jeff Hammerbacher, the pioneer leads of information and analytics efforts at LinkedIn and Facebook. In but a decade, it's become one in all the most well liked and most trending professions within the market.

Data science is that the field of study that mixes domain experience, programming skills, and data of arithmetic and statistics to extract meaning insights from information.

1.2 PROBLEM DEFINITION

Over 120 million individuals are affected by the coronavirus illness (COVID-19), which is a serious global public health epidemic that has killed over 2 million people in 199 nations. In March 2020, the World Health Organization (WHO) classified the COVID-19 outbreak as a pandemic. Since then, the front-line nurses have had to contend with a number of difficulties, such as a severe nursing shortage, a lack of medical supplies, and a range of psychological issues like burnout and infection fear. These discoveries will help nurses fight the pandemic more resiliently as the disease continues to evolve. In our situation, there will be less interaction between the medical staff and the patients, preventing the transmission of infection. In the event of a pandemic outbreak, our technology will act as a barrier between the nurse and the afflicted patient. For example,

Disease X, as classified by the World Health Organization (WHO), is a fictitious pathogen that has the potential to trigger a worldwide health emergency. Healthcare workers in the UK are bracing for a possible new pandemic called "Disease X," which has the potential to kill 20 times as many people as COVID-19. It is possible that Disease X will kill up to 50 million people.

CHAPTER-2
LITERATURE SURVEY

2. LITERATURE SURVEY

Mortality Prediction in the ICU, Joon Lee, Joel A. Dubin and David M. Maslove, 2016 [1]. Patients admitted to the ICU suffer from critical illness or injury and are at high risk of dying. ICU mortality rates differ widely depending on the underlying disease process, with death rates as low as 1 in 20 for patients admitted following elective surgery, and as high as 1 in 4 for patients with respiratory diseases. The risk of death can be approximated by evaluating the severity of a patient's illness as determined by important physiologic, clinical, and demographic determinants. In clinical practice, estimates of mortality risk can be useful in triage and resource allocation, in determining appropriate levels of care, and even in discussions with patients and their families around expected outcomes. Estimates of mortality risk are, however, based on studying aggregate data from large, heterogeneous groups of patients, and as such their validity in the context of any single patient encounter cannot be assured. This shortcoming can be mitigated by personalized mortality risk estimation, which is well discussed in [2, 3], but is not a subject of the present study.

Dynamic mortality prediction using machine learning techniques for acute cardiovascular cases, Oleg Metskera, Sergey Sikorsky, 2018 [2]. The Study of model components and their connection is developed. The model structure identification assimilates the patient condition, treatment phases in treatment dynamic. It provides the prediction of better model structure on following steps and request for necessary data to improve the forecast for more informed decision-making. The dynamic data extracted directly from medical information system were analysed, that is very close to the real process. Using machine learning methods it is possible to make an early prediction of mortality risks.

Mortality Prediction in ICU Patients Using Machine Learning Models, Akhyar Ali Khan, Rehan Liaqat, 2021 [3]. Effective utilization of limited intensive care unit (ICU) allocations is a challenging task for medical experts to save precious human lives. The prolonged ICU stay of relatively secure patients and patients with low chances of recovery can cause life-threatening effects on patients waiting for ICU accommodation. Machine learning based techniques for early prediction of mortality can help in this regard. This paper presents two mortality prediction models using the support vector machine (SVM) and linear discriminant analysis. The proposed models use clinical data of the ICU patients for early prediction of mortality. Distribution filtering is performed using the chi-square distribution during pre-processing. A subset of the publicly available Medical Information Mart for Intensive Care (MIMIC-III v1.4) dataset is used for the evaluation of the proposed models. The problem of class imbalance is handled by synthetic minority oversampling technique. The comparison of obtained results is performed with existing SVM and multiple logistic regression models to show the effectiveness of the proposed models. The results of the study can be helpful for clinical experts for better decision making regarding the utilization of ICU allocations.

Identifying Predictors of COVID-19 Mortality Using Machine Learning, Tsz-Kin Wan, Rui-Xuan Huang, 2022 [4]. (1) Background: Coronavirus disease 2019 (COVID-19) is a dominant, rapidly spreading respiratory disease. However, the factors influencing COVID-19 mortality still have not been confirmed. The pathogenesis of COVID-19 is unknown, and relevant mortality predictors are lacking. This study aimed to investigate COVID-19 mortality in patients with pre-existing health conditions and to examine the association between COVID-19 mortality and other morbidities. (2) Methods: De-identified data from 113,882, including 14,877 COVID-19 patients, were collected from the UK Biobank. Different types of data, such as disease history and lifestyle factors, from the COVID-19 patients, were input into the following three machine learning models: Deep Neural Networks (DNN), Random Forest Classifier (RF), eXtreme Gradient Boosting classifier (XGB) and Support Vector Machine (SVM). The Area under the Curve (AUC) was used to measure the experiment result as

a performance metric. (3) Results: Data from 14,876 COVID-19 patients were input into the machine learning model for risk-level mortality prediction, with the predicted risk level ranging from 0 to 1. Of the three models used in the experiment, the RF model achieved the best result, with an AUC value of 0.86 (95% CI 0.84–0.88).

Length-of-stay and mortality prediction for a major hospital through interpretable machine learning, Dimitris Bertsimas, Jean Pauphilet [5].

Understanding the discharge process at a hospital level is key in improving efficiency and quality of care. Objective: Investigate how machine learning can help anticipate various aspects of patient discharges, from predicting length-of-stay to discharge destination or hospital mortality. Design: Retrospective study performed on inpatients admitted at Beth Israel Deaconess Medical Center between January 2017 and August 2018. Setting: Single-center study in a large academic medical center in the Boston area. Participants: We included inpatients admitted at BIDMC between January 2017 and August 2018, excluding patients admitted into psychiatry, obstetrics and newborns. The final cohort consisted of 48,770 unique admissions.

CHAPTER-3
SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

Clinical risk prediction using Electronic Health Records (EHR) can help physicians make better decisions and understand early diagnosis. On the other hand, efficient representations from multi-dimensional time series EHR data are crucial to the prediction performance. Current approaches typically concentrate on the temporal aspects or the innate relationships between clinical event variables, or they extract both data in two stages. This typically results in poor prediction performance due to the limited patient feature information. Furthermore, current techniques utilizing heterogeneous graph neural networks typically necessitate the human identification of appropriate meta-paths. To address these issues, we introduce the time-aware context-gated graph attention network (TContext GGAN). In particular, we create a GNN-based module with time-aware-meta-paths and a self-attention mechanism to automatically pick meta-paths and extract temporal semantic information and essential relations from EHR data at the same time. We take the first 48-hour EHR data from two open-source datasets in the first Intensive Care Unit (ICU) admission of three different tasks and model different clinical factors on the suggested EHR Graph in order to assess the proposed model. The following are the demerits:

- Their process required lot of computational power.
- They did not deploy the model.
- Their accuracy much lower than ours.

3.2 PROPOSED WORK

ICU patient risk level monitoring system utilizing supervised learning techniques. This system would assist healthcare professionals in assessing and monitoring the risk levels of patients in intensive care units (ICUs) in real-time. Gather a comprehensive dataset consisting of patient demographics, vital signs, laboratory results, medical history, medication records, and other relevant variables for ICU patients. This dataset will serve as the input for training and validating the supervised learning models. We Implement a system that continuously collects real-time patient data from the ICU, applies the

trained models, and provides risk level predictions for individual patients. This system can generate alerts or it’s important to note that the specific implementation details and choice of supervised learning algorithms may vary depending on the available data, healthcare institution, and desired performance objectives. The proposed system provides a high-level overview of the key components involved in developing an ICU patient risk level monitoring system using supervised learning techniques. Notifications to healthcare professionals when a patient's risk level exceeds a predefined threshold, enabling early intervention and timely medical attention. The following are the merits:

• We build a large scalable application for deployment purpose.
• Accuracy will be improved.
• Our maintained and scalable data.

3.3 REQUIREMENT ANALYSIS AND SPECIFICATION

Requirements are the basic constrains that are required to develop a system. Requirements are collected while designing the system. The following are the requirements that are to be discussed.

1. Functional requirements
2. Non-Functional requirements
3. Environment requirements
    A. Hardware requirements
    B. Software requirement

Functional Requirements

The software requirements specification is the first step in the requirements analysis process. It lists requirements of a particular software system. The following details to follow the special libraries like tensorflow, keras, matplotlib.

Non-Functional Requirements

Process of non-functional steps,

1. Problem definition
2. Preparing data
3. Evaluating algorithm

4. Improving results
5. Prediction the result

Environmental Requirements

1. **Software Requirements**

Operating System : Windows / Linux

Simulation Tool : Anaconda with Jupyter Notebook

2. **Hardware Requirements**

Processor : Pentium IV/III

Hard disk : minimum 80 GB

RAM : minimum 2 GB

3.4 TECHNOLOGY STACK

Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing (data science, machine learning applications, large-scale data processing, predictive analytics, etc.), that aims to simplify package management and deployment. Package versions are managed by the package management system "Conda". Anaconda distribution is used by over 12 million users and includes more than 1400 popular data-science packages suitable for Windows, Linux, and MacOS. So, Anaconda distribution comes with more than 1,400 packages as well as the Conda package and virtual environment manager called Anaconda Navigator and it eliminates the need to learn to install each library independently. The open source packages can be individually installed from the Anaconda repository with the conda install command or using the pip install command that is installed with Anaconda. Pip packages provide many of the features of conda packages and in most cases they can work together. Custom packages can be made using the `conda build` command, and can be shared with others by uploading them to Anaconda Cloud, PyPI or other repositories. The default installation of Anaconda2 includes Python 2.7 and Anaconda3 includes Python 3.7. However, you can create new environments that include any version of Python packaged with conda.

ANACONDA NAVIGATOR

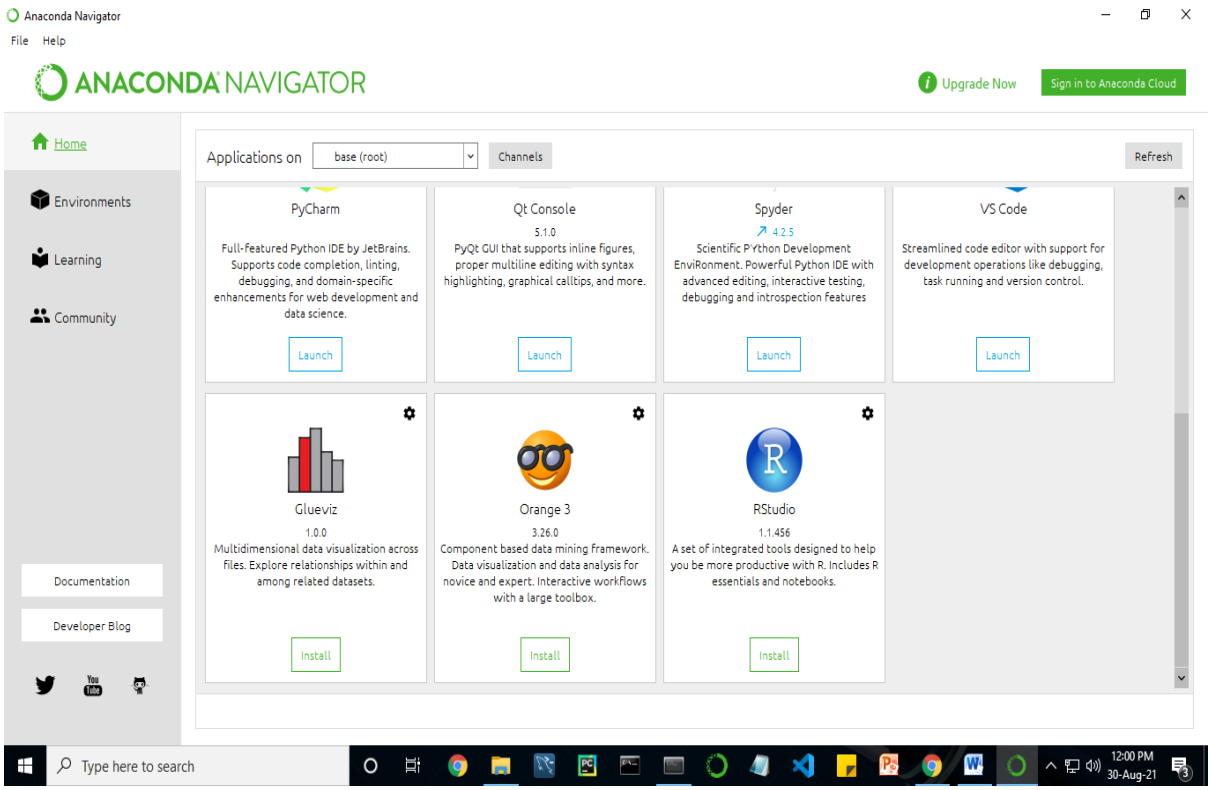
Anaconda Navigator is a desktop graphical user interface (GUI) included in Anaconda® distribution that allows you to launch applications and easily manage conda packages, environments, and channels without using command-line commands. Navigator can search for packages on Anaconda.org or in a local Anaconda Repository.

In order to run, many scientific packages depend on specific versions of other packages. Data scientists often use multiple versions of many packages and use multiple environments to separate these different versions.

The command-line program conda is both a package manager and an environment manager. This helps data scientists ensure that each version of each package has all the dependencies it requires and works correctly.

Navigator is an easy, point-and-click way to work with packages and environments without needing to type conda commands in a terminal window. You can use it to find the packages you want, install them in an environment, run the packages, and update them – all inside Navigator.
The following applications are available by default in Navigator:

- JupyterLab
- Jupyter Notebook
- Spyder
- PyCharm
- VSCode
- Glueviz
- Orange 3 App
- RStudio
- Anaconda Prompt (Windows only)
- Anaconda PowerShell (Windows only)



(FIG 3.4.1 ANACONDA NAVIGATOR HOME)

Anaconda Navigator is a desktop graphical user interface (GUI) included in Anaconda distribution.Navigator allows you to launch common Python programs and easily manage conda packages, environments, and channels without using command-line commands. Navigator can search for packages on Anaconda Cloud or in a local Anaconda Repository.

Anaconda comes with many built-in packages that you can easily find with conda list on your anaconda prompt. As it has lots of packages (many of which are rarely used), it requires lots of space and time as well. If you have enough space, time and do not want to burden yourself to install small utilities like JSON, YAML, you better go for Anaconda.

Conda

Conda is an open source, cross-platform, language-agnostic package manager and environment management system that installs, runs, and updates packages and their dependencies.

Anaconda is freely available, open source distribution of python and R programming languages which is used for scientific computations. It consists of many softwares which will help you to build your machine learning project and deep learning project. these softwares have great graphical user interface and these will make your work easy to do. you can also use it to run your python script.

JUPYTER NOTEBOOK

This website acts as “meta” documentation for the Jupyter ecosystem. It has a collection of resources to navigate the tools and communities in this ecosystem, and to help you get started.

Project Jupyter is a project and community whose goal is to "develop open-source software, open-standards, and services for interactive computing across dozens of programming languages". It was spun off from IPython in 2014 by Fernando Perez.

JUPYTER Notebook App: The *Jupyter Notebook App* is a server-client application that allows editing and running notebook documents via a web browser. The *Jupyter Notebook App* can be executed on a local desktop requiring no internet access (as described in this document) or can be installed on a remote server and accessed through the internet.In addition to displaying/editing/running notebook documents, the *Jupyter Notebook App* has a “Dashboard” (Notebook Dashboard), a “control panel” showing local files and allowing to open notebook documents or shutting down their kernels.

WORKING PROCESS

- Download and install anaconda and get the most useful package for machine learning in Python.
- Load a dataset and understand its structure using statistical summaries and data visualization.
- Machine learning models, pick the best and build confidence that the accuracy is reliable.

PYTHON

Python is a general-purpose interpreted, interactive, object-oriented, and high-level programming language. It was created by Guido van Rossum during1985-1990.

- **Python is Interpreted**−Python is processed at run time by the interpreter. No do not need to compile the program be for executing it. This is similar to PERL and PHP.

- **Python is Object-Oriented**−Python supports Object-Oriented style or technique of programming that encapsulates code within objects.

- **Python is a Beginner Language**−Python is a great language for the beginner-level programmers and supports the development of a wide range of applications from simple text processing to WWW browsers to games.

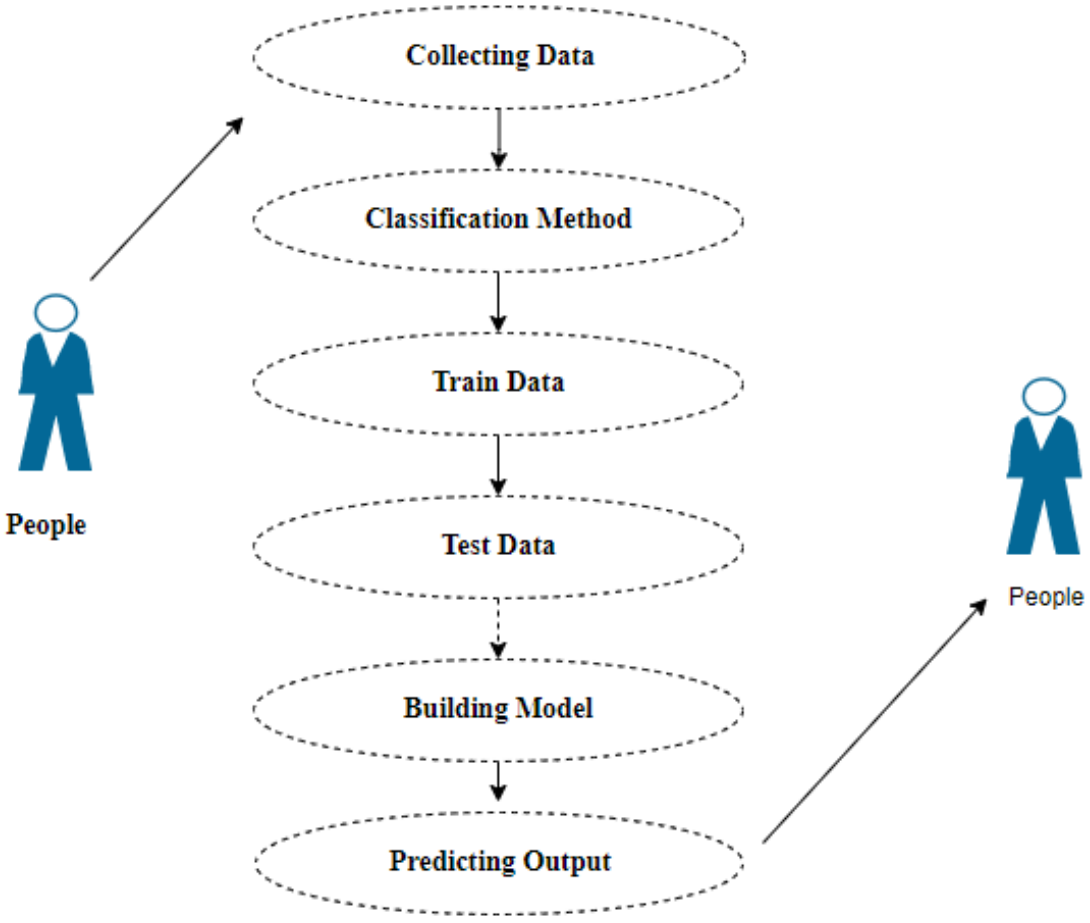
CHAPTER-4

SYSTEM DESIGN

Unified Modeling Language (UML) is a general purpose modelling language. The main aim of UML is to define as a standard way to visualize the way a system has been designed. It is quite similar to blue prints used in other fields of engineering.

4.1 USE CASE DIAGRAM

Use case diagrams are considered for high level requirement analysis of a system. So when the requirements of a system are analyzed the functionalities are captured in use cases. So, it can say that uses cases are nothing but the system functionalities written in an organized manner.

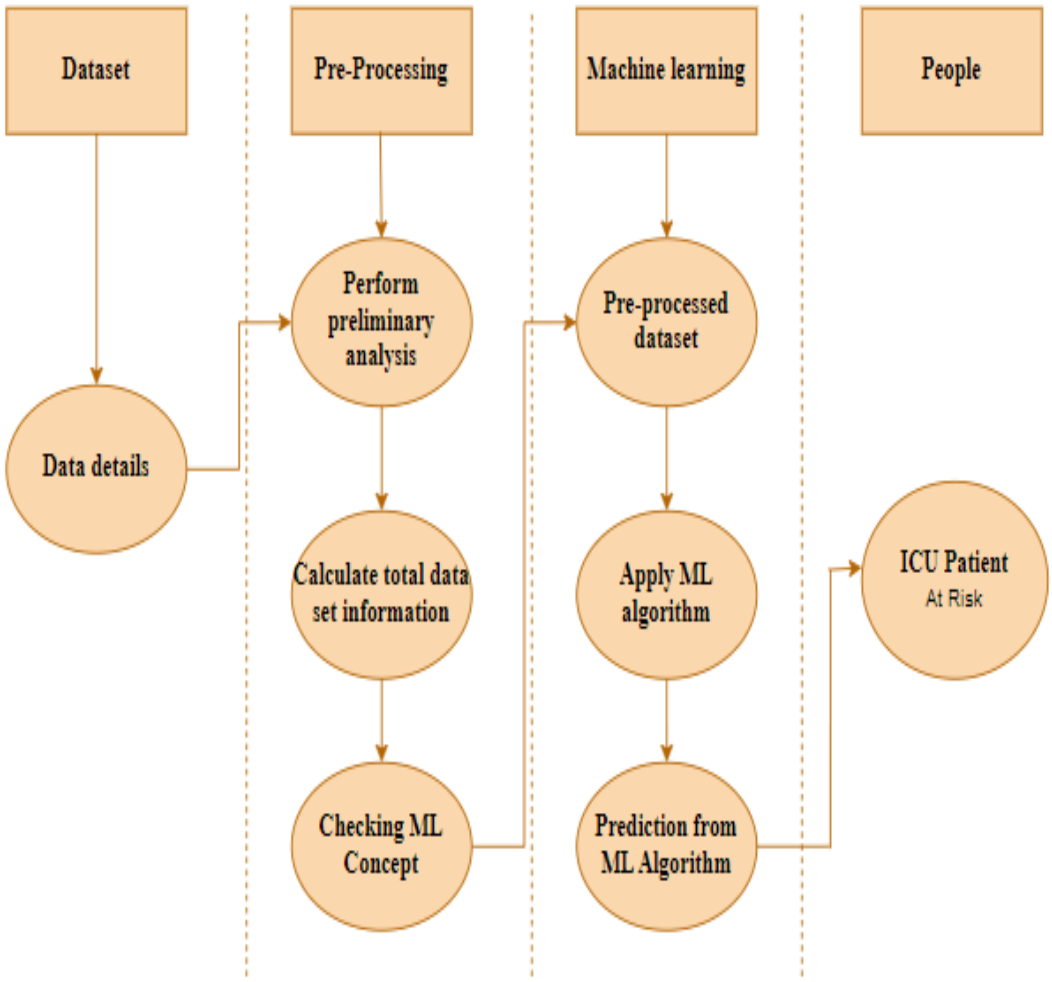


(FIG 4.1 USE CASE DIAGRAM)

The interaction between clinicians and patients is described by the use case diagram that shows the ICU patient Risk Level Monitoring System. The process begins with the collection of patient data, which is then classified, tested, and trained before the model is constructed and the result is predicted.

4.2 ACTIVITY DIAGRAM:

A graphical representation of an executed set of procedural system activities and considered as tate chart diagram variation. Activity diagrams describe parallel and conditional activities, usecases and system functions at a detailed level.

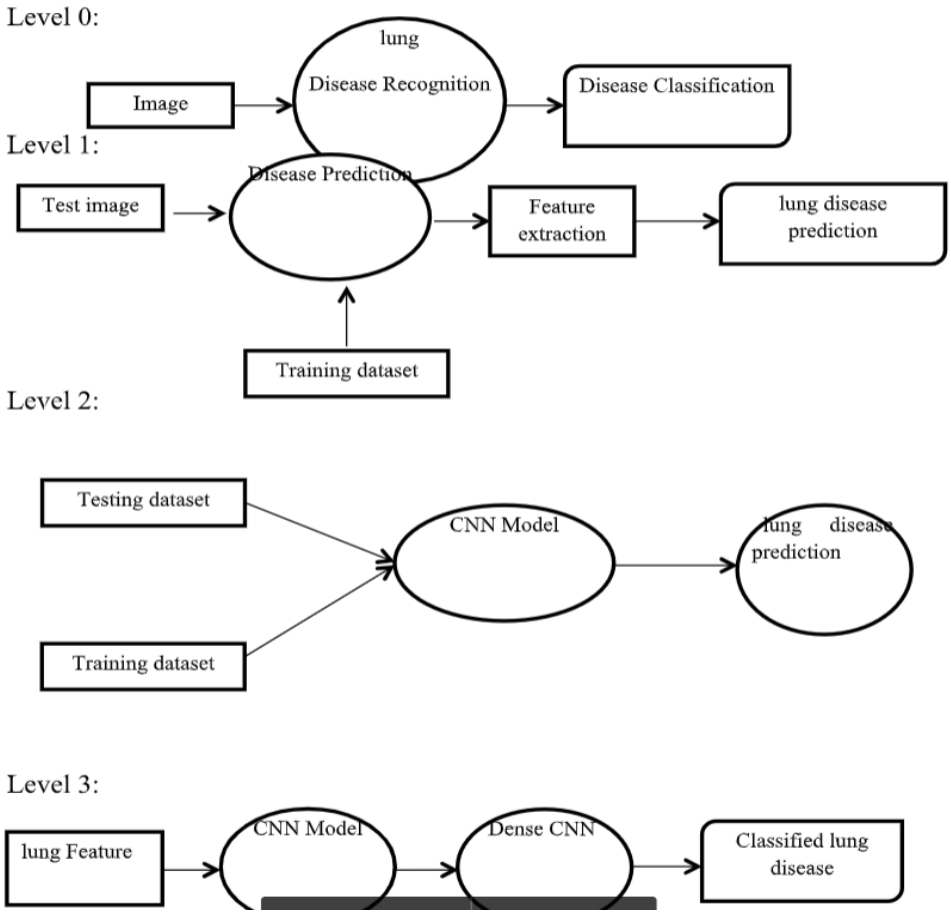


(FIG 4.1.2 ACTIVITY DIAGRAM)

The interaction between clinicians and patients is described by the Activity diagram that shows the ICU patient Risk Level Monitoring System. The process begins with the collection of patient data, which is then classified, tested, and trained before the model is constructed and the result is predicted.

4.3 DATA FLOW DIAGRAM

A data flow diagram (DFD) is a graphical representation of the "flow" of data through an information system, modeling its process aspects. It can be used for the visualization of data processing (structured design).Data flow diagrams are also known as bubble charts. DFD is a designing tool used in the top down approach to Systems Design. DFD levels are numbered 0, 1 or 2, and occasionally go to even Level 3 or beyond. DFD Level 0 is also called a Context Diagram.

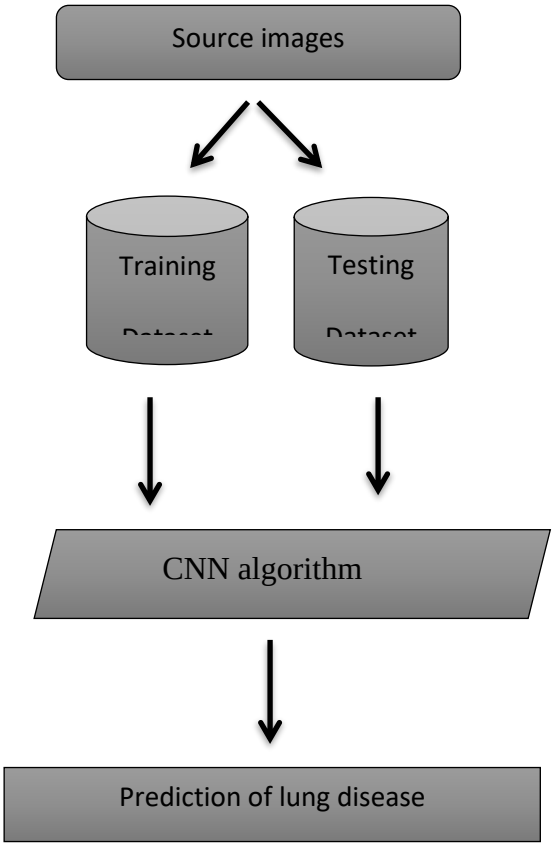


(FIG 4.3 DFD DIAGRAM)

The interaction between clinicians and patients is described by the data flow diagram that shows the ICU patient Risk Level Monitoring System. The process begins with the collection of patient data, which is then classified, tested, and trained before the model is constructed and the result is predicted.

4.4 WORK FLOW DIAGRAM

A workflow diagram (also known as a workflow) provides a graphic overview of the business process. Using standardized symbols and shapes, the workflow shows step by step how your work is completed from start to finish. It also shows who is responsible for work at what point in the process.



(FIG 4.4 WORK FLOW DIAGRAM)

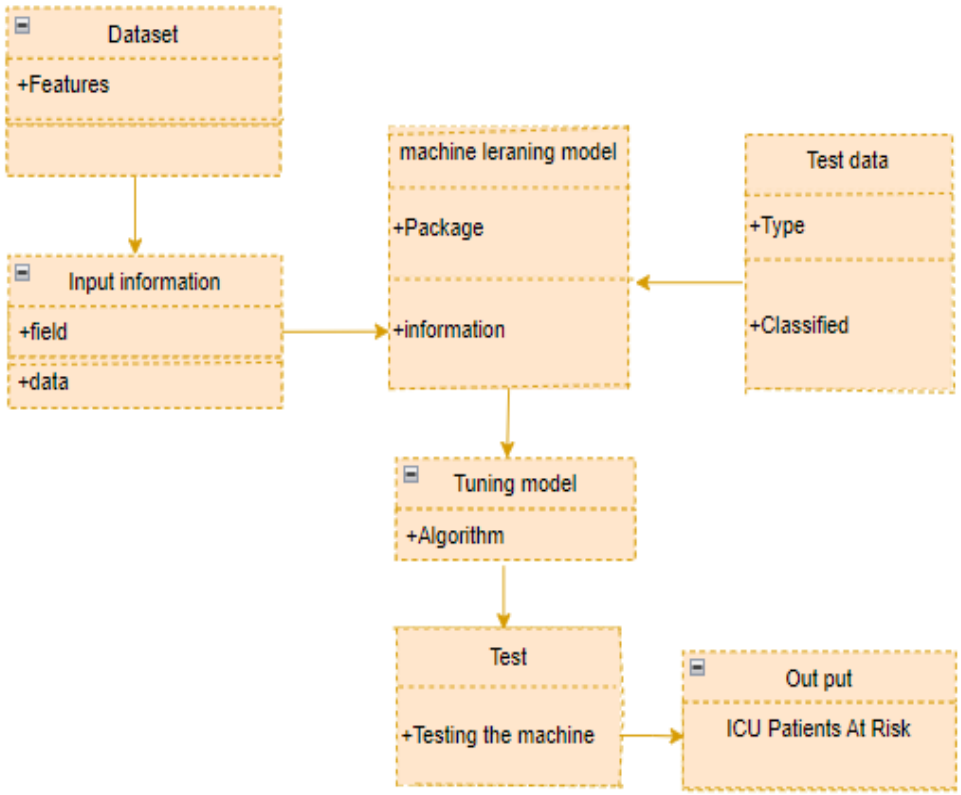
A flowchart is a diagram depicting a process, a system or a computer algorithm. It is a diagrammatic representation of the solution to a given problem but, more importantly, it provides a breakdown of the essential steps to solving the problem.

The interaction between clinicians and patients is described by the work flow diagram that shows the ICU patient Risk Level Monitoring System. The process begins with the collection of patient data, which is then classified, tested, and trained before the model is constructed and the result is predicted.

4.5 CLASS DIAGRAM

Class diagram is basically a graphical representation of the static view of the system and represents different aspects of the application. The name of the class diagram should be meaningful to describe the aspect of the system. Each element and their relationships should be identified in advance.

Class diagrams are the most important kind of UML diagram and are vitally important in software development. Class diagrams are the best way to illustrate a system's structure in a detailed way, showing its attributes.

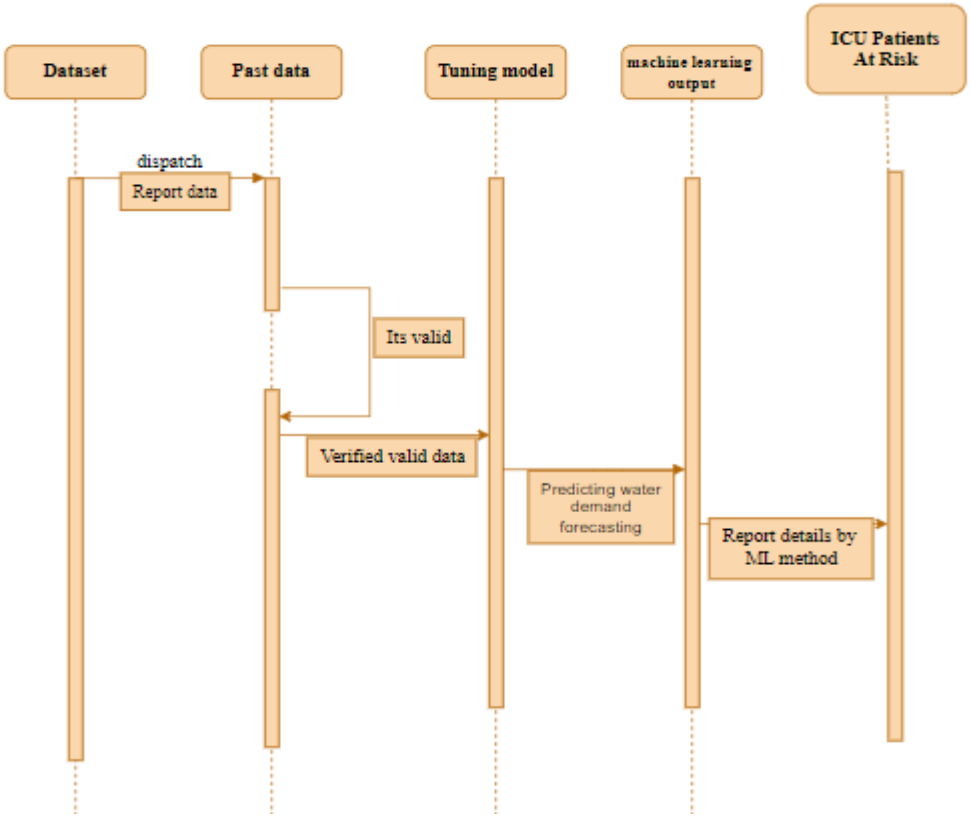


(FIG 4.5 CLASS DIAGRAM)

The interaction between clinicians and patients is described by the class diagram that shows the ICU patient Risk Level Monitoring System. The process begins with the collection of patient data, which is then classified, tested, and trained before the model is constructed and the result is predicted.

4.1.6 SEQUENCE DIAGRAM

Sequence diagrams model the flow of logic within your system in a visual manner, enabling you both to document and validate your logic, and are commonly used for both analysis and design purposes. Sequence diagrams are the most popular UML artifact for dynamic modelling, which focuses on identifying the behaviour within your system.



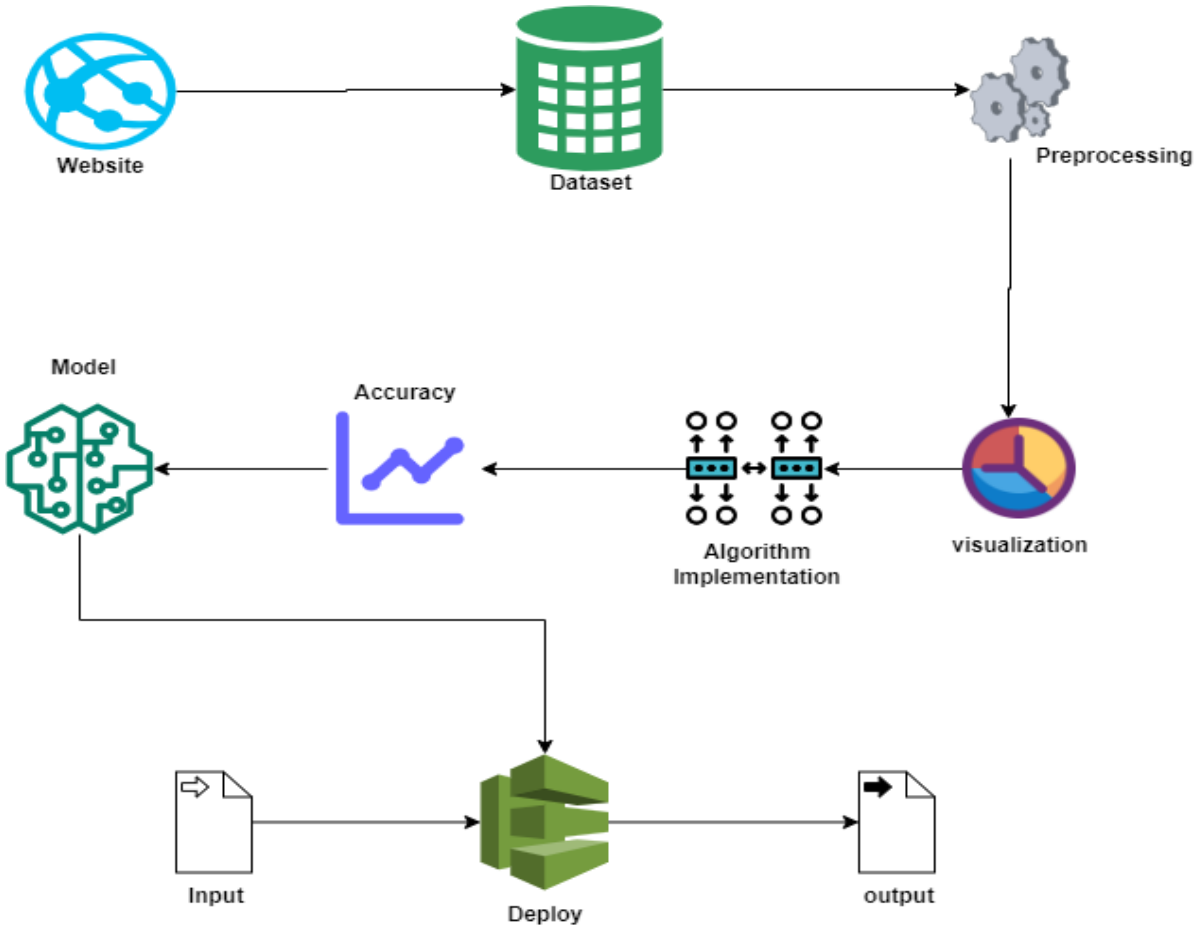
(FIG 4.6 SEQUENCE DIAGRAM)

The interaction between clinicians and patients is described by the sequence diagram that shows the ICU patient Risk Level Monitoring System. The process begins with the collection of patient data, which is then classified, tested, and trained before the model is constructed and the result is predicted

CHAPTER-5
SYSTEM ARCHITECTURE

5. SYSTEM ARCHITECTURE

A system architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system. Three types of system architectures are identified, integrated, distributed and mixed, (partly integrated and partly distributed). It is shown that the type of interfaces defines the type of architecture. Integrated systems have more interfaces, which furthermore are vaguely defined.



(FIG 5.1 SYSTEM ARCHITECTURE)

5.2 MODULE DESIGN SPECIFICATION

1. DATA PRE-PROCESSING
2. DATA VISUALIZATION
3. KNN CLASSIFIER
4. CAT BOOST CLASSIFIER
5. RANDOM FOREST CLASSIFIER
6. DEPLOY

5.2.1 MODULE DESCRIPTION

5.2.1.1 DATA PRE-PROCESSING

Validation techniques in machine learning are used to get the error rate of the Machine Learning (ML) model, which can be considered as close to the true error rate of the dataset. If the data volume is large enough to be representative of the population, you may not need the validation techniques. However, in real-world scenarios, to work with samples of data that may not be a true representative of the population of given dataset. To finding the missing value, duplicate value and description of data type whether it is float variable or integer. The sample of data used to provide an unbiased evaluation of a model fit on the training dataset while tuning model hyper parameters. The evaluation becomes more biased as skill on the validation dataset is incorporated into the model configuration. It as machine learning engineers use this data to fine-tune the model hyper parameters. Data collection, data analysis, and the process of addressing data content, quality, and structure can add up to a time-consuming to-do list. During the process of data identification, it helps to understand your data and its properties; this knowledge will help you choose which algorithm to use to build your model.

GIVEN INPUT EXPECTED OUTPUT

Input: Data

Output: Removing noisy data

5.2.1.2 DATA VISUALIZATION

Data visualization is an important skill in applied statistics and machine learning. Statistics does indeed focus on quantitative descriptions and estimations of data. Data

visualization provides an important suite of tools for gaining a qualitative understanding. This can be helpful when exploring and getting to know a dataset and can help with identifying patterns, corrupt data, outliers, and much more. With a little domain knowledge, data visualizations can be used to express and demonstrate key relationships in plots and charts that are more visceral and stakeholders than measures of association or significance. Data visualization and exploratory data analysis are whole fields themselves and it will recommend a deeper dive into some the books mentioned at the end.

GIVEN INPUT EXPECTED OUTPUT

input: data

output: visualized data

5.2.1.3 KNN CLASSIFIER

The KNN algorithm can compete with the most accurate models because it produces predictions that are incredibly accurate. Consequently, applications that demand great accuracy but don't need a human readable model can employ the KNN method. The distance measure affects how accurate the predictions are. It is a simple, supervised machine learning algorithm that can be used to solve both classification and regression problems. Although it's simple to use and comprehend, it has a huge disadvantage in that it slows down considerably as the amount of data being used increases. Not suitable for handling big datasets. The significant cost of determining the distance between each new point and each current point has an adverse effect on KNN's speed because it is a distance-based algorithm.

```
1 from sklearn.neighbors import KNeighborsClassifier
```

```
1 KNN = KNeighborsClassifier(n_neighbors=10)
2 KNN.fit(x_train,y_train)
```

```
KNeighborsClassifier(n_neighbors=10)
```

```
from sklearn.metrics import accuracy_score
a = accuracy_score(y_test,predicted)
print("THE ACCURACY SCORE OF KNEIGHBORS CLASSIFIER IS :",a*100)
```

```
THE ACCURACY SCORE OF KNEIGHBORS CLASSIFIER IS : 78.08219178082192
```

GIVEN INPUT EXPECTED OUTPUT

Input: Data

Output: Getting accuracy

5.2.1.4 CAT BOOST CLASSIFIER MODULE

The goal of training is to select the model py, depending on a set of features x{i} xi, that best solves the given problem (regression, classification, or multiclassification) for any input object. A training dataset, or collection of objects with known features and label values, is used to find this model. The validation dataset, which contains data in the same format as the training dataset, is used to verify accuracy; however, it is not utilized for actual training. Instead, it is used to assess the quality of training. Cat Boost is based on gradient-boosted decision trees. In training, a series of decision trees are constructed one after the other. In comparison to the preceding trees, each new tree is constructed with less loss. The initial settings determine how many trees are planted. Use the overfitting detector to stop overfitting. It stops the construction of trees when it is triggered.

```
from catboost import CatBoostClassifier
```

```
CAT = CatBoostClassifier()
CAT.fit(x_train,y_train)
```

```
Learning rate set to 0.008164
0:      learn: 0.6867486        total: 160ms    remaining: 2m 40s
1:      learn: 0.6811809        total: 164ms    remaining: 1m 22s
```

```
from sklearn.metrics import accuracy_score
a = accuracy_score(y_test,predicted)
print("THE ACCURACY SCORE OF CATBOOST CLASSIFIER IS :",a*100)
```

```
THE ACCURACY SCORE OF CATBOOST CLASSIFIER IS : 97.94520547945206
```

GIVEN INPUT EXPECTED OUTPUT

Input: Data

Output: Getting accuracy

5.2.1.5 RANDOM FOREST CLASSIFIER MODULE

Random Forest is a machine learning algorithm that uses a combination of decision trees to make predictions. It uses a technique called "bagging" or bootstrap aggregation, where subsets of the dataset are randomly selected and trained on. The results are then combined through a voting mechanism for classification or averaging for regression problems. This ensemble approach reduces overfitting and improves generalization. Random Forest also allows for feature importance assessment, providing insights into the most influential variables in the model's decision-making process. This makes it suitable for various applications.

```
from sklearn.metrics import accuracy_score
a = accuracy_score(y_test,predicted)
print("THE ACCURACY SCORE OF RANDOM FOREST CLASSIFIER IS :",a*100)
```

```
THE ACCURACY SCORE OF RANDOM FOREST CLASSIFIER IS : 99.31506849315068
```

```
from sklearn.ensemble import RandomForestClassifier
```

```
RFC = RandomForestClassifier(random_state=42)
RFC.fit(x_train,y_train)
```

```
RandomForestClassifier
RandomForestClassifier(random_state=42)
```

GIVEN INPUT EXPECTED OUTPUT

Input: Data

Output: Getting accuracy

5.2.1.5 DEPLOYMENT

In this module, the trained deep learning model is converted into a hierarchical data format file (.h5 file), which is then deployed in our Django framework for providing a better user interface and predicting the output whether the given image is CKD or not. Deploying the model in Django Framework and predicting output. Django is a high-level Python web framework that enables rapid development of secure and maintainable websites. Built by experienced developers, Django takes care of much of the hassle of

web development, so you can focus on writing your app without needing to reinvent the wheel.

HTML

HTML stands for HyperText Markup Language. It is used to design web pages using a markup language. HTML is the combination of Hypertext and Markup language. Hypertext defines the link between the web pages. A markup language is used to define the text document within tag which defines the structure of web pages. This language is used to annotate (make notes for the computer) text so that a machine can understand it and manipulate text accordingly. Most markup languages (e.g. HTML) are human-readable. The language uses tags to define what manipulation has to be done on the text.

Basic Construction of an HTML Page

These tags should be placed underneath each other at the top of every HTML page that you create**.**

CSS

CSS stands for Cascading Style Sheets. It is the language for describing the presentation of Web pages, including colours, layout, and fonts, thus making our web pages presentable to the users.

CSS is designed to make style sheets for the web. It is independent of HTML and can be used with any XML-based markup language.

Now let's try to break the acronym:

- Cascading: Falling of Styles
- Style: Adding designs/Styling our HTML tags
- Sheets: Writing our style in different documents

CSS Syntax

```
Selector {
        Property 1 : value;
    Property 2 : value;
    Property 3 : value;
     }
```

For example

```
  h1
    {
Color: red;
        Text-align: center;
    }
```

CHAPTER-6

SYSTEM IMPLEMENTATION

6.1 SERVER-SIDE CODING:

MANAGE.PY

```
#!/usr/bin/env python
"""Django's command-line utility for administrative tasks."""
import os
import sys
def main():
    """Run administrative tasks."""
    os.environ.setdefault('DJANGO_SETTINGS_MODULE', 'PROJECT.settings')
    try:
        from django.core.management import execute_from_command_line
    except ImportError as exc:
        raise ImportError(
            "Couldn't import Django. Are you sure it's installed and "
            "available on your PYTHONPATH environment variable? Did you "
            "forget to activate a virtual environment?"
        ) from exc
    execute_from_command_line(sys.argv)
if __name__ == '__main__': main()
```

RFC:

```
import pandas as pd

import numpy as np

import matplotlib.pyplot as plt

import seaborn as sns

df = pd.read_csv('ICU.csv')

del df['ID']

del df['gendera']

del df['group']

df.head()
```

outcome age BMI hypertensive atrialfibrillation CHD with no MI diabetes deficiencyanemias depression Hyperlipemia ... Blood sodium Blood calcium Chloride Anion gap Magnesium ion PH Bicarbonate Lactic acid PCO2 EF

0 0.0 72 37.588179 0 0 0 1 1 0 1 ... 138.750000 7.463636 109.166667 13.166667 2.618182 7.230 21.166667 0.5 40.0 55

1 0.0 75 NaN 0 0 0 0 1 0 0 ... 138.888889 8.162500 98.444444 11.444444 1.887500 7.225 33.444444 0.5 78.0 55

2 0.0 83 26.572634 0 0 0 0 1 0 0 ... 140.714286 8.266667 105.857143 10.000000 2.157143 7.268 30.571429 0.5 71.5 35

3 0.0 43 83.264629 0 0 0 0 0 0 0 ... 138.500000 9.476923 92.071429 12.357143 1.942857 7.370 38.571429 0.6 75.0 55

4 0.0 75 31.824842 1 0 0 0 1 0 0 ... 136.666667 8.733333 104.500000 15.166667 1.650000 7.250 22.000000 0.6 50.0 55

5 rows × 48 columns

dtype='object')

(1177, 48)

outcome age BMI hypertensive atrialfibrillation CHD with no MI diabetes deficiencyanemias depression Hyperlipemia ... Blood sodium Blood calcium Chloride Anion gap Magnesium ion PH Bicarbonate Lactic acid PCO2 EF

1088 0.0 83 20.347657 1 1 0 0 0 0 0 ... 137.800000 7.925000 102.400000 16.600000 2.250000 7.273333 23.000000 3.550 48.333333 55

1090 0.0 37 26.638051 0 0 0 0 0 0 0 ... 135.666667 8.400000 100.333333 13.333333 2.050000 7.370000 26.333333 3.775 29.000000 20

1091 0.0 61 29.836962 1 0 0 1 0 0 1 ... 135.444444 8.571429 99.444444 15.888889 1.900000 7.368125 24.333333 4.150 43.000000 20

1092 0.0 71 32.804298 1 0 0 1 0 1 0 ... 141.823529 8.500000 101.470588 12.066667 2.005882 7.385806 32.933333 4.160 42.870968 55

1094 0.0 37 26.255155 0 0 0 0 0 0 0 ... 126.230769 8.000000 92.923077 16.083333 2.141667 7.430000 21.666667 4.200 21.000000 15

df.shape

df=df.dropna()

df.columns

df.tail()

x1 = df.drop(labels='outcome', axis=1)

y1 = df.loc[:,'outcome']

import imblearn

from imblearn.over_sampling import RandomOverSampler

from collections import Counter

ros =RandomOverSampler(random_state=42)

x,y=ros.fit_resample(x1,y1)

print("OUR DATASET COUNT : ", Counter(y1))

print("OVER SAMPLING DATA COUNT : ", Counter(y))

from sklearn.model_selection import train_test_split

```
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.20,
random_state=42, stratify=y)

print("NUMBER OF TRAIN DATASET : ", len(x_train))

print("NUMBER OF TEST DATASET : ", len(x_test))

print("TOTAL NUMBER OF DATASET : ", len(x_train)+len(x_test))

print("NUMBER OF TRAIN DATASET : ", len(y_train))

print("NUMBER OF TEST DATASET : ", len(y_test))

print("TOTAL NUMBER OF DATASET : ", len(y_train)+len(y_test))

from sklearn.ensemble import RandomForestClassifier

RFC = RandomForestClassifier(random_state=42)

RFC.fit(x_train,y_train)

predicted = RFC.predict(x_test)

from sklearn.metrics import confusion_matrix

cm = confusion_matrix(y_test,predicted)

print('THE CONFUSION MATRIX SCORE OF RANDOM FOREST
CLASSIFIER:\n\n\n',cm)

from sklearn.model_selection import cross_val_score

accuracy = cross_val_score(RFC, x, y, scoring='accuracy')

print('THE CROSS VALIDATION TEST RESULT OF ACCURACY :\n\n\n',
accuracy*100)

from sklearn.metrics import accuracy_score

a = accuracy_score(y_test,predicted)

print("THE ACCURACY SCORE OF RANDOM FOREST CLASSIFIER IS

:",a*100)
```

```
from sklearn.metrics import hamming_loss

hl = hamming_loss(y_test,predicted)

print("THE HAMMING LOSS OF RANDOM FOREST CLASSIFIER IS :",hl*100)

from sklearn.metrics import precision_score

P = precision_score(y_test,predicted)

print("THE PRECISION SCORE OF RANDOM FOREST CLASSIFIER IS
:",P*100)

from sklearn.metrics import recall_score

R = recall_score(y_test,predicted)

print("THE RECALL SCORE OF RANDOM FOREST CLASSIFIER IS :",R*100)

from sklearn.metrics import f1_score

f1 = f1_score(y_test,predicted)

print("THE PRECISION SCORE OF RANDOM FOREST CLASSIFIER IS
:",f1*100)

def plot_confusion_matrix(cm, title='THE CONFUSION MATRIX SCORE OF
RANDOM FOREST CLASSIFIER\n\n', cmap=plt.cm.Blues):

target_names=['']

plt.imshow(cm, interpolation='nearest', cmap=cmap)

plt.title(title)

plt.colorbar()

tick_marks = np.arange(len(target_names))

plt.xticks(tick_marks, target_names, rotation=45)

plt.yticks(tick_marks, target_names)

plt.tight_layout()

plt.ylabel('True label')

plt.xlabel('Predicted label')
```

```
cm=confusion_matrix(y_test, predicted)

print('THE CONFUSION MATRIX SCORE OF RANDOM FOREST CLASSIFIER:\n\n')

print(cm)

sns.heatmap(cm/np.sum(cm), annot=True, cmap = 'Blues', annot_kws={"size": 16},fmt='.2%')

plt.show()

def graph():

import matplotlib.pyplot as plt

data=[a]

alg="RANDOM FOREST CLASSIFIER"

plt.figure(figsize=(5,5))

b=plt.bar(alg,data,color=("gold"))

plt.title("THE ACCURACY SCORE OF RANDOM FOREST CLASSIFIER IS\n\n\n")

plt.legend(b,data,fontsize=9)

graph()

import joblib

joblib.dump(RFC, 'ICU.pkl')
```

6.2 CLIENT-SIDE CODING:

REGISTER.HTML

```
<!--
<!DOCTYPE html>
{% load static %}
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>REGISTRATION</title>
</head>
<body>
    <body>
        <div class="heading">
          <p>TO</p>
          <p>REGISTER</p>
          <p>YOUR ACCOUNT</p>
        </div>
        <section class="container">
          <div class="main_box">
            <div class="one">
```

```
<imgsrc="https://st.depositphotos.com/1008709/4676/i/600/depositphotos_46768767stock-photo-hands-in-art-logo.jpg"
    alt="logo">
  <h1>
    WELCOME TO REGISTERATION
  </h1><br>
  <h4>
    TO REGISTER YOUR ACCOUNT
  </h4>
 </div><br>
 <form method="POST">
  {% csrf_token %}
        <div>
            <label>USERNAME</label>
            <input type="text" name="username" placeholder="Username" required>
  </div>
  <div>
    <label>EMAIL</label>
    <input type="email" name="email" placeholder="email" required>
  </div>
  <div>
```

```
            <label>PASSWORD1</label>
            <input type="password" name="password1" placeholder="PASSWORD1" required>
           </div>
           <div>
            <label>PASSWORD2</label>
            <input type="password" name="password2" placeholder="PASSWORD2" required>
           </div><br><br>
          <input type="submit"></button>
          </form><br>
          <footer>
           <a href="{% url 'Login_3' %}">Already Have an Account? </a>
          </footer>
         </div>
       </section>
     </body>
</body>
</html> -->
<!DOCTYPE html>
<html lang="en">
<head>
   <title>How To Create</title>
```

```
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" href="https://cdn.jsdelivr.net/npm/bootstrap-icons@1.4.1/font/bootstrap-icons.css">
  <link  href="https://cdn.jsdelivr.net/npm/bootstrap@5.0.2/dist/css/bootstrap.min.css" rel="stylesheet">
</head>
<style>
  a {
    text-decoration: none;
}
.login-page {
    width: 100%;
    height: 100vh;
    display: inline-block;
    display: flex;
    align-items: center;
}
.form-right i {
    font-size: 100px;
}
</style>
<body>
```

```
<div class="login-page bg-light">
  <div class="container">
    <div class="row">
      <div class="col-lg-10 offset-lg-1">
        <h3 class="mb-3">Sing Up Now</h3>
        <div class="bg-white shadow rounded">
          <div class="row">
            <div class="col-md-7 pe-0">
              <div class="form-left h-100 py-5 px-5">
                <form action="" class="row g-4" method="post">
                  {% csrf_token %}
                  <div class="col-12">
                    <label>Username<span class="text-danger">*</span></label>
                    <div class="input-group">
                      <div class="input-group-text"><i class="bi bi-person-fill"></i></div>
                      <input type="text" name="username" class="form-control" placeholder="Enter Username">
                    </div>
                  </div>
                  <div class="col-12">
                    <label>Email<span class="text-danger">*</span></label>
                    <div class="input-group">
```

<input type="email" name='email' class="form-control" placeholder="Enter Username">

<label>Password</label>

<input type="password" name="password1" class="formcontrol" placeholder="Enter Password">

<label>Confirm-Password*</label>

<input type="password" name="password2" class="form control" placeholder="Enter Password">

```
                        <div class="form-check">
                            <input class="form-check-input" type="checkbox" id="inlineFormCheck">
                            <labelclass="form-check-label" for="inlineFormCheck">Remember me</label>
                        </div>
                    </div>
                    <div class="col-sm-6">
<a href="{% url 'Login_3' %}" class="float-end text-primary">Already have Account?</a>
                    </div>
                <div class="col-12">
                    <button type="submit" class="btn btn-primary px-4 float-end mt-4">login</button>
                    </div>
                </form>
            </div>
        </div>
        <div class="col-md-5 ps-0 d-none d-md-block">
            <div class="form-right h-100 bg-primary text-white text-center pt-5">
                <i class="bi bi-bootstrap"></i>
                <br>
                <h2 class="fs-1">Welcome Back!!!</h2>
            </div>
```

```
                    </div>
                </div>
            </div>
            <!-- <p class="text-end text-secondary mt-3">Bootstrap 5 Login Page Design</p>
        </div> -->
    </div>
</div>
</div> </body> </html>
```

LOGIN.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
  <title>How To Create</title>
  <meta charset="utf-8">
  <meta name="viewport" content="width=device-width, initial-scale=1">
  <link rel="stylesheet" href="https://cdn.jsdelivr.net/npm/bootstrap-icons@1.4.1/font/bootstrap-icons.css">
 <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.0.2/dist/css/bootstrap.min.css" rel="stylesheet">
</head>
<style>
 a {
```

```
    text-decoration: none;
}
.login-page {
    width: 100%;
    height: 100vh;
    display: inline-block;
    display: flex;
    align-items: center;
}
.form-right i {
    font-size: 100px;
}
</style>
<body>

    <div class="login-page bg-light">
        <div class="container">
            <div class="row">
                <div class="col-lg-10 offset-lg-1">
                  <h3 class="mb-3">Login Now</h3>
                    <div class="bg-white shadow rounded">
                        <div class="row">
                            <div class="col-md-7 pe-0">
```

```
<div class="form-left h-100 py-5 px-5">
  <form action="" class="row g-4" method="post">
    {% csrf_token %}
    <div class="col-12">
      <label>Username<span class="text-danger">*</span></label>
      <div class="input-group">
        <div class="input-group-text"><i class="bi bi-person-fill"></i></div>
        <input type="text" name="username" class="form-control" placeholder="Enter Username">
      </div>
    </div>
    <div class="col-12">
      <label>Password<span class="text-danger">*</span></label>
      <div class="input-group">
        <div class="input-group-text"><i class="bi bi-lock-fill"></i></div>
        <input type="password" name="password" class="form-control" placeholder="Enter Password">
      </div>
    </div>

    <div class="col-sm-6">
```

```
                        <div class="form-check">
                            <input class="form-check-input" type="checkbox" id="inlineFormCheck">
                            <label class="form-check-label" for="inlineFormCheck">Remember me</label>
                        </div>
                    </div>

                    <div class="col-sm-6">
                        <a href="{% url 'Register_2'%}" class="float-end text-primary">Don't have an account? Create One</a>
                    </div>

                    <div class="col-12">
                        <button type="submit" class="btn btn-primary px-4 float-end mt-4">login</button>
                    </div>
                </form>
                {% for message in messages %}
                <p>{{message}}</p>
                {% endfor %}
            </div>
        </div>
        <div class="col-md-5 ps-0 d-none d-md-block">
```

```
                    <div class="form-right h-100 bg-primary text-white text-center pt-5">
                        <i class="bi bi-bootstrap"></i>
                        <h2 class="fs-1">Welcome Back!!!</h2>
                    </div>
                </div>
            </div>
        </div>
        <!-- <p class="text-end text-secondary mt-3">Bootstrap 5 Login Page Design</p> -->
    </div>
  </div>
</body>
</html>
```

LANDING.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
```

```
  <title>Document</title>
</head>
<body>
  <nav>
    <div class="logo">
      <div class="arrow-down"></div>
    </div>
    <ul>
    </ul>
  </nav>
  <section class="banner">
    <div class="container">
      <div class="banner-text">
        <h1>Icu Patients Risk Prediction</h1>
        <p><strong>ICU Risk Assessment.</strong> Learn about our rigorous risk assessment protocols designed to identify potential challenges and proactively address them.</p>
        <button><a href="{% url 'Register_2' %}" style="color: #fff;">Sign Up</a></button>
      </div>
    </div>
    <img class="banner-image" src="https://preview.ibb.co/bMi5Y6/banner_img.png" alt="monitoring" ></section>
</body>
</html>
```

CHAPTER-7
SYSTEM TESTING

7.1 UNIT TESTING

Unit testing is conducted to verify the functional performance of each modular component of the software. Unit testing focuses on the smallest unit of the software design (i.e.), the module.

Unit testing is a software development process that involves a synchronized application of a broad spectrum of defect prevention and detection strategies in order to reduce software development risks, time, and costs. It is performed by the software developer or engineer during the construction phase of the software development life cycle. Unit testing aims to eliminate construction errors before code is promoted to additional testing; this strategy is intended to increase the quality of the resulting software as well as the efficiency of the overall development process.

7.1.1 WHITE BOX TESTING

White Box testing is a test case design method that uses the control structure of the procedural design to the drive cases. Using the white box testing methods, we derived test cases that guarantee that all independent paths within a module have been exercised at least once. White-box testing (also known as clear box testing, glass box testing, transparent box testing, and structural testing) verifies the internal structures or workings of a program, as opposed to the functionality exposed to the end-user. In white-box testing, an internal perspective of the system (the source code), as well as programming skills, are used to design test cases. The tester chooses inputs to exercise paths through the code and determine the appropriate outputs. This is analogous to testing nodes in a circuit, e.g., in-circuit testing (ICT).

7.1.2 BLACK BOX TESTING

Black-box testing (also known as functional testing) treats the software as a "black box," examining functionality without any knowledge of internal implementation,

without seeing the source code. The testers are only aware of what the software is supposed to do, not how it does it.

Black-box testing methods include: equivalence partitioning, boundary value analysis, all-pairs testing, state transition tables, decision table testing, fuzz testing, model-based testing, use case testing, exploratory testing, and specification-based testing.
Specification-based testing aims to test the functionality of software according to the applicable requirements. This level of testing usually requires thorough test cases to be provided to the tester, who then can simply verify that for a given input, the output value (or behaviour), either "is" or "is not" the same as the expected value specified in the test case.
Test cases are built around specifications and requirements, i.e., what the application is supposed to do. It uses external descriptions of the software, including specifications, requirements, and designs to derive test cases. These tests can be functional or non-functional, though usually functional. Specification-based testing may be necessary to assure correct functionality, but it is insufficient to guard against complex or high-risk situations. One advantage of the black box technique is that no programming knowledge is required.

- Black box testing is done to find incorrect or missing function
- Interface error
- Performance error
- Error in external database access

7.2 INTEGRATION TESTING

Integration testing is a systematic technique for construction of the program structure while at the same time conducting tests to uncover errors associated with interfacing. i.e., integration testing is the complete testing of the set of modules which makes up the product.
The objective is to take untested modules and build a program structure tester should identify critical modules. Critical modules should be tested as early as possible. One

approach is to wait until all the units have passed testing, and then combine them and then tested. This approach is evolved from unstructured testing of small programs.
Another strategy is to construct the product in increments of tested units. A small set of modules are integrated together and tested, to which another module is added and tested in combination. And so on. The advantages of this approach are that, interface dispenses can be easily found and corrected.
The major error that was faced during the project is linking error.

7.3 TEST CASES AND REPORTS

SI NO	TESTCASE / ACTION TO BE PERFORMED	EXPECTED RESULTS	ACTUAL RESULTS	RESULTS
1.	Selecting “Sign up” Button	Display Sign up Page	Displays Sign up Page	Pass
2.	Selecting “Submit” Button	It Generates new user Data	It Generates new user Data	Pass
3.	Click The “Already Have a Account” Button	It Displays the Login Page	It Displays the Login Page	Pass
4.	Click the "Login" button after entering your credentials.	Display Home Page	Displays Home Page	Pass
5.	Selecting “Deployment” button In Menu Bar	Display the form for predicting risk.	Displays the form for predicting risk.	Pass
6.	Once the patient's vitals have been entered, click the submit button	Display its risk level and notifies the physicians	Displays its risk level and notifies the physicians	Pass

CHAPTER-8

CONCLUSION

8. 1 CONCLUSION

Our system provides the analytical process started from data cleaning and processing, missing value, exploratory analysis and finally model building and evaluation. The best accuracy on patient test set of higher accuracy score algorithm will be find out. Through continuous refinement and adaptation, such systems hold promise in improving resource allocation, reducing medical errors, and ultimately saving lives in critical care settings. The founded one is used in the application which can help to find the Hospital Mortality. Our application reduces the working hours of the staffs in the hospitals as our application will monitor the stats of the patient and send an alert to the respective doctors in charge if the patient is at risk. Over 120 million individuals are affected by the coronavirus illness (COVID-19), which is a serious global public health epidemic that has killed over 2 million people in 199 nations. In March 2020, the World Health Organization (WHO) classified the COVID-19 outbreak as a pandemic. Since then, the front-line nurses have had to contend with a number of difficulties, such as a severe nursing shortage, a lack of medical supplies, and a range of psychological issues like burnout and infection fear. These discoveries will help nurses fight the pandemic more resiliently as the disease continues to evolve. In our situation, there will be less interaction between the medical staff and the patients, preventing the transmission of infection. In the event of a pandemic outbreak, our technology will act as a barrier between the nurse and the afflicted patient. For example, Disease X, as classified by the World Health Organization (WHO), is a fictitious pathogen that has the potential to trigger a worldwide health emergency. Healthcare workers in the UK are bracing for a possible new pandemic called "Disease X," which has the potential to kill 20 times as many people as COVID-19. It is possible that Disease X will kill up to 50 million people.

8.2 FUTURE ENHANCEMENTS

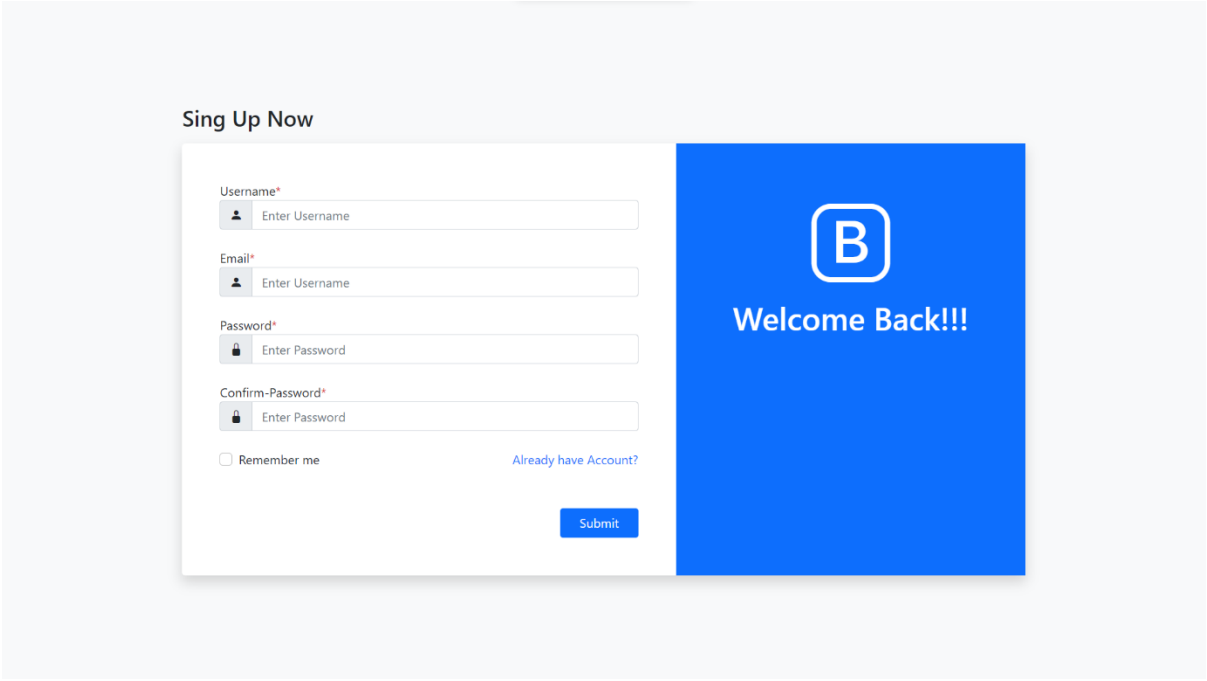
The following are the future improvements to our project,

- Shall host the platform on online servers to make it accessible worldwide.
- To optimize the work to implement in the IOT system.
- To develop an application for mobile devices that allows family and friends to instantly check on a patient's vitals.

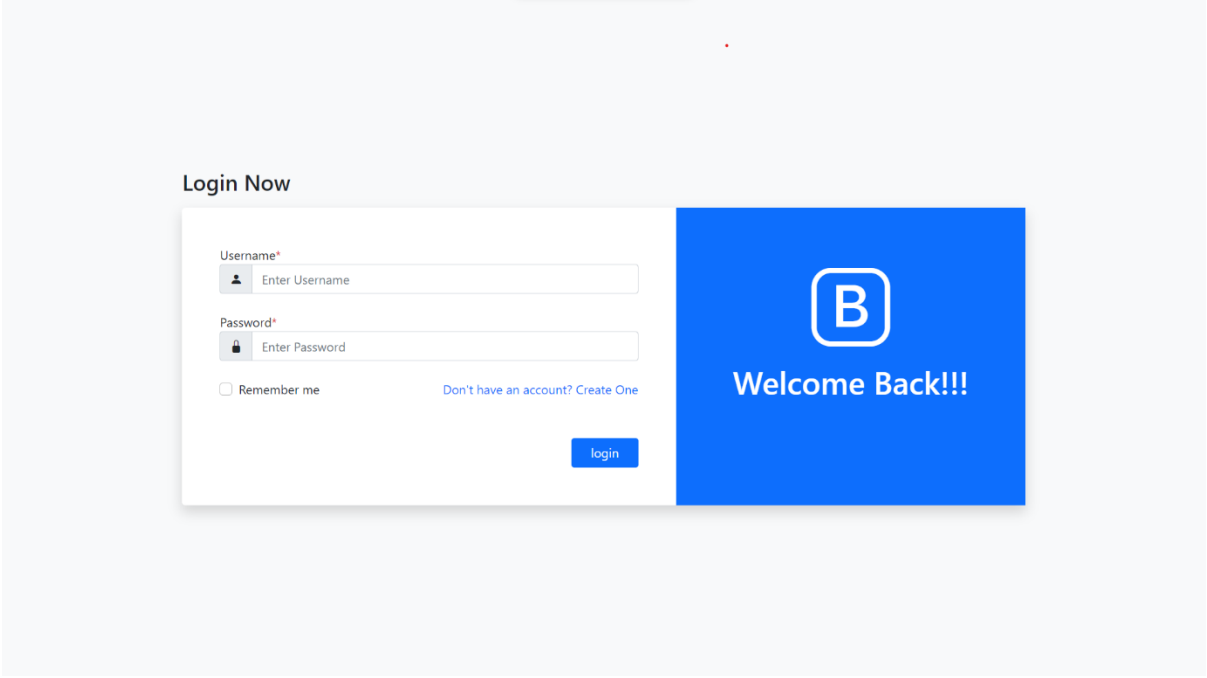
  The above mentioned are the future enhancements that can be done to make this project much more dynamic.

APPENDICES

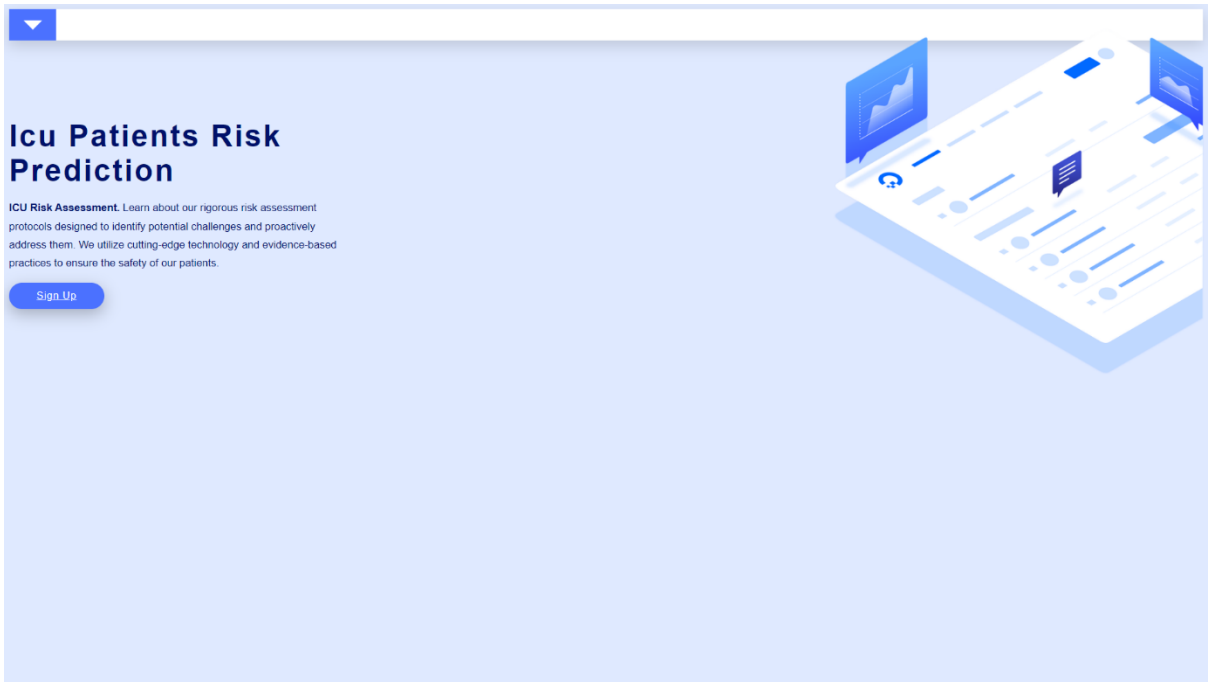
OUTPUT SCREENSHOTS:



(FIG A.1 Sign Up Page)

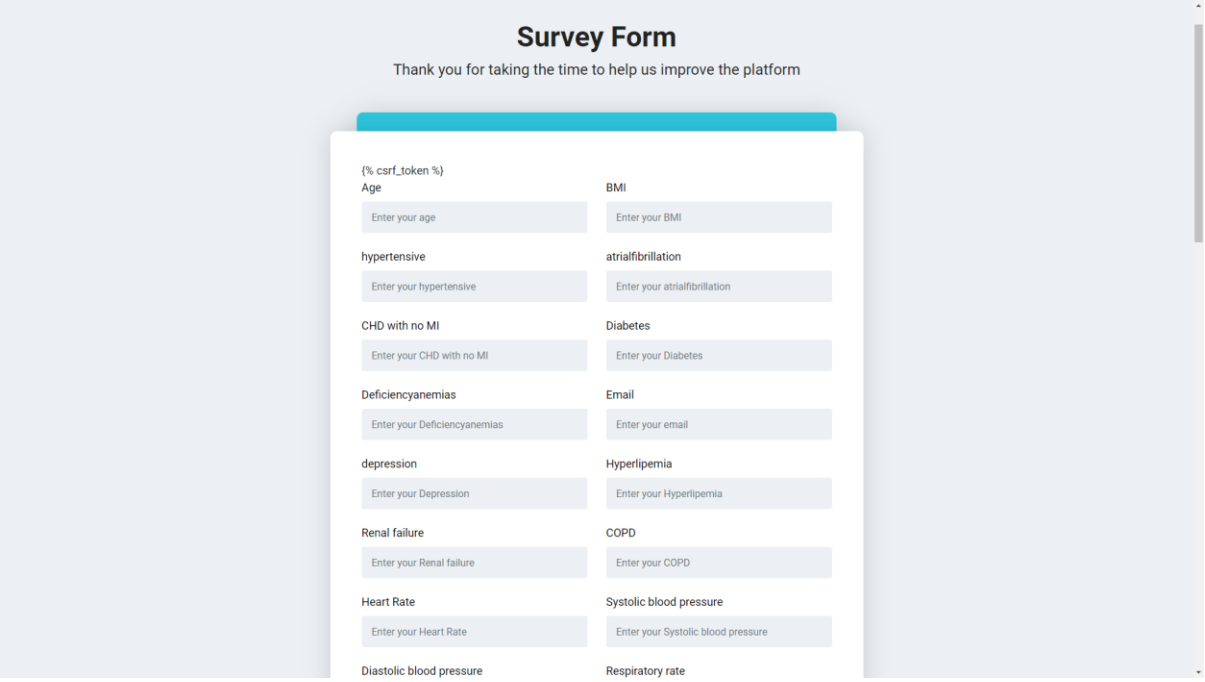


(FIG A.2 Login Page)

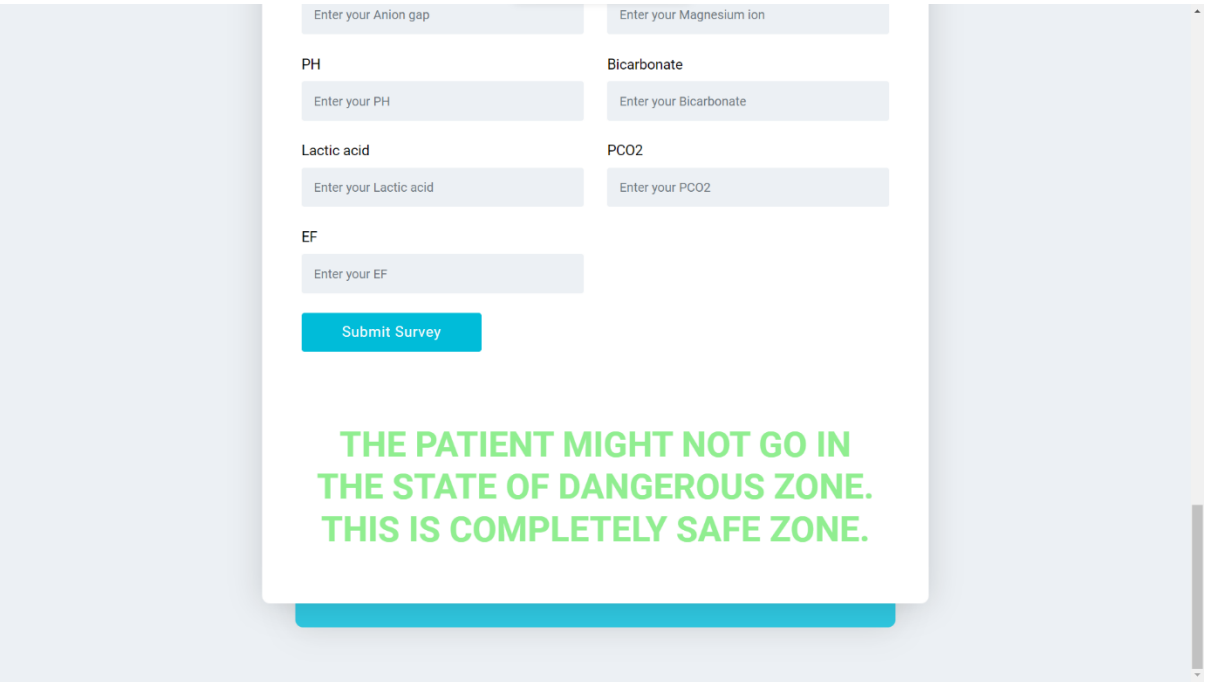


(FIG A.3 Home Page)

(FIG A.4 Dashboard Page)



(FIG A.5 Survey Page)



(FIG A.6 Result Page)

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