TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

KATHMANDU ENGINEERING COLLEGE

DEPARTMENT OF COMPUTER ENGINEERING

MINOR PROJECT FINAL REPORT

ON

HEALTH-MATE: APPOINTMENT BOOKING SYSTEM

[Code No: CT 654]

Submitted By:

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Kathmandu, Nepal

Falgun, 2080

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PROJECT REPORT SUBMITTED
TO THE DEPARTMENT OF COMPUTER ENGINEERING
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE BACHELOR OF ENGINEERING

By

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TRIBHUVAN UNIVERSITY
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CERTIFICATE

The undersigned certify that they have read and recommended to the Department of Computer Engineering a minor project work entitled "Health Mate: Appointment Booking System" submitted by Aditya Gnawali -77005, Bhuwan Shrestha -77014, Jyoti Bhushan Dahal -77028, Mohit Raj Aryal -77030 in partial fulfillment of the requirements for the degree of Bachelor of Engineering.

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ACKNOWLEDGEMENT

We would also like to express our gratitude to **Kathmandu Engineering College** for providing the necessary resources and fostering an environment that encourages academic and research endeavors. The support received from the institution has been instrumental in the successful execution of our minor project.

We extend our sincere gratitude to Assoc. Professor **Sharad Chandra Joshi**, Supervisor for his unwavering guidance and expertise throughout our minor project. His insightful feedback and continuous support played a vital role in refining our work and ensuring its success. Mr. Joshi's dedication to our project has been a source of inspiration, and we are truly thankful for the valuable mentorship he provided.

A special acknowledgment goes to Lecturer **Krista Byanju**, Minor Project Coordinator, for her diligent coordination and oversight. Her keen insights and constructive feedback significantly contributed to the overall quality of our project. Ms. Byanju's commitment to facilitating a conducive environment for our academic pursuits has not gone unnoticed, and we appreciate her efforts in ensuring the smooth progress of our project.

Our thanks are extended to Assoc. Professor **Sudeep Shakya**, Faculty Head of Department for his leadership and commitment to academic excellence. Additionally, we appreciate the efforts of Assoc. Professor Nabin Neupane, Year Coordinator, for his support in coordinating academic activities and ensuring a seamless learning experience.

Collectively, the contributions of these individuals have shaped our minor project and enriched our learning journey. We are grateful for their mentorship, encouragement, and the conducive academic environment provided by Kathmandu Engineering College.

ABSTRACT

Our minor project, "Health-Mate (H-Mate)," presents a web-based system revolutionizing healthcare connectivity by employing a Machine Learning Random Forest Algorithm. This innovative platform facilitates direct patient-healthcare provider interactions, offering services such as doctor appointment bookings and specialist recommendations based on symptoms. H-Mate integrates a robust dbSQLite3 database for efficient record-keeping, reducing administrative complexities and manpower requirements. The system's user-friendly interface aims to enhance the overall healthcare experience by providing intelligent doctor recommendations and streamlined appointment management. With a focus on creating stronger connections between patients and healthcare providers, H-Mate envisions contributing to a cohesive and accessible healthcare ecosystem. The project's objectives include providing a platform for patient-doctor interaction and implementing a system for comprehensive record-keeping. The incremental model was chosen for its flexibility, adaptability, and risk mitigation capabilities during the development process. The Random Forest Algorithm, a key component, analyzes symptoms to make informed disease predictions, supporting users in making informed decisions about their health. The methodology involves importing libraries, dataset cleaning, encoding categorical data, model training, and predicting specialists. H-Mate's holistic approach and robust algorithm contribute to its potential to revolutionize healthcare engagement and awareness in Nepal and beyond.

Keywords: *Health-mate, healthcare technology, web-based systems, specialist recommendations, Machine Learning, dbSQLite3 database, appointment booking, user-friendly interface, specialist prediction.*

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LIST OF ABBREVIATIONS

CAGR: Compound Annual Growth Rate

CSS: Cascading Style Sheets

HTML: Hypertext Markup Language

ITU: International Telecommunication Union

ML: Machine Learning

MVC: Model View Controller

MVT: Model View Template

RDBMS: Relational Database Management System

CHAPTER 1: INTRODUCTION

1.1 Background Theory

The healthcare landscape is undergoing a significant transformation with the integration of medical application systems, reshaping how individuals connect with healthcare providers. Our innovative system, "Health-Mate (H-Mate)," stands out as a pioneer in this digital evolution. Utilizing advanced Machine Learning algorithms, specifically the Random Forest Algorithm, H-Mate empowers patients by providing personalized recommendations for specialist doctors based on patients' symptoms. This streamlined process not only enhances efficiency but also allows users to seamlessly book appointments directly with their chosen healthcare professionals from the comfort of their homes.

In Nepal, the introduction of H-Mate holds the potential to revolutionize healthcare engagement by bridging the gap between individuals and specialized medical expertise. This user-friendly system aims to empower people across the country, simplifying the process of booking appointments and accessing specialized healthcare services. Beyond its functional attributes, H-Mate serves as an invaluable tool for raising awareness about prevalent health-related issues, promoting regular health checkups, and demystifying healthcare facilities. The holistic approach of H-Mate envisions a future where individuals are effortlessly connected with the right specialists and inspired to prioritize their health through regular checkups, contributing to a healthier and more informed society.

In the ever-evolving landscape of medical application systems, H-Mate offers a unique solution designed to assist users in finding specialist doctors based on their symptoms and facilitating direct appointment bookings. This application not only enhances accessibility to healthcare services but also serves as an awareness medium for individuals about common health-related issues. With its emphasis on simplicity and efficiency, H-Mate is composed to bring positive changes to the health sector in Nepal, encouraging people to prioritize their well-being through easy appointment scheduling and informed decision-making regarding their health.

1.2 Problem Statement

In Nepal, there is a lack of proper medical care for people whose salary is less than the average. The long waiting hours for medical services and a tight schedule with a lack of ability for timely and routine checkups. Moreover, there is a lack of awareness of diseases and their control measures. The geographical condition of Nepal makes it difficult to provide proper health services to people due to lack of mobility.

Currently, medical services in Nepal are predominantly managed by private sectors, which tend to be expensive, or through government-funded hospitals. The significant costs associated with infrastructure, transportation, and manpower pose challenges in

delivering affordable healthcare. However, this is where H-Mate comes into the picture. H-Mate is a solution that aims to reduce costs and manpower requirements in the healthcare sector.

1.3 Objectives

The main objectives of this project are:

1. To provide a platform for patients to book an appointment with a specialist doctor based on their symptoms.
2. To make a system where the system can keep a record of patients and appointment histories.

1.4 Scope and Application

Hospital-based applications in Nepal can bring significant improvements to healthcare. They can help people access healthcare services easily, improve patient health, and make healthcare systems more efficient.

Hospital-based applications have been in the market for quite some time in Nepal. With the success of some hospital-based applications like Hamro Doctor, Mero Doctor, Okhati, and others, it is clear that the people of Nepal are interested in these types of applications too. As these models work relatively well, we believe that our new approach to designing hospital-based applications will work well. In our application, every user will be able to solve most of their problems related to Health conditions in a very effective, efficient, and user-friendly way.

Scope and application in Nepal:

1. H-Mate can enable patients to book an appointment with doctors without the need to wait long hours in line.
2. It can be used to suggest doctors of different specialties based on the disease of the patients.
3. Our application can be able to store the medical history of patients so that they can be accessed at any time.

CHAPTER 2: LITERATURE REVIEW

With the rise of digital technologies, there has been a global surge in developing innovative mobile applications, spanning from games to social media platforms, unlocking endless possibilities. In this digital landscape, the advent of medical health apps was inevitable, catering to general health, tracking, and condition-specific needs. However, as technology evolves, a shift towards website applications has become increasingly prevalent.

Over the years, website-based health applications have emerged as powerful tools for improving healthcare accessibility, information dissemination, diagnostics, condition tracking, and medical training. The transition from mobile to website applications signifies a broader reach and enhanced user experience. While the benefits of mobile health apps are acknowledged, the flexibility and accessibility provided by website applications contribute significantly to the evolution of digital health services.

As we witness this transition, the focus on website applications introduces new opportunities for streamlined healthcare services, bridging the gap between patients and healthcare providers. The impact of website-based health applications becomes particularly crucial in a world where connectivity and ease of access are paramount. The shift towards website applications aligns with the changing dynamics of digital health, ensuring that individuals can access vital healthcare resources seamlessly.

As per the report of 2015, the majority of people will encounter at least one diagnostic mistake during their lifespan. Various factors may influence the misdiagnosis, which includes: the lack of a proper system, the lack of proper management and tracking of symptoms, and the condition of rare diseases [1].

The computer-based systems for managing electronic medical records emerged in the 1980’s and 1990’s. Electronic medical records replaced paper-based records, providing greater access and facilities for efficient communication between medical professionals enhancing the coordination of treatment and care.

Digital technologies are becoming an important resource for health series delivery and public health. Mobile wireless technologies are particularly relevant, due to their ease of use, broad reach, and wide acceptance. According to ITU, in 2015 there were more than 7 billion mobile telephone subscriptions across the world, over 70% of which were in low-or middle-income countries [2]. The study indicates the scope of mobile health services.

The global mHealth app’s market size was valued at USD 43.5 billion in 2022 and is expected to expand at a compound annual growth rate (CAGR) of 11.6% from 2023 to 2030[3]. There are numerous mobile applications worldwide that offer personalized healthcare to patients. Some popular apps include Aetna and ADA, which provide patients with information about their health conditions and offer step-

by-step guidance for treatment. In the context of Nepal also there exists applications like Hamro Doctor, and Okhati which provide health-related services. The Covid-19 crisis has raised people's awareness about the challenges that can arise during a pandemic. Additionally, it has resulted in the wider adoption of smartphones making them more accessible to a larger population and making a health-related application handy to a huge audience.

Machine learning plays a crucial role in various health applications, leveraging its ability to analyze vast amounts of data and identify patterns. J. Gao, L. Tian, J. Wang, Y. Chen, B. Song, and X. Hu, this study confirms the application of machine learning algorithms in the prediction and early detection of diseases. To our best understanding, the model built according to the proposed method exhibits better accuracy than the existing ones. The prediction accuracy of our proposed method reaches 87.1% in Heart disease detection using Logistic Regression, 85.71% in Diabetes prediction using Support Vector Machine (linear kernel), and 98.57% using AdaBoost classifier for Breast Cancer detection. The future scope and improvement of the project involve automation of steps such as data mugging, feature selection, and model fitting for best prediction accuracy. The use of a pipeline structure for data pre-processing could further help in achieving improved results. [4]

Numerous studies have explored the application of ML algorithms in healthcare, demonstrating their potential to assist in decision-making processes. The work of Monto et al. [5] on predicting influenza based on symptoms showcases the effectiveness of statistical models. However, the focus shifts to personalized recommendations in the context of doctor specialties.

The proposed Doctor Specialty Recommendation System can be benchmarked against existing methodologies in healthcare recommendation systems. Mir et al. [6] and Vijayarani et al. have explored Naïve Bayes and SVM for disease prediction, providing a baseline for comparison. The challenge lies in extending these models to recommend specialized doctors based on patient data.

The K-Nearest Neighbors (KNN) algorithm was used by Keniya et al. [7]. They used this method by assigning the data point to the class that most of the K data points belong to, while it is sensitive to noisy and missing data. They have considered certain factors such as age group, symptoms, and gender of the person to predict the disease. While considering these parameters lower accuracy on machine learning models is getting [7].

2.1 Existing Hospital-Based System in Nepal

Some of the existing hospital-based applications in Nepal that are similar to our H-Mate are listed below:

1. Hamro Doctor: Hamro Doctor is a popular healthcare application in Nepal that offers different health services such as doctor recommendations, blood donor requests, and stored medical records for future reference. Hamro Doctor is the first online healthcare service provider from Nepal where patients can enjoy different kinds of health services.

2. Okhati: Okhati is a healthcare platform in Nepal that connects patients with hospitals and doctors. It is a smart software for clinics, labs, and hospitals that consists of features like patient-flow management, billing, accounting, reporting, bulk messaging, and doctor recommendations based on patients' preferences and requirements such as doctors by their specialty, and location. Patients can also search for doctors by their specialty, and locations and also view doctor profiles with patient reviews.

3. Saral Health: Saral Health is a health and wellness application in Nepal. Patients have features like searching doctors by their specialty, location, and experience level. This application also includes features such as appointment booking, health tips, and medical news.

2.2 Limitations of Existing Systems

Hospital-based applications in Nepal have been around for quite some time now and are also popular nowadays and common among the users of Nepal. While the current hospital-based applications have been doing a good job of informing users about the advantages and benefits of using these applications there are some limitations while using this program.

Some limitations are:

1. These systems lack the functionality for patients to upload their previous medical reports during the appointment booking process, which could streamline the consultation for doctors.
2. These systems lack the functionality of providing personalized recommendations for specialist doctors based on the specific symptoms presented by the patient.

CHAPTER 3: METHODOLOGY

3.1. Process Model

3.1.1 Incremental Development Model

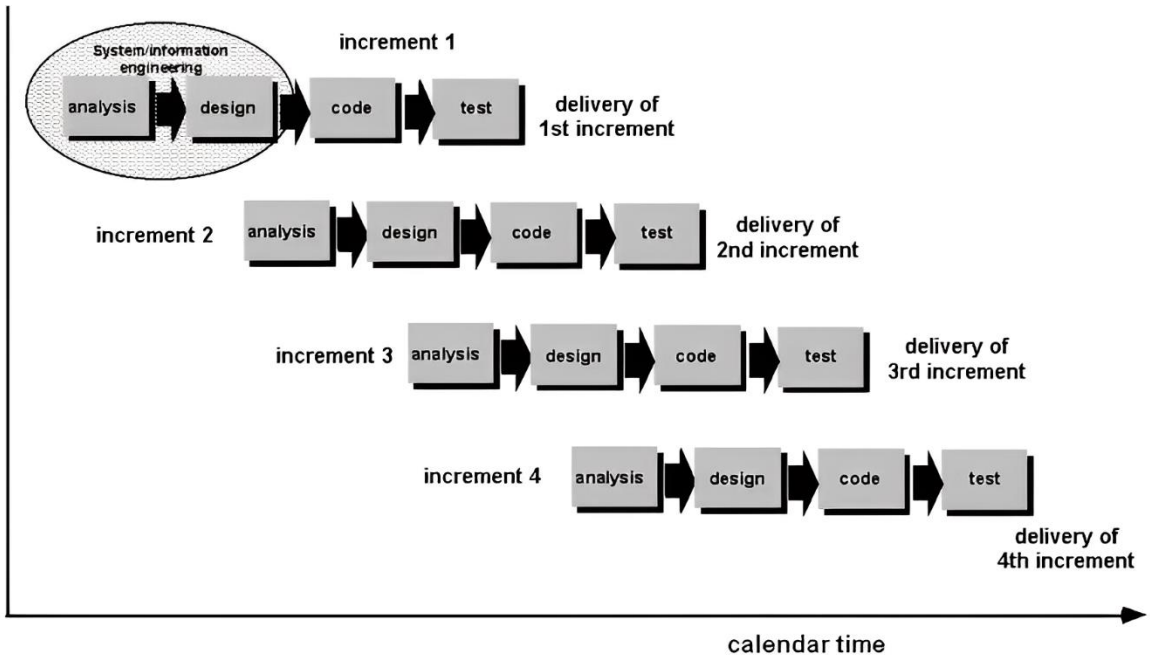


Figure 3.1 Block diagram of Incremental Development Model

The incremental model applies linear sequences in a staggered fashion as calendar time progresses. Each linear sequence produces a deliverable "increment" of software. When an incremental model is used, the first increment is often a core product. That is, basic requirements are addressed, but many supplementary features (some known, others unknown) remain undelivered. The core product is used by the customer (or undergoes detailed review). As a result of use and/or evaluation, a plan is developed for the next increment. The plan addresses the modification of the core product to better meet the needs of the customer and the delivery of additional features and functionality. This process is repeated following the delivery of each increment until the complete product is produced. The various phases of the incremental model are as follows:

Requirement analysis: In the first phase of the incremental mode, the product analysis expertise identifies the requirements. The system's functional requirements are understood by the requirement analysis team.

Design and Development: In this phase, the design of the system functionality and its development methods are finished with success.

Testing: In the incremental model, the testing phase checks the performance of each existing function as well as additional functionality. In the testing phase, various methods are used to test the behavior of each task.

Implementation: After the software is fully tested and is free of errors and defects, the client reviews the test results and approves the deployment. It involves the final coding that is designed in the designing and development phase and testing the functionality in the testing phase.

We have picked the incremental model because of its flexibility and adaptability during the development process as it enables us to make changes and adjustments based on feedback and evolving requirements. Since we are not certain about the number of features that could be designed and implemented within the timeframe. The incremental model allows us to include the core features of the app in the first increment and later on increment features as per the requirements. Furthermore, since projects face risks and uncertainties the incremental model assists in risk mitigation by breaking down the development process into smaller, independent increments. For above mentioned reasons we believe that the incremental model is the right model for our project.

3.2 System Block Diagram

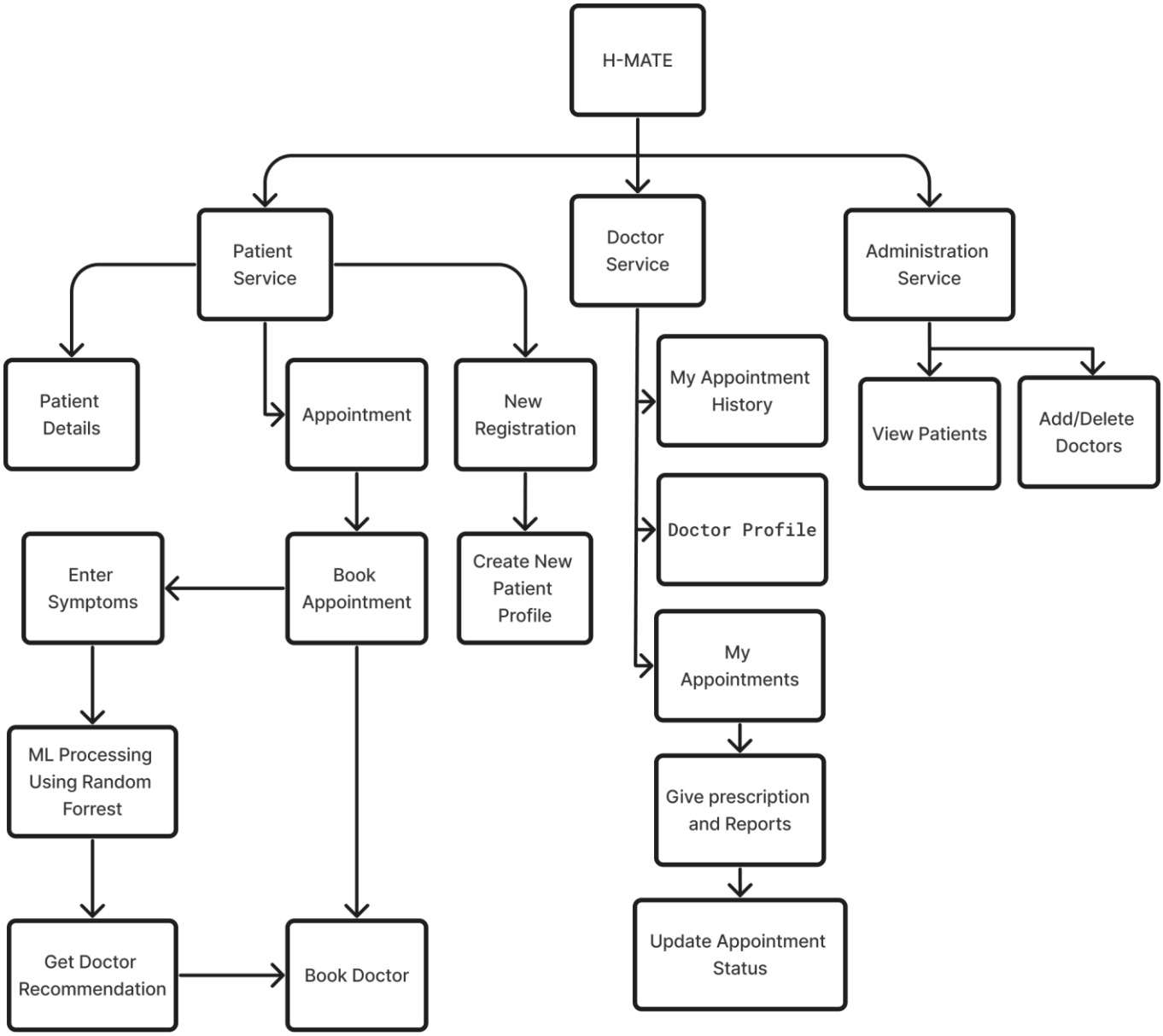


Figure 3.2 System Block Diagram

The system block diagram consists of patient, doctor and administration services, which represents the services that is provided to the respective users. The service available includes registrations, viewing profile details, managing doctors, checking appointments and booking appointments which is done either manually or by providing input of symptoms based on which using random forest algorithm we recommend the specialists.

3.3 Algorithm

3.3.1 Random Forest Algorithm

The random forest produces decision trees from multiple data using their average for regression and most of the voting for categorization [8]. The research reported by Paul et al. [9] used the Random Forest Algorithm as the main algorithm.

The random forest algorithm is used to train the model with the dataset which contains a combination of symptoms and the corresponding diseases [9]. The driving force behind using the random forest algorithm is that it can handle data sets with continuous variables, as in regression, and categorical variables, as in classification. It produces superior results in classification problems.

The working Methodology of the Random Forest is illustrated in Figure 3.3.1.

Step 1: Select arbitrary samples from a given data set or training set.

Step 2: This method will create a decision tree for every training data set.

Step 3: Using the decision tree's average, voting will be done.

Step 4: Lastly, select the predicted outcome that gathered the greatest support as the final prediction outcome.

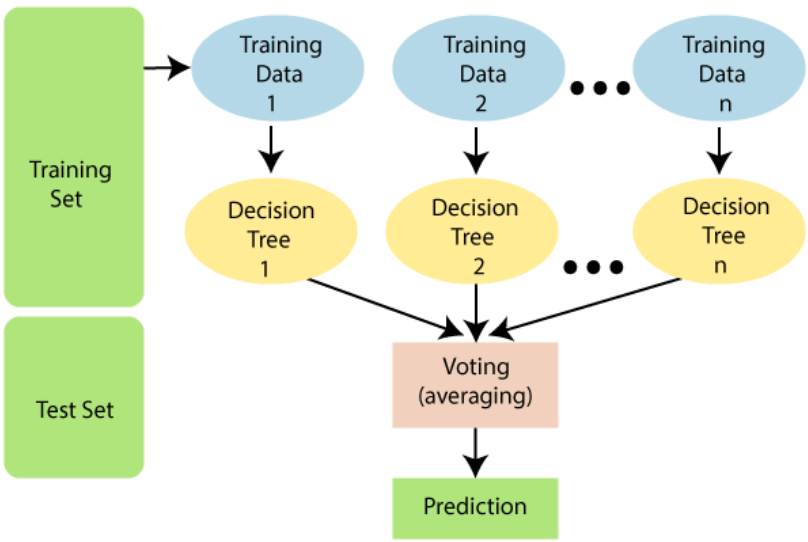


Figure 3.3.1: Methodology of Random Forest Algorithm

The Random Forest Algorithm analyses the symptoms in the provided dataset by Kaushil268, [10] to make judgments about a disease. Then it analyzes the outcome with the labels supplied before going back to assess the model's reliability. The formula for the random forest algorithm:

$$MSE = 1/N \; i{=}1\sum N \; (fi - yi) \; 2) \text{ ---------- } (1)$$

In Equation (1), N represents the total amount of data points, fi denotes the model's output, and yi denotes the real value for data point i. This is used for the calculation of the Mean Squared Error. This method calculates the distance between every node and the expected real value to identify which branch is the best option for your forest. fi is the decision tree's output and yi is the value of the data point that you are evaluating at a certain node.

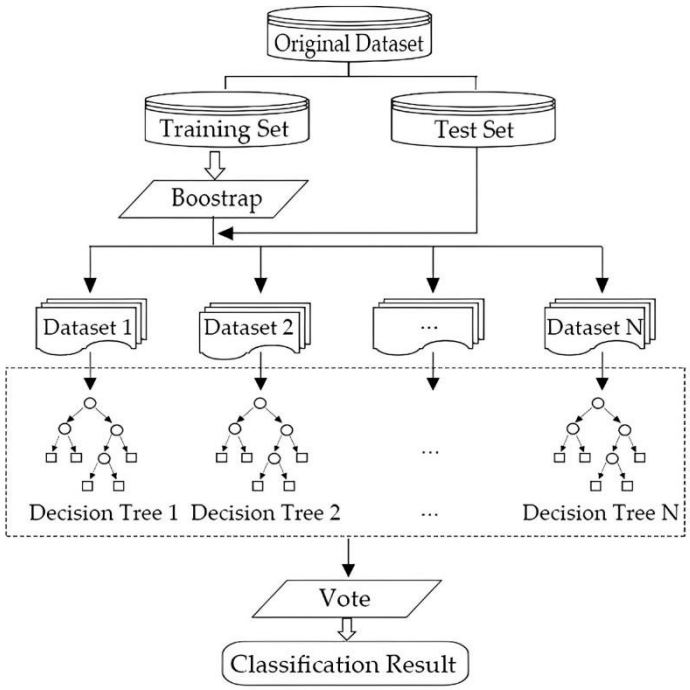


Figure 3.3.2: Architecture of Random Forest Algorithm

The Random Forest Algorithm consists of the following steps in our ML development cycles:

1. Importing the Libraries:

Pandas is a powerful library for data manipulation and analysis, providing data structures like DataFrame. NumPy is used for numerical computations, offering support for arrays, matrices, and mathematical functions.

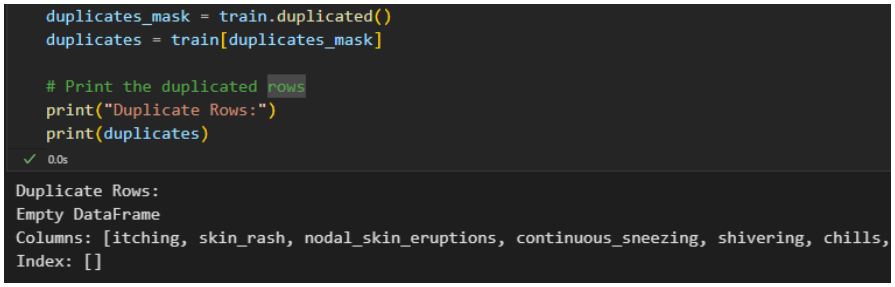
2. Importing the Dataset:

The dataset is imported from the Kaggle provided by Kaushil268 [10] and verified by the professional doctor "Dr. Bipin Kumar Shrestha (Nepal Police Hospital)". The dataset is loaded from CSV files into Pandas DataFrames (`train` and `test`). CSV files are a common format for storing tabular data. The training dataset typically

contains labeled data used to train the machine learning model, while the testing dataset is used to evaluate its performance.

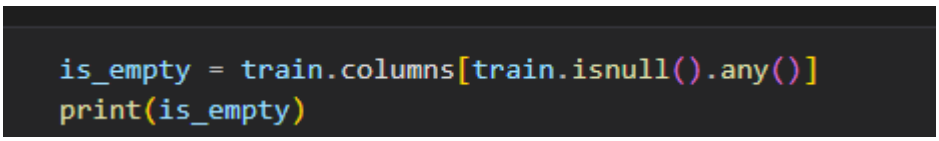
3. Data Cleaning:

While checking for the duplicate data in the dataset, we found no duplicate data. Symptoms that do not appear in any disease are removed from both the training and testing datasets. This step ensures that the model does not train on irrelevant or non-informative features.



4. Checking Empty Values:

The code checks for any missing values in the dataset. Handling missing values is crucial to ensure the quality of the data and the performance of the model. In this case, no missing values are found.



5. Creating Test and Train Sets

The dataset is split into input features (X) and target labels (Y). Input features represent the symptoms, while target labels represent the corresponding diseases. The dataset is divided into training and testing sets to assess the model's performance on unseen data.

```
x_train = train.iloc[:, :-1]
x_test = test.iloc[:, :-1]
y_train = train.iloc[:, -1]
y_test = test.iloc[:, -1]
```

6. Encoding Categorical Data:

Categorical labels (diseases) are encoded into numerical values using LabelEncoder. Machine learning algorithms typically require numerical inputs, so encoding categorical variables is necessary.

```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
y_train = le.fit_transform(y_train)
y_test = le.transform(y_test)
```

7. Training the Model:

A Random Forest Classifier model is trained on the training dataset. Random Forest is an ensemble learning method that builds multiple decision trees and combines their predictions to improve accuracy and reduce overfitting. The number of decision trees in the forest (n_estimators) is set to 10.

```
np.random.seed(42)
from sklearn.ensemble import RandomForestClassifier
rfc = RandomForestClassifier(n_estimators=10)
rfc.fit(x_train,y_train)
```

8. Prediction and Accuracy Test:

The trained model is used to predict disease labels for the testing dataset. The accuracy of the model's predictions is calculated using ‘accuracy_score’, which measures the proportion of correctly predicted labels.

```
y_predict = rfc.predict(x_test)
from sklearn.metrics import accuracy_score
accuracy_score(y_test,y_predict)
```

✓ 0.0s

```
1.0
```

9. Predict Output:

The code prompts the user to input symptoms, simulating a real-world scenario where a user describes their symptoms.

The model predicts the disease based on the input symptoms, repeating the prediction process multiple times for robustness.

```
user_symptoms = []
for i in range(4):
    symptom = input(f'Enter symptom {i + 1}: ')
    user_symptoms.append(symptom)

prediction = [rfc.predict(np.array([1 if symptom in user_symptoms else 0 for symptom in symptom_names]).reshape(1, -1))[0] for _ in range(5)]

prediction_in_string = le.inverse_transform(prediction)
```

13.1s

```
print(prediction_in_string[0])
```

0.0s

```
Fungal infection
```

10. Mapping Disease to Specialist Doctor:

A dictionary (`doctor_specialists`) maps predicted diseases to specialist doctors. Each disease is associated with a medical specialist who is qualified to treat it.

11. Printing the Specialist:

The associated specialist doctor for the predicted disease is printed, providing users with guidance on the appropriate medical professional to consult based on their symptoms and predicted disease.

These steps illustrate a comprehensive workflow for building a machine-learning model to predict diseases based on symptoms and provide relevant medical advice to users.

```
predicted_specialist = doctor_specialists.get(prediction_in_string[0], 'Specialist not found')
print(f'Associated Doctor Specialist: {predicted_specialist}')
```

0.0s

```
Associated Doctor Specialist: Dermatologist
```

3.4 Flowchart

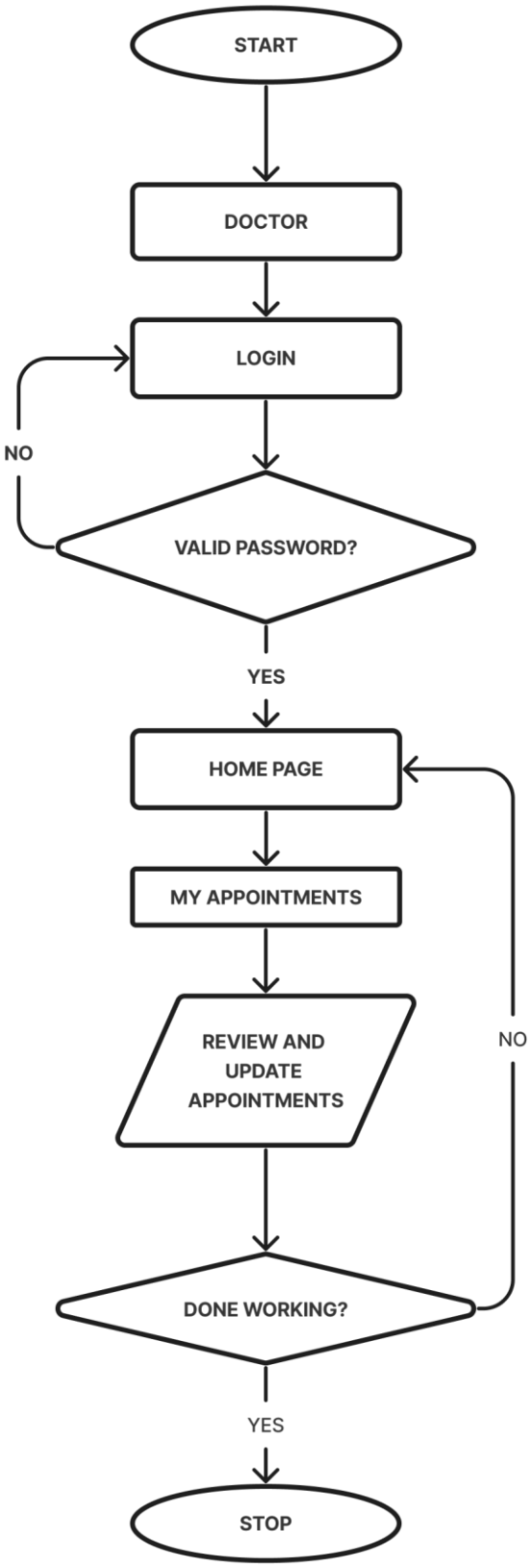


Figure 3.4.1 Flowchart of Doctor

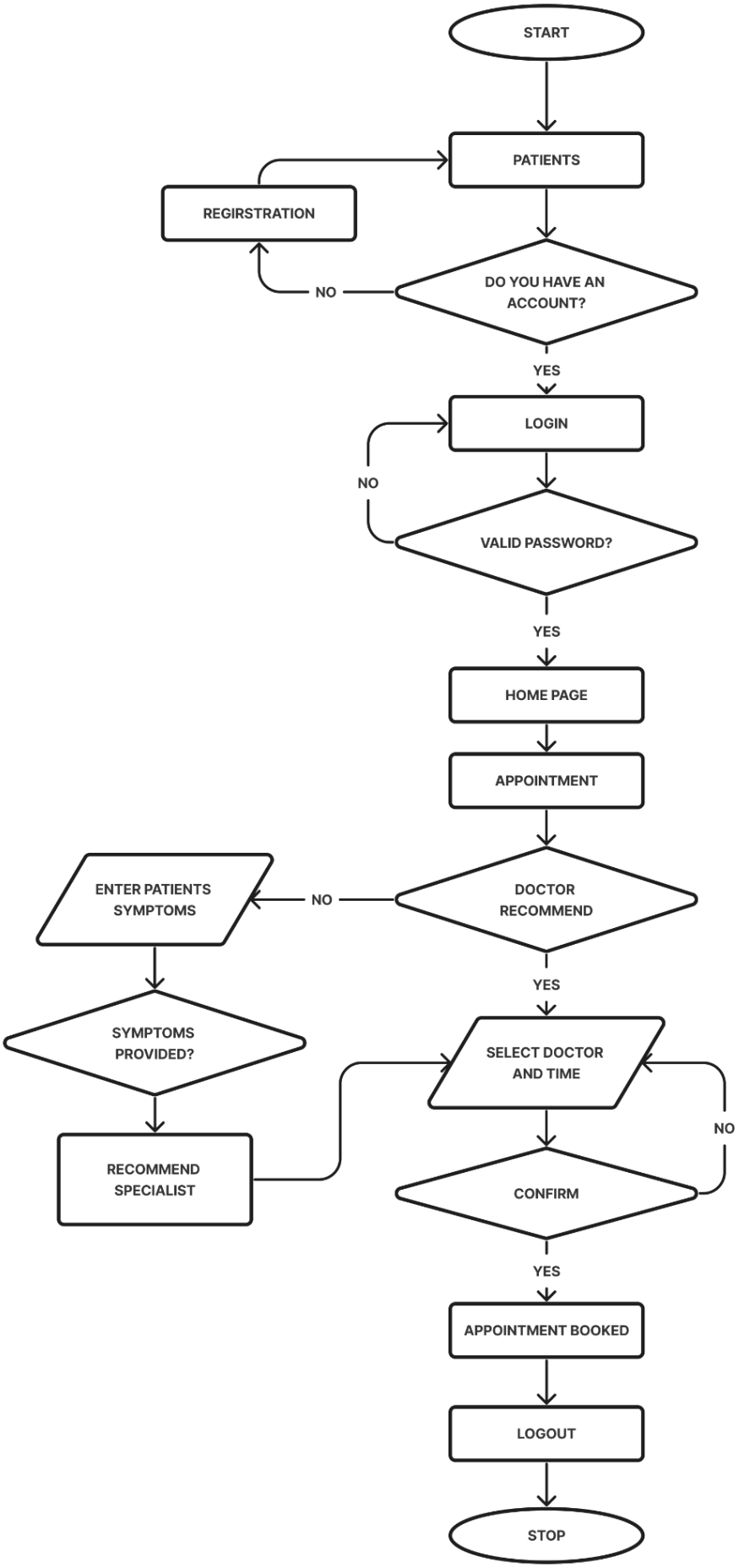


Figure 3.4.2 Flowchart of Patient

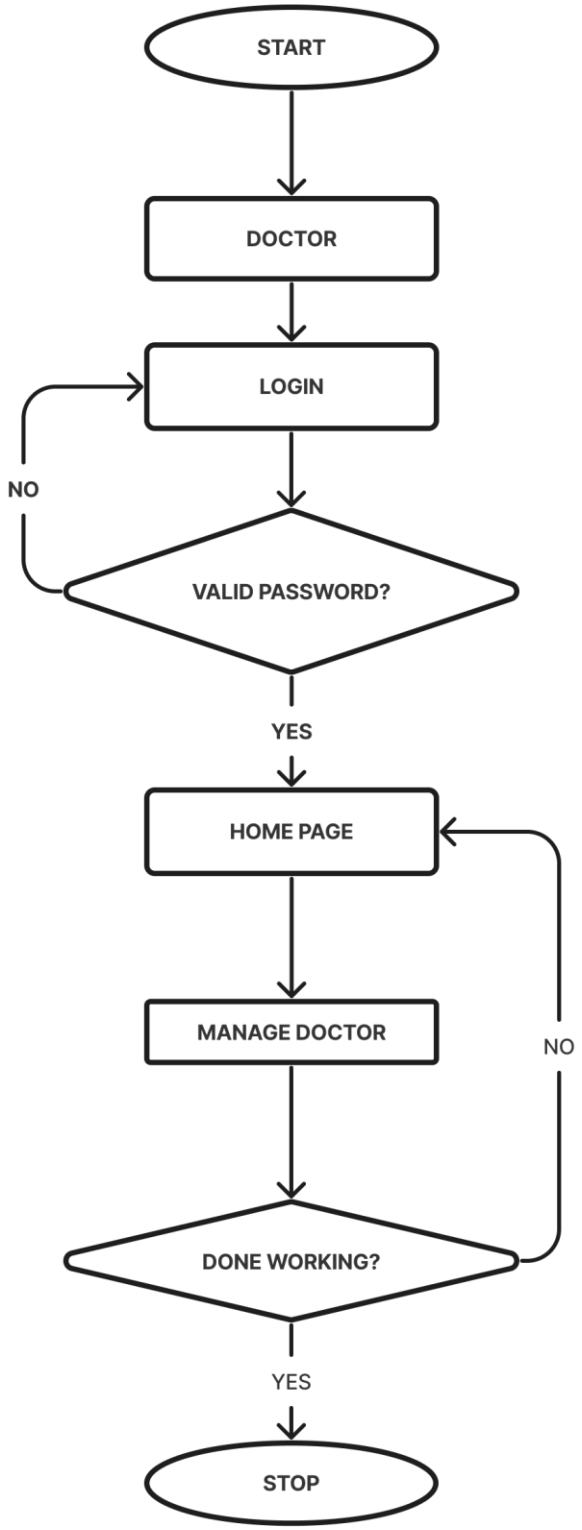


Figure 3.4.3 Flowchart of Admin

3.5 UML Diagrams

3.5.1 Use Case Diagram

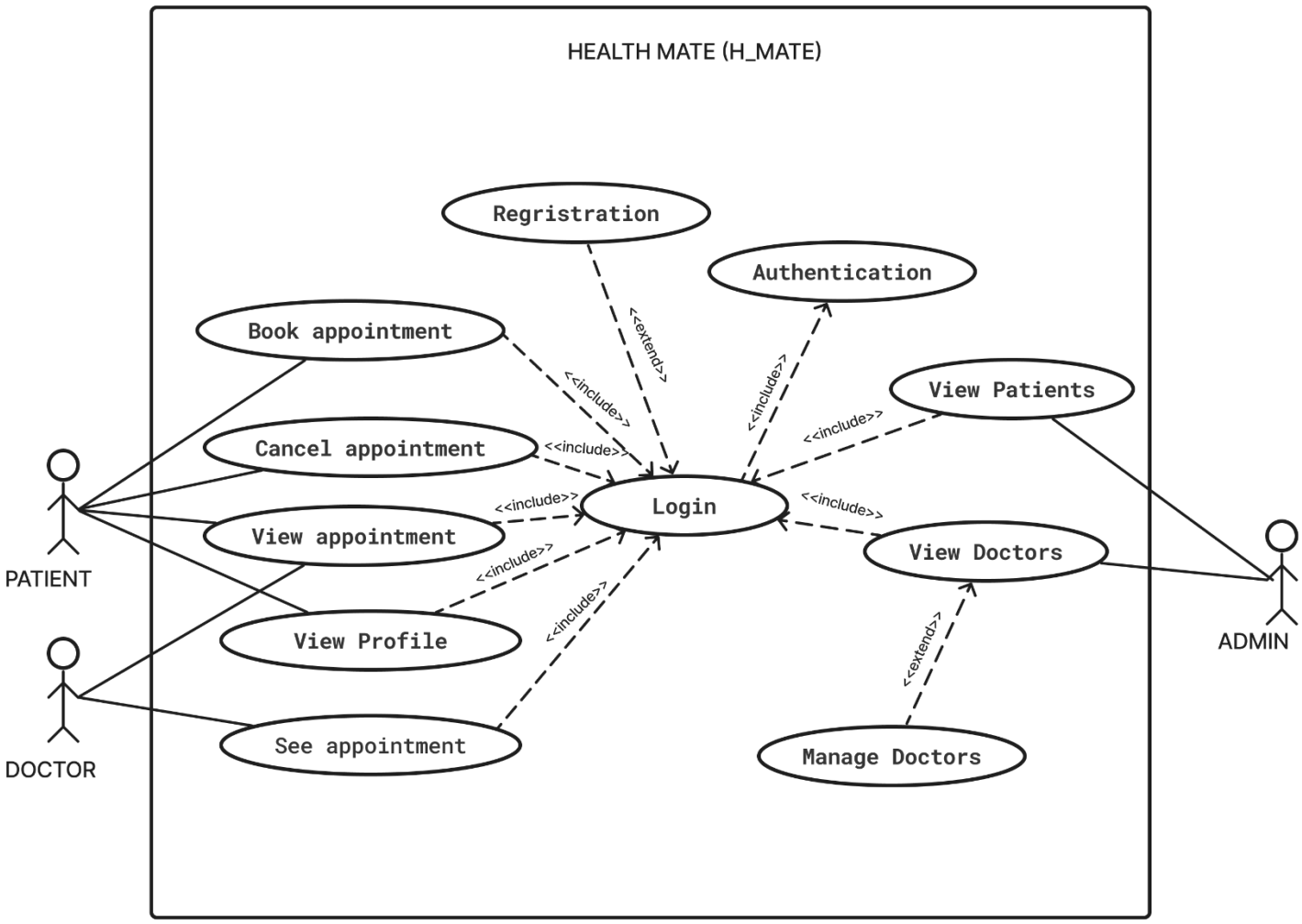


Figure 3.5.1 Use case Diagram

3.5.2 Patient Sequence Diagram

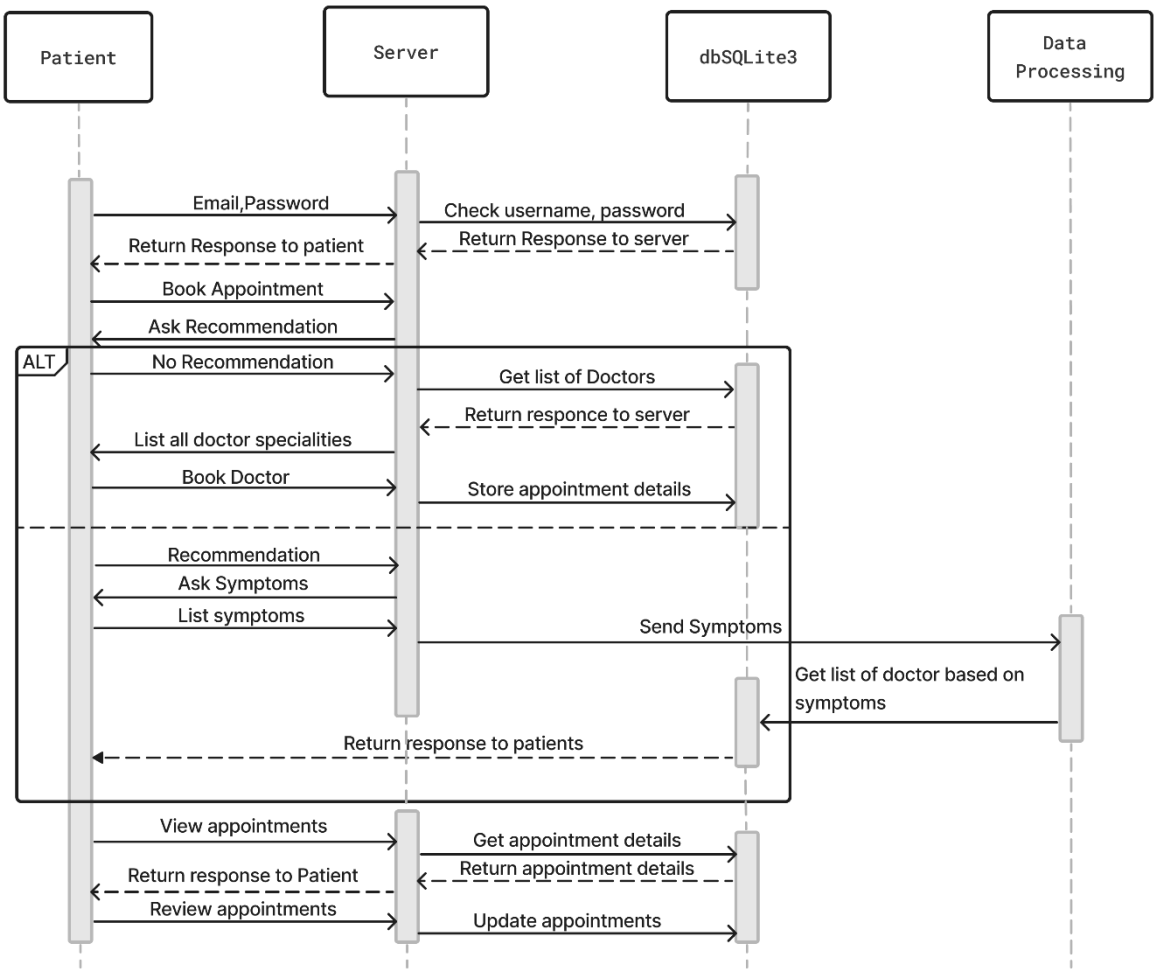


Figure 3.5.2 Patient Sequence Diagram

This sequence diagram shows the interaction of the patient with the server along with the database management dbSQLite3. Here the sequence diagram shows the following steps:

1. The patient initially provides a username and password to the server to log in, the server checks the login credentials in the database then returns response to the patient as if it is correct then moves to the new portal else shows error.

2. When the patient wants to book an appointment in server, the server provides an alternative choice as use a recommendation system or directly appointing the doctor.

3. When no recommendation is provided the server gets the list of doctors from the database and provides to doctor and patients book the doctor the server stores all the information regarding appointments in the database.

4. When the recommendation is used, the server provides an option to input symptoms after symptoms are provided the server sends the symptoms to ML for data

processing which uses a Random Forest Algorithm to process and gets the list of doctors from the database after processing and sends it to the patient.

5. Similarly, the patient views an appointment then the server gets all the appointment details of the patient from the database and then returns to the patient.

3.5.3 Doctor Sequence Diagram

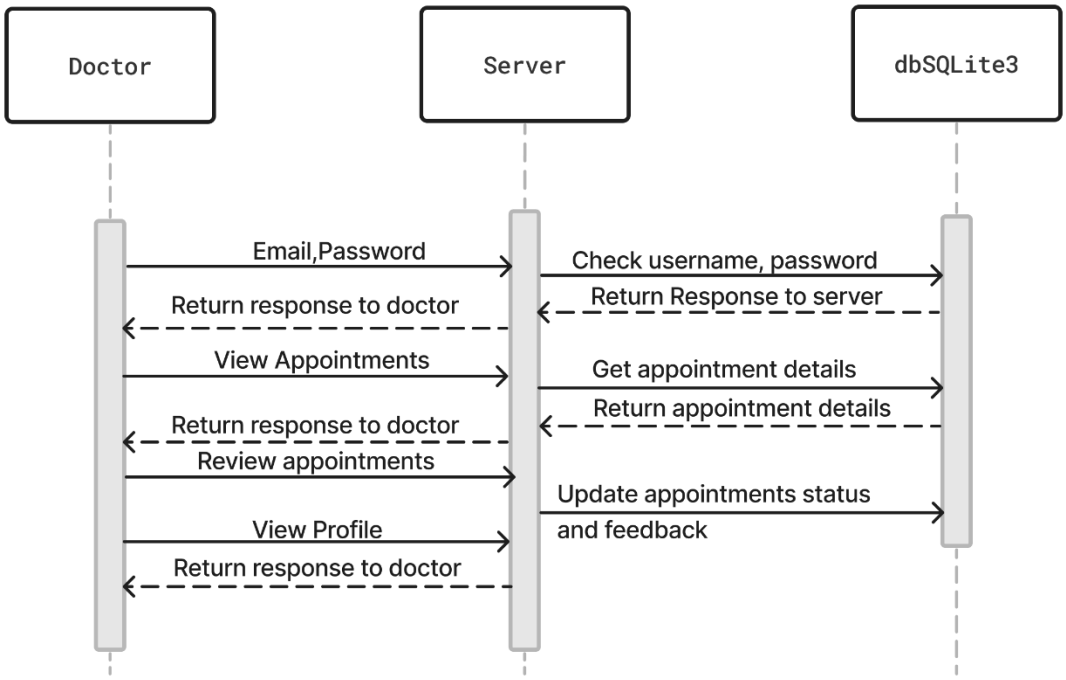


Figure 3.5.3 Doctor Sequence Diagram

This sequence diagram shows the interaction of the doctor with the server along with the database management dbSQLite3. Here the sequence diagram shows the following steps:

1. The doctor initially provides a username and password to the server to log in; the server checks the login credentials in the database then returns a response to the patient as if it is correct then moves to the new portal else shows an error.

2. The doctor views appointments from the server, then the server gets all appointment details of the doctor from the database and then returns to the doctor.

3. The doctor reviews the appointment after an appointment then updates the status of the appointment and provides feedback and reports in the database.

4. The doctor views the profile from the server then the server provides the details of the doctor from the database dbSQLite3.

3.5.4 Entity-Relationship Diagram

An Entity-Relationship (ER) diagram is a visual representation of the data model that describes how different entities are related to each other in a database. ER diagrams are widely used in database design and systems analysis to provide a graphical representation of the structure of a database, helping to define the relationships between entities and the attributes associated with those entities.

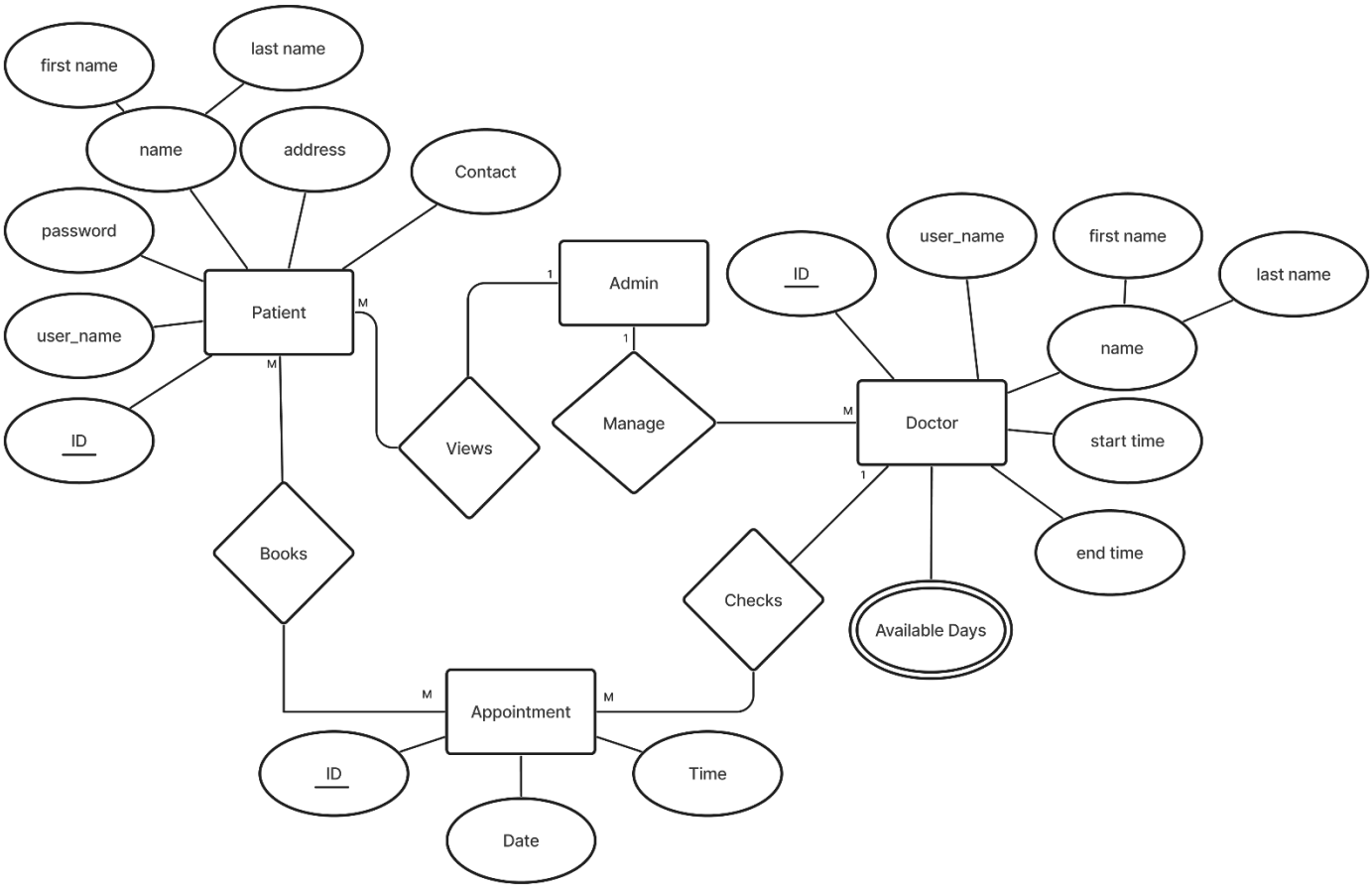


Figure 3.5.4 E-R Diagram

3.5.5 DFD Diagram

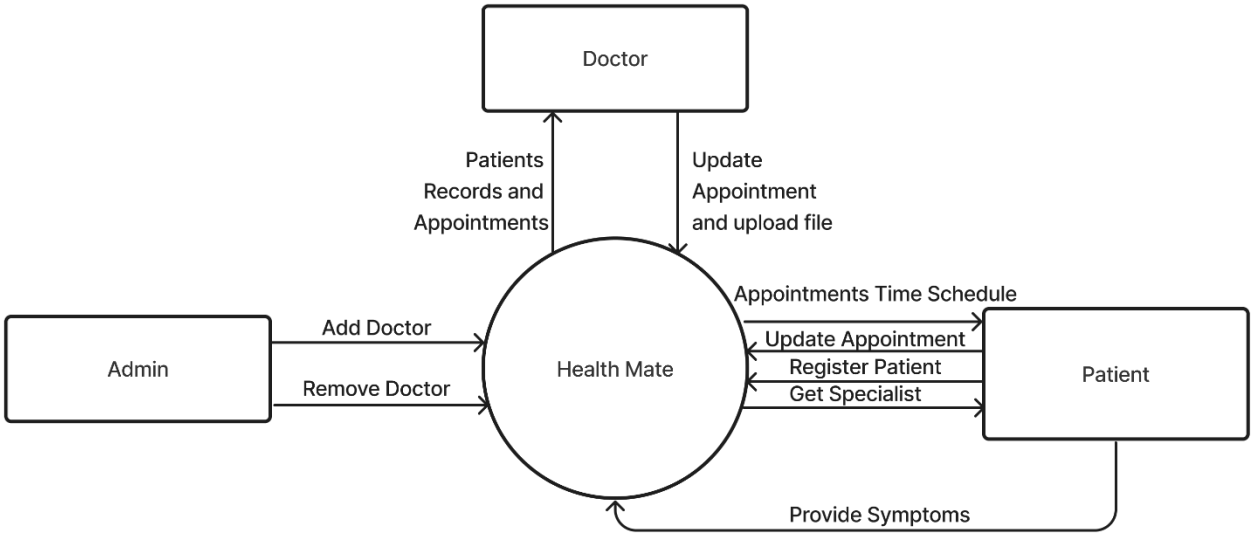


Figure 3.5.5.1 DFD Level-0 Diagram

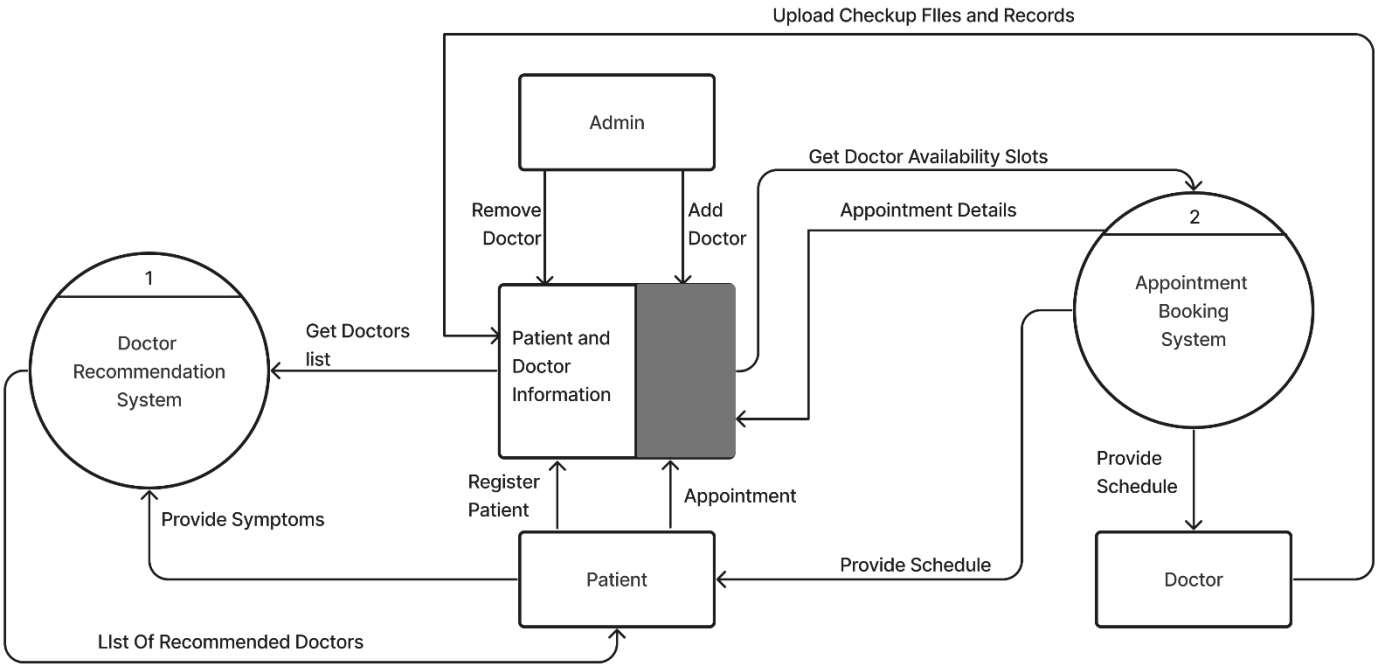


Figure 3.5.5.2 DFD Level-1 Diagram

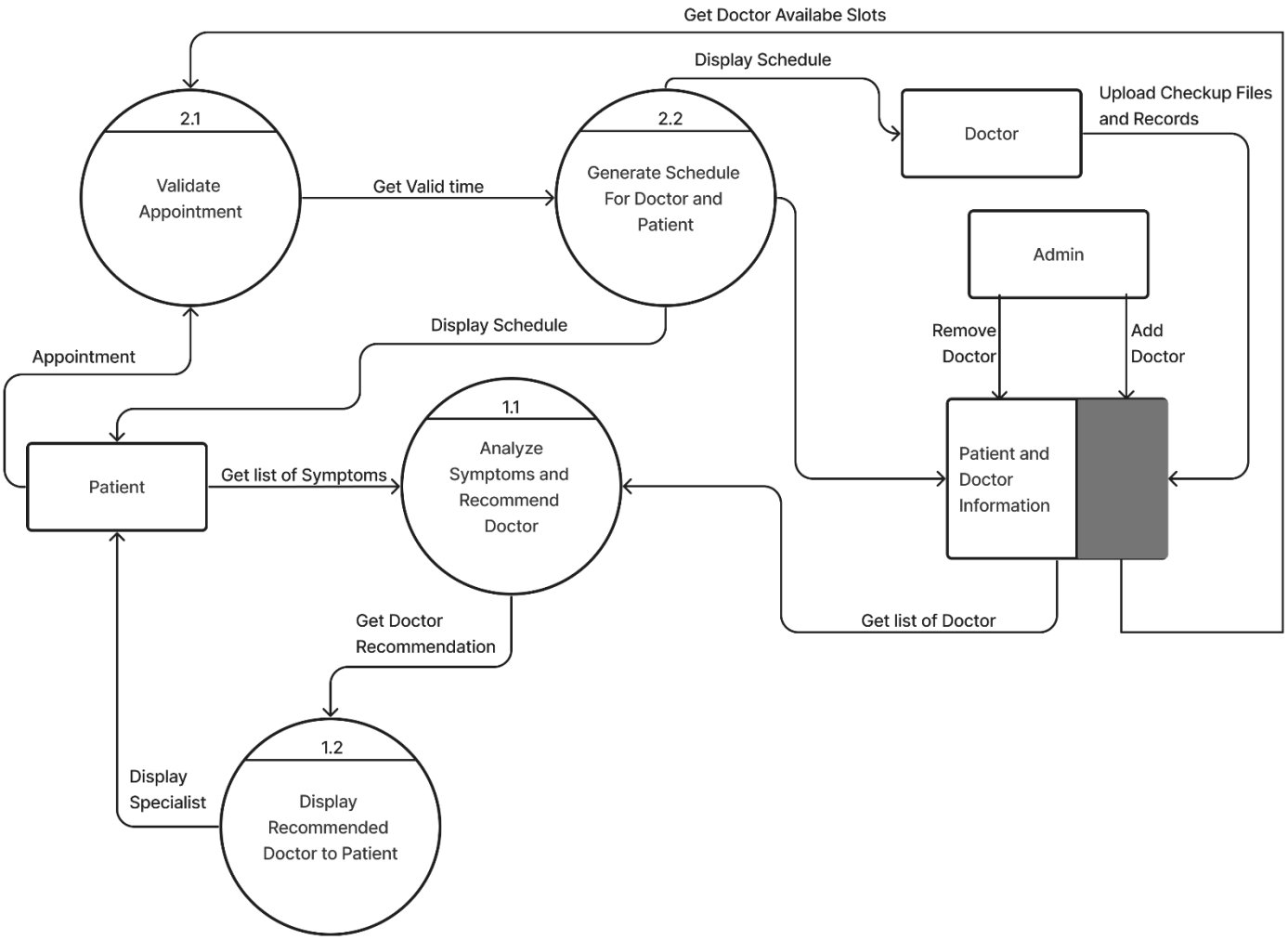


Figure 3.5.5.3 DFD Level-2 Diagram

3.6 Tools Used

- **Python**

  Python is a high-level, general-purpose programming language known for its simplicity, readability, and versatility. Python is easy to read and write which emphasizes code readability with its clean and intuitive syntax. Python is a general-purpose language which means it can be used for a wide range of applications, such as web development, artificial intelligence, automation, etc.

- **Django**

  Django is a high-level, open-source web framework written in Python that encourages rapid development and clean, pragmatic design. It follows the model-view-controller (MVC) architectural pattern, but in Django terminology, it's often referred to as the model-view-template (MVT) pattern.

- **NumPy**

  NumPy, which stands for Numerical Python, is a powerful open-source library in Python for numerical computing. It provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays. NumPy is a fundamental package for scientific computing in Python and is widely used in various fields such as data science, machine learning, signal processing, and more.

- **Pandas**

  Pandas is a powerful Python library widely used for data manipulation and analysis. It offers two primary data structures: Series and Data Frame. A Series is a one-dimensional array-like object, while a Data Frame is a two-dimensional table with labeled axes (rows and columns).

  Pandas excels at handling structured data, making it a go-to tool for tasks like cleaning, filtering, and transforming datasets. It integrates seamlessly with other libraries, such as NumPy, and provides functionalities for reading and writing data in various formats, including CSV, Excel, SQL databases, and more.

- **Git**

  Git is a free and open-source distributed version control system that helps developers manage, and handle, changes to their codebase efficiently. It allows coders or developers to work together in groups on the same project simultaneously while keeping track of each change made and providing tools to merge them into one and resolve the conflicts.

- **GitHub**

  GitHub is a web-based platform that provides hosting for Git repositories. It helps developers to store and manage their code, as well as track and control

changes to their code. It also provides features like repository hosting, collaborations among members for the project, issue tracking, project management, and so on.

- **HTML**

  HTML is the backbone of web development, providing the essential structure and content for web pages. It uses a markup language consisting of various tags to define the elements on a webpage. These elements include headings, paragraphs, images, links, forms, and more. The structure created by HTML forms the basis for how information is presented on a website. HTML documents are hierarchical, with a nested structure that represents the relationships between different elements.

- **CSS**

  CSS is the styling language used to enhance the presentation and layout of HTML elements on a webpage. It works by applying styles to HTML elements, such as setting colors, fonts, margins, and positioning. CSS allows developers to create visually appealing and consistent designs across different devices and screen sizes. By separating the content (HTML) from the presentation (CSS), web developers can easily update the look and feel of a website without altering the underlying structure.

3.7 Verification and Validation

3.7.1 Authentication and Authorize Patient

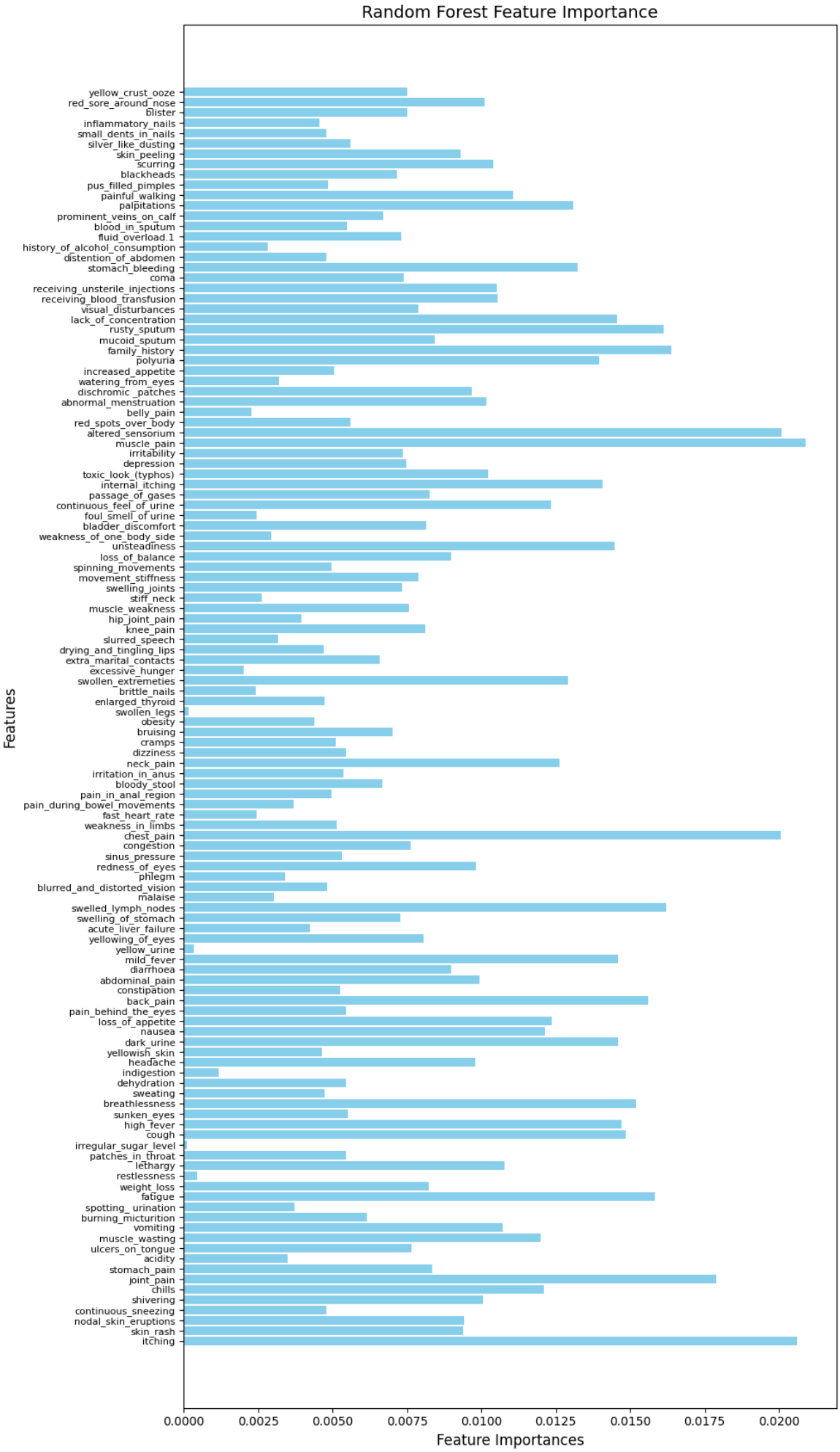
S.N.	Test Cases	Expected Result	Actual Result
1	Trying to register with an existing username or email or contact	Registration error: Username, Email, and Contact already exists	As expected
2	Trying to register with blank fields	Registration error: Fill all the blank fields	As expected
3	Trying to register with valid details with all fields filled	Registration Success	As expected
4	Trying to log in with an invalid username and password	Login error: Invalid username or password	As expected
5	Trying to log in with a valid username and password	Login successful	As expected
6	Trying to sign out of the dashboard	Redirected to Login screen	As expected
7	Trying to get a specialist doctor's recommendation using ML with only 2 symptoms input	Error: Please provide at least 3 symptoms	As expected
8	Trying to get a specialist doctor's recommendation using ML with 3 symptoms input	Success: Redirect to the page to get a list of recommended doctors	As expected
9	Booking an appointment with a doctor with details in the booked slot	Booking Error: Shows an error message as the appointment time is booked	As expected
10	Booking an appointment with a doctor with details in an available slot	Booking Succes: Redirect to the home page with a success message	As expected

Table 3.7.1: Test Cases for Authenticating and Authorizing Patient

3.7.2 Authentication and Authorize Doctor

S.N.	Test Cases	Expected Result	Actual Result
1	Trying to register with an existing username or email or contact	Registration error: Username, Email, and Contact already exists	As expected
2	Trying to register with blank fields	Registration error: Fill all the blank fields	As expected
3	Trying to register with valid details with all fields filled	Registration Success	As expected
4	Trying to log in with an invalid username and password	Login error: Invalid username or password	As expected
5	Trying to log in with a valid username and password	Login successful	As expected
6	Trying to sign out of the dashboard	Redirected to Login screen	As expected

Table 3.7.2: Test Cases for Authenticating and Authorizing Doctor


Random Forest Feature Importance
Features
yellow_crust_ooze
red_sore_around_nose
blister
inflammatory_nails
small_dents_in_nails
silver_like_dusting
skin_peeling
scurring
blackheads
pus_filled_pimples
painful_walking
palpitations
prominent_veins_on_calf
blood_in_sputum
fluid_overload.1
history_of_alcohol_consumption
distention_of_abdomen
stomach_bleeding
coma
receiving_unsterile_injections
receiving_blood_transfusion
visual_disturbances
lack_of_concentration
rusty_sputum
mucoid_sputum
family_history
polyuria
increased_appetite
watering_from_eyes
dischromic _patches
abnormal_menstruation
belly_pain
red_spots_over_body
altered_sensorium
muscle_pain
irritability
depression
toxic_look_(typhos)
internal_itching
passage_of_gases
continuous_feel_of_urine
foul_smell_of urine
bladder_discomfort
weakness_of_one_body_side
unsteadiness
loss_of_balance
spinning_movements
movement_stiffness
swelling_joints
stiff_neck
muscle_weakness
hip_joint_pain
knee_pain
slurred_speech
drying_and_tingling_lips
extra_marital_contacts
excessive_hunger
swollen_extremeties
brittle_nails
enlarged_thyroid
swollen_legs
obesity
bruising
cramps
dizziness
neck_pain
irritation_in_anus
bloody_stool
pain_in_anal_region
pain_during_bowel_movements
fast_heart_rate
weakness_in_limbs
chest_pain
congestion
sinus_pressure
redness_of_eyes
phlegm
blurred_and_distorted_vision
malaise
swelled_lymph_nodes
swelling_of_stomach
acute_liver_failure
yellowing_of_eyes
yellow_urine
mild_fever
diarrhoea
abdominal_pain
constipation
back_pain
pain_behind_the_eyes
loss_of_appetite
nausea
dark_urine
yellowish_skin
headache
indigestion
dehydration
sweating
breathlessness
sunken_eyes
high_fever
cough
irregular_sugar_level
patches_in_throat
lethargy
restlessness
weight_loss
fatigue
spotting_ urination
burning_micturition
vomiting
muscle_wasting
ulcers_on_tongue
acidity
stomach_pain
joint_pain
chills
shivering
continuous_sneezing
nodal_skin_eruptions
skin_rash
itching
0.0000
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
Feature Importances

Training - Testing Data Ratio: 4:1

Training Accuracy: 1.0

Testing Accuracy: 1.0

CHAPTER 4: EPILOGUE

4.1 Results and Discussion

The "Health-Mate: Appointment Booking System" developed in our minor project successfully integrates a user-friendly platform where patients can effortlessly book appointments with doctors at their preferred time slots. Additionally, the system incorporates a recommendation feature, utilizing a Machine Learning (ML) model powered by the Random Forest (RF) Algorithm to suggest specialist doctors based on patient symptoms. The prediction algorithm employed by Health-Mate demonstrates an accuracy of 100% in identifying and predicting the disease based on the patient's symptoms based on the dataset and recommends the specialist doctor for that predicted disease.

The system operates through distinct user models, catering to patients, doctors, and administrators. Patient registration is an essential first step, involving the submission of details such as a unique username, email, contact number, and other information. Once registered, patients can choose specific doctors and book appointments by selecting available dates and times, providing additional details like the reason for the appointment, and uploading any relevant old reports.

Doctors are added to the system database exclusively by the system administrator, ensuring controlled access. Doctors receive login credentials from the system administrator, ensuring that only authorized medical professionals can access the doctor portal. The system administrator has a pivotal role, in managing the addition/deletion of doctors and overseeing the patient registration process.

4.2 Conclusion

In conclusion, "Health-Mate" stands as a comprehensive specialist doctor recommendation and appointment booking system. Developed using the Django Python framework for the backend, coupled with HTML and CSS for frontend development, and employing dbSQLite3 for robust database management, our system seamlessly integrates essential healthcare functionalities.

The unique feature of our system lies in its ML-driven specialist doctor recommendation, enhancing the patient experience by providing tailored suggestions based on symptoms. Furthermore, patients can efficiently book appointments with recommended doctors, streamlining the healthcare access process. The dataset we used for this system was used by Pahirathan Nithilan [11] in which he uses 3 different algorithms for prediction. The algorithms he used were the MLP classifier in which the accuracy was 97.61%, the Random Forest Classifier in which the accuracy was 100% and the last model was Decision Tree Classifier in which the accuracy was 95.238%.

"Health-Mate" contributes to the efficiency and accessibility of healthcare services, ensuring a user-friendly interface for patients, doctors, and administrators alike. The amalgamation of technological advancements and healthcare services in our system signifies a step towards a more streamlined and patient-centric healthcare experience.

4.3 Future Enhancements

We have identified some features in our system that hold potential for enhancement in the future. Some of them are:

1. Allow patients to filter doctors based on their locations for more convenient access.
2. Implement a reminder system for patients and doctors before scheduled appointments.

REFERENCES

[1] Balogh E.P, Miller B.T., Ball J R Improving Diagnosis in Health Care. National Academic Press; Washington, DC, USA: 2015

https://pubmed.ncbi.nlm.nih.gov/26803862/

[2] 'Use of appropriate digital technologies for public health' 26 March 2018 by WHO Director-General

https://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_20-en.pdf

[3] 'mHealth Apps Market Size, Share & Trends Analysis' by Grand View Research

https://www.grandviewresearch.com/industry-analysis/mhealth-app-market

[4] J. Gao, L. Tian, J. Wang, Y. Chen, B. Song, and X. Hu, "Similar Disease Prediction With Heterogeneous Disease Information Networks," in IEEE Transactions on Nano Bioscience, vol. 19, no. 3, pp. 571-578, July 2020, doi: 10.1109/TNB.2020.2994983.

https://www.researchgate.net/publication/366714094_Health_assistance_system_with_disease_prediction_medicine_exercise_and_diet_suggestion_using_Machine_Learning_algorithms

[5] A.S. Monto, S. Gravenstein, M. Elliott, M. Colopy, J. Schweinle, Clinical signs and symptoms predicting influenza infection, Archives of internal medicine 160(21), 3243 (2000)

https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/485554

[6] A. Mir, S.N. Dhage, in 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA) (IEEE, 2018), pp. 1-6

https://ieeexplore.ieee.org/document/8697477

[7] Keniya, R., Khakharia, A., Shah, V., Gada, V., Manjalkar, R., Thaker, T., Warang, M. and Mehendale, N., "Disease prediction from various symptoms using machine learning", Available at SSRN 3661426, (2020).

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3661426

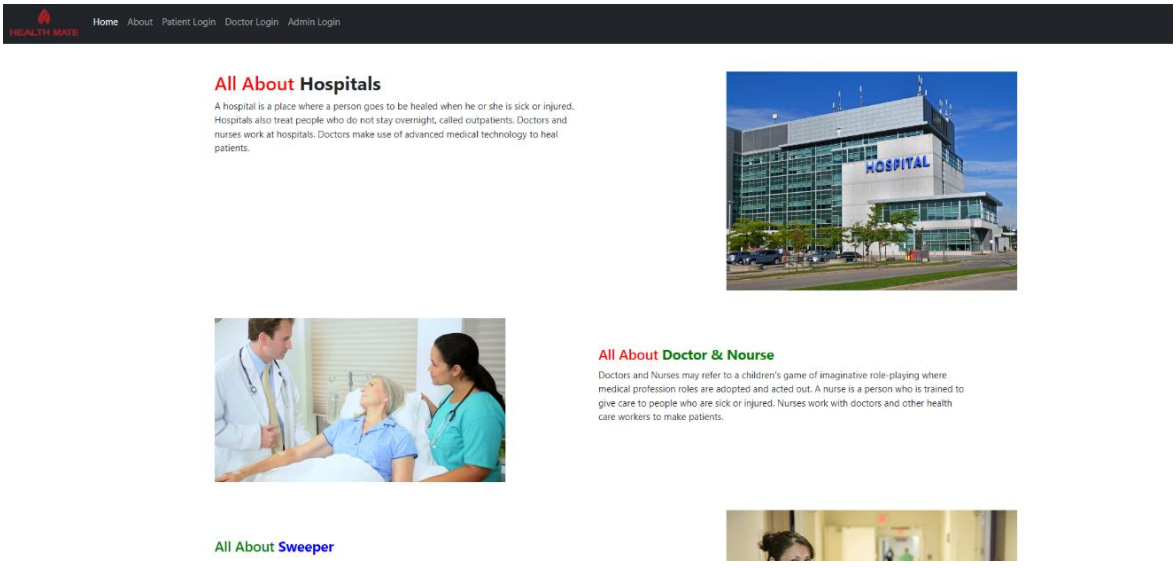
[8] Biau, G. and Scornet, E., "A random forest guided tour", Test, Vol. 25, (2016), 197-227. doi: 10.1007/s11749-016-0481-7.

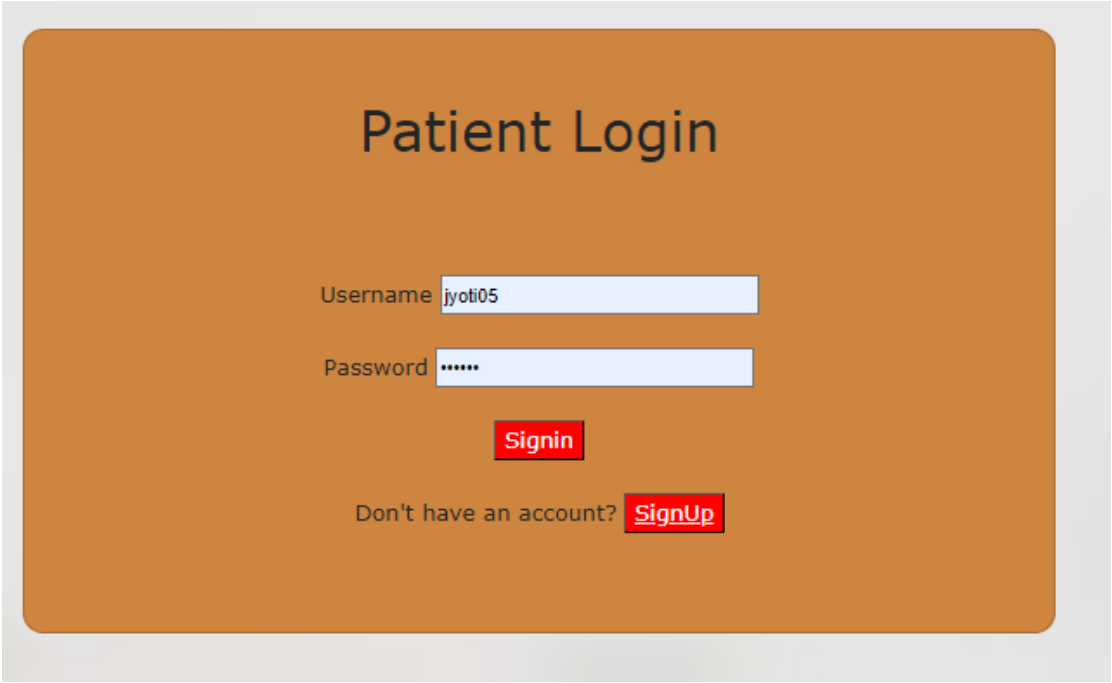
[9] Paul, S., Ranjan, P., Kumar, S. and Kumar, A., "Disease predictor using random forest classifier", in 2022 International Conference for Advancement in Technology (ICONAT), IEEE., (2022), 1-4.

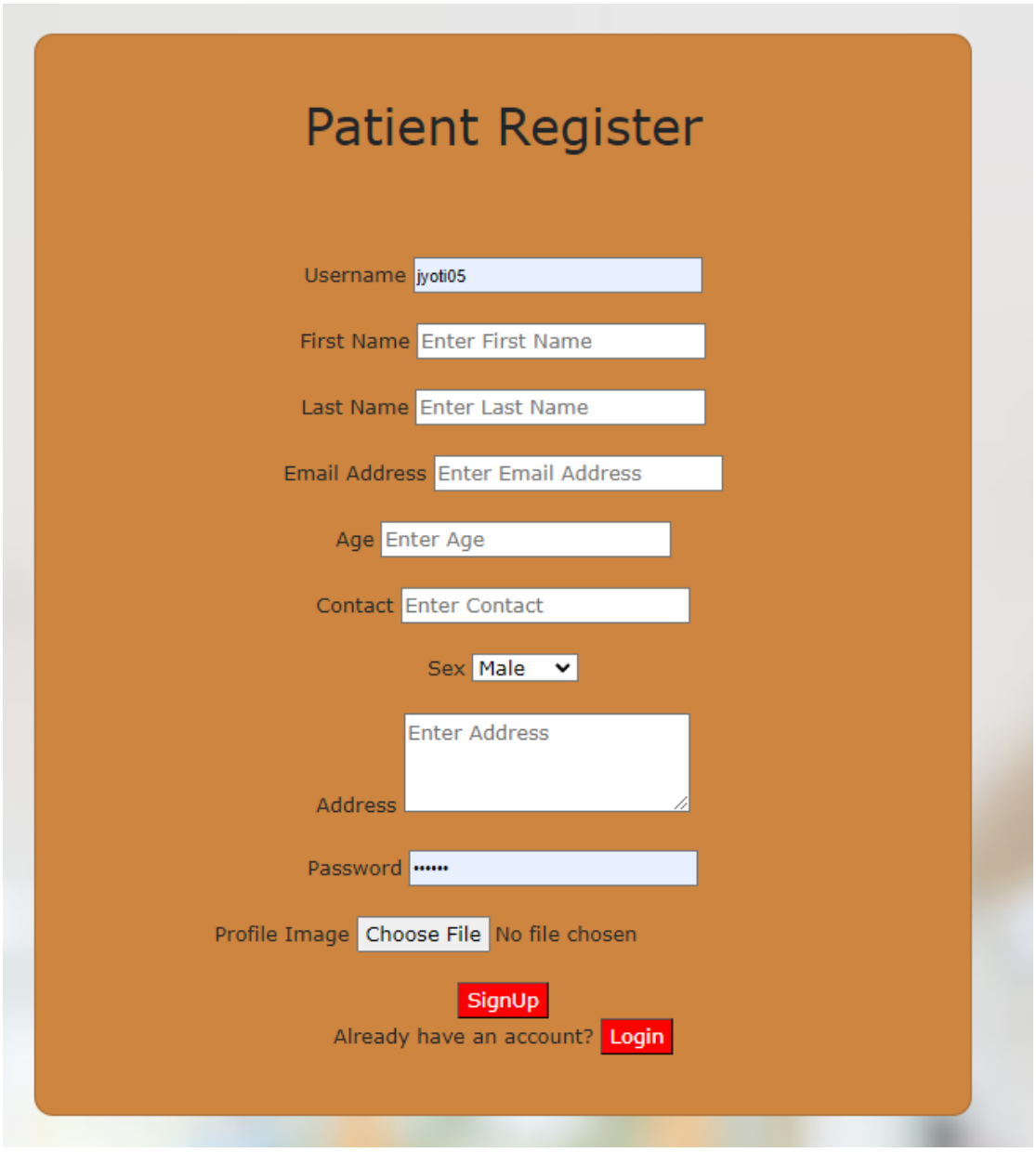
[10] https://www.kaggle.com/datasets/kaushil268/disease-prediction-using-machine-learning/

[11] https://www.kaggle.com/code/pahirathannithilan/disease-prediction-from-medical-data#Data-Modelling

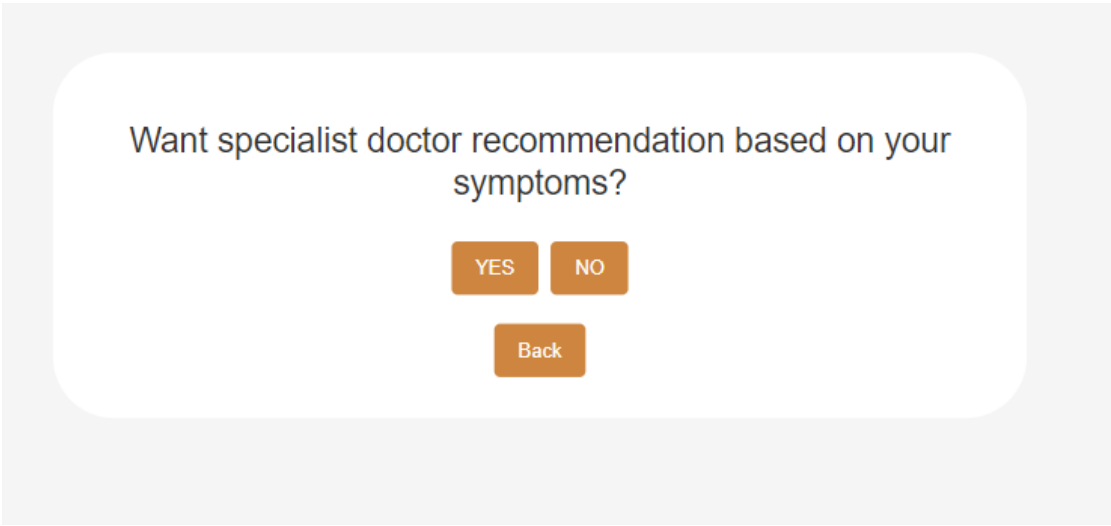
SCREENSHOTS

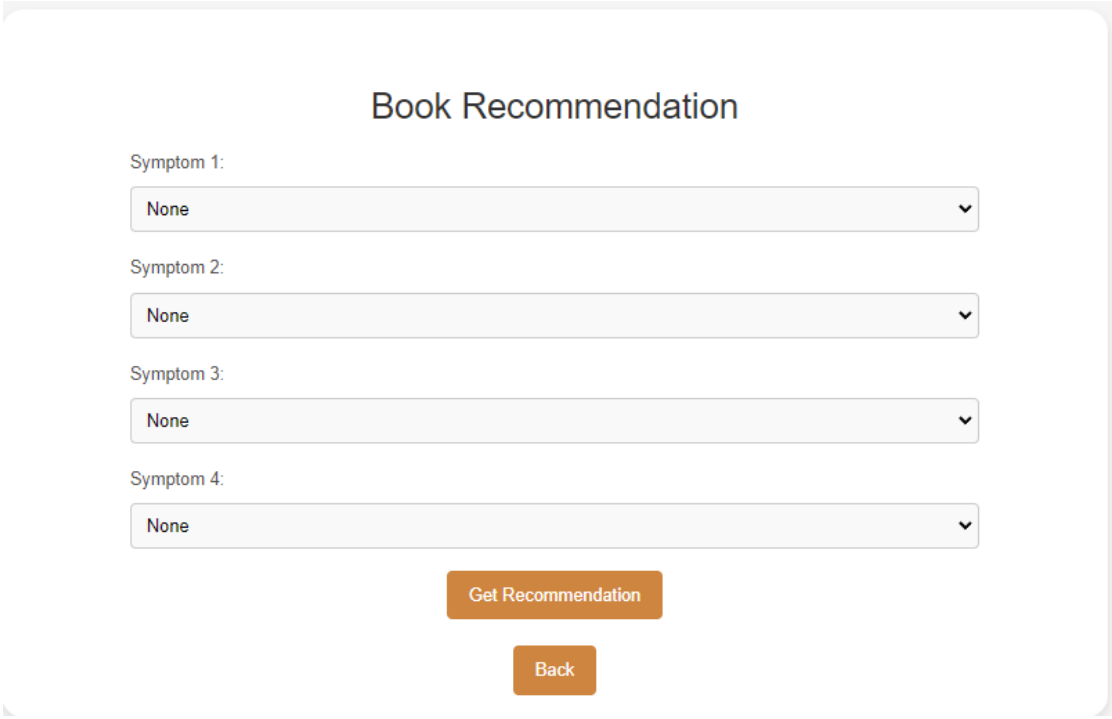


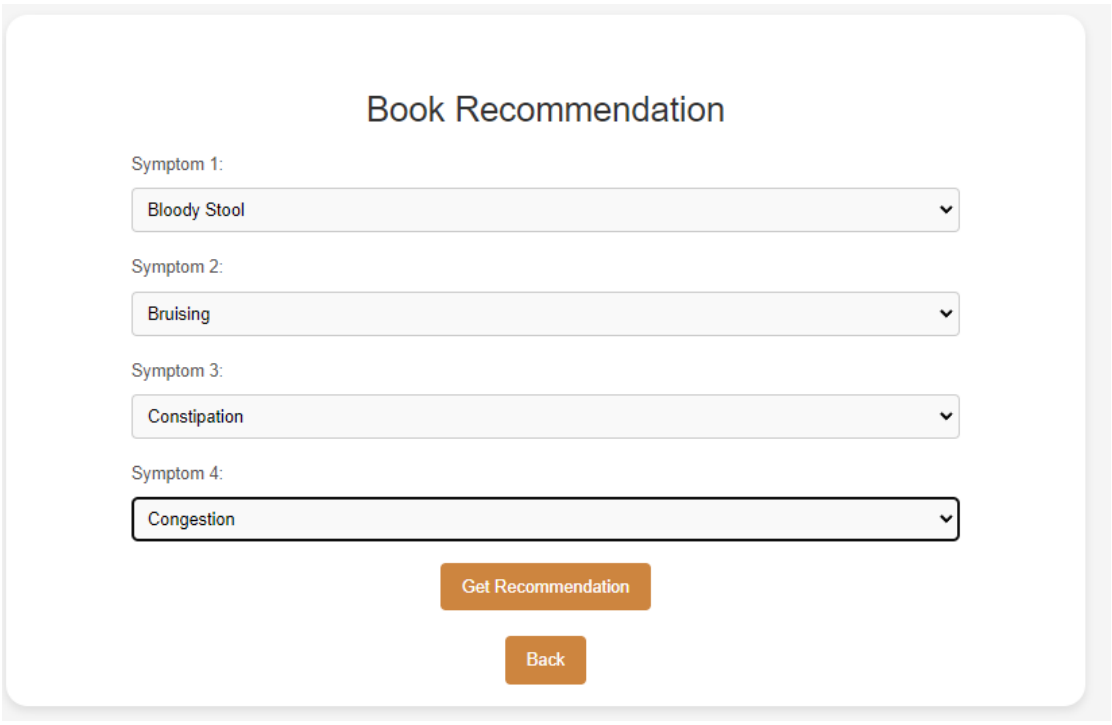

Patient Login
Username
jyoti05
Password
Signin
Don't have an account?
SignUp

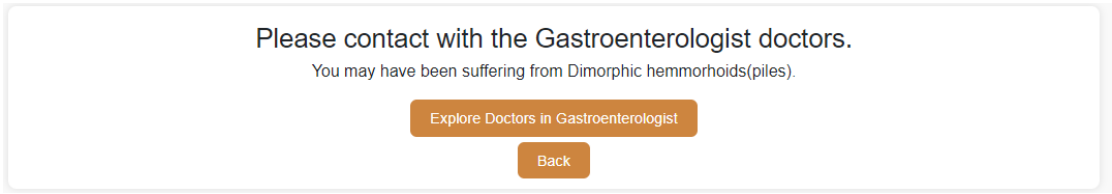

Patient Register
Username
jyoti05
First Name
Enter First Name
Last Name
Enter Last Name
Email Address
Enter Email Address
Age
Enter Age
Contact
Enter Contact
Sex
Male
Address
Enter Address
Password
Profile Image
Choose File
No file chosen
SignUp
Already have an account?
Login

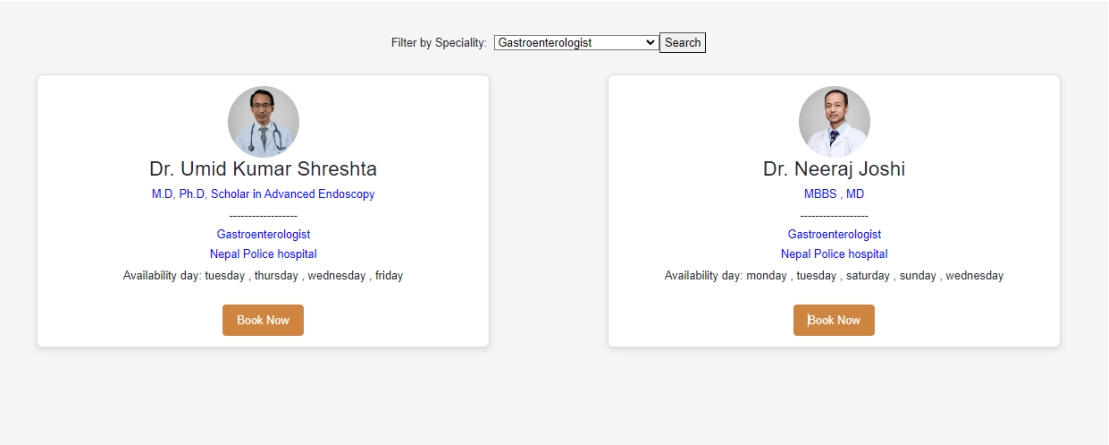

Welcome to H-MATE, Jyoti Bhusan
Your Profile
View and update your patient profile details.
Go to Profile
View My Appointment
View my appointments with a specialist doctor.
View
Book An Appointment
Schedule an appointment with a specialist doctor.
Book Now
Some common diseases
Influenza
Flu is a contagious respiratory illness caused by influenza viruses that infect the nose, throat, and sometimes the lungs. It can cause mild to severe illness, and at times can lead to death.
Malaria
Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected female Anopheles mosquitoes. It is preventable and curable.
Diabetes
Diabetes is a chronic (long-lasting) health condition that affects how your body turns food into energy. Your body breaks down most of the food you eat into sugar (glucose) and releases it into your bloodstream.


Want specialist doctor recommendation based on your symptoms?
YES
NO
Back

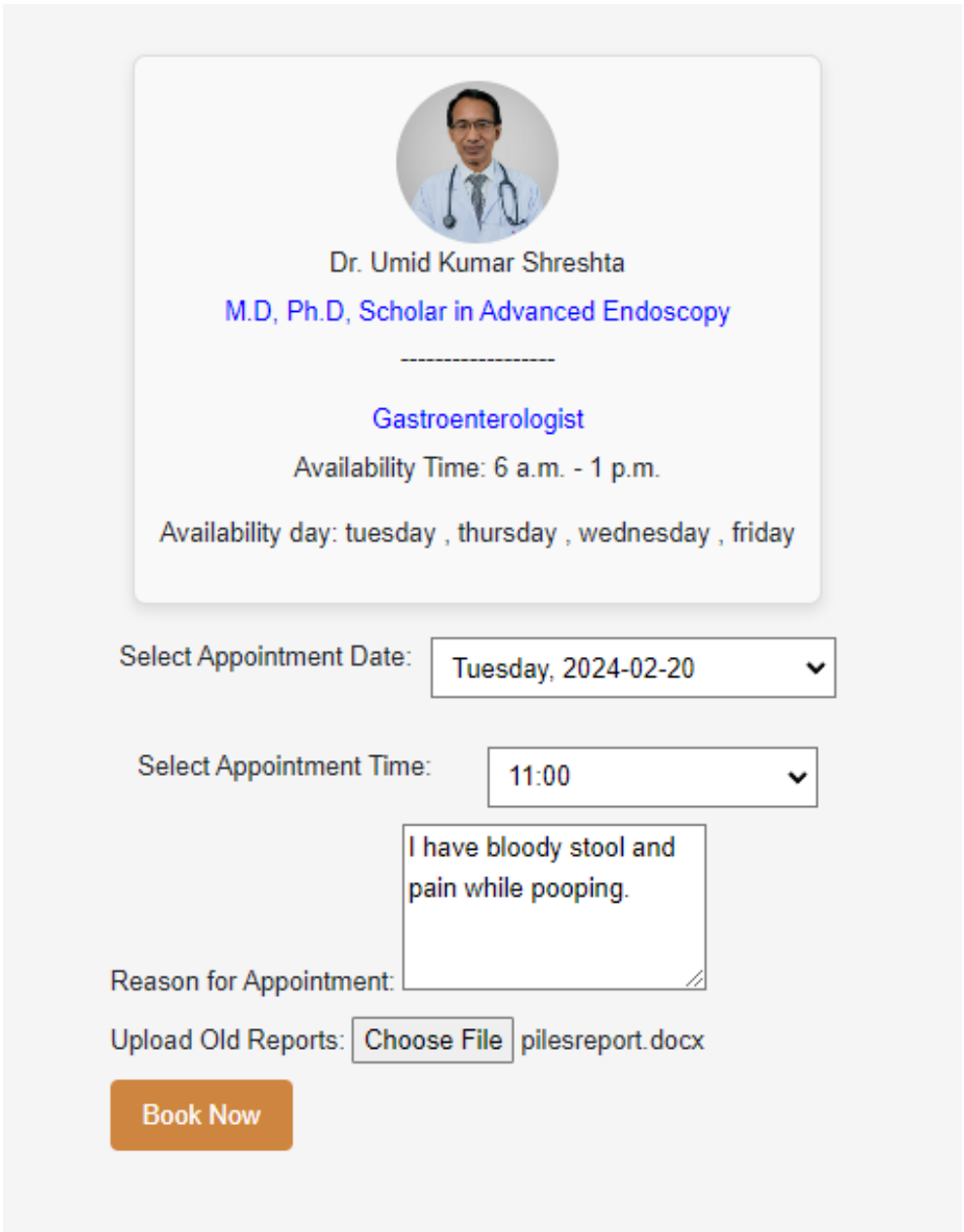

Book Recommendation
Symptom 1:
None
Symptom 2:
None
Symptom 3:
None
Symptom 4:
None
Get Recommendation
Back

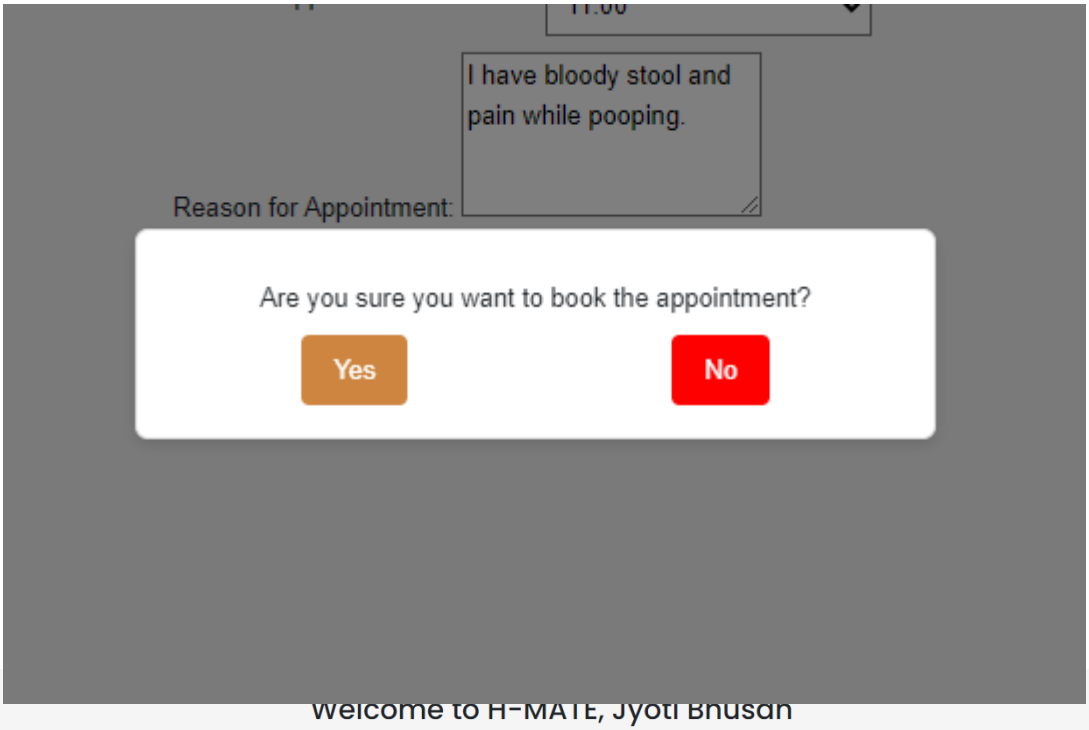

Book Recommendation
Symptom 1:
Bloody Stool
Symptom 2:
Bruising
Symptom 3:
Constipation
Symptom 4:
Congestion
Get Recommendation
Back

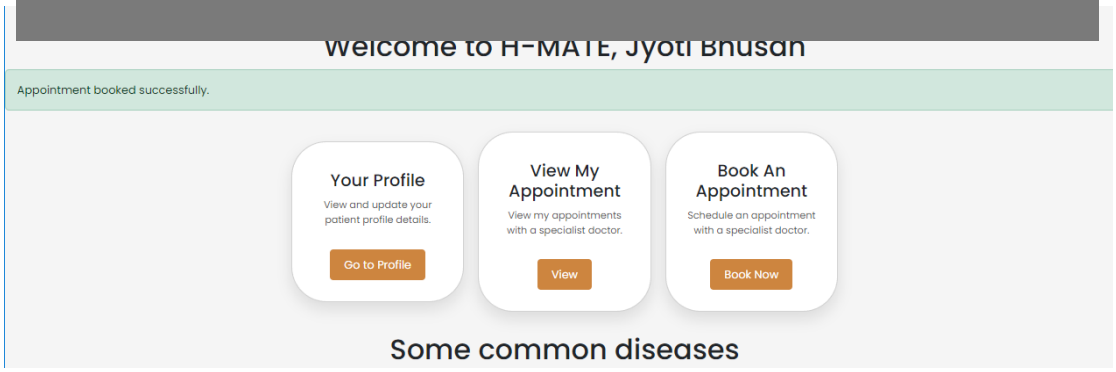

Please contact with the Gastroenterologist doctors.
You may have been suffering from Dimorphic hemmorhoids(piles).
Explore Doctors in Gastroenterologist
Back

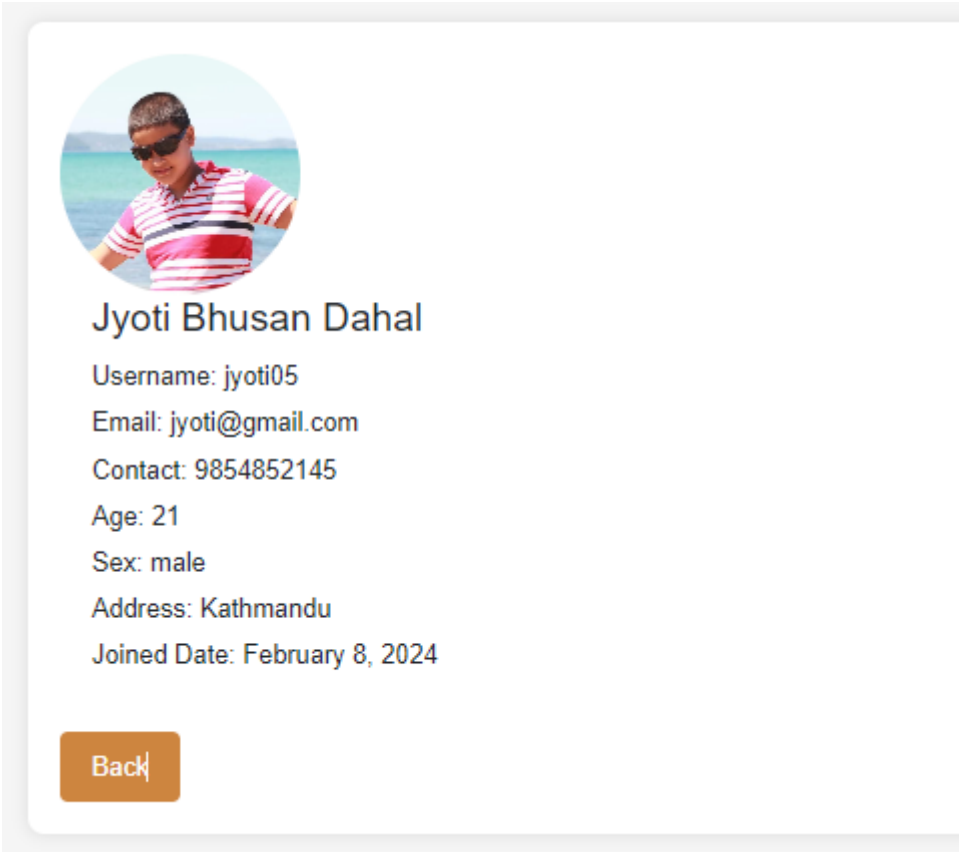

Filter by Speciality: Gastroenterologist Search
Dr. Umid Kumar Shreshta
M.D, Ph.D, Scholar in Advanced Endoscopy
Gastroenterologist
Nepal Police hospital
Availability day: tuesday , thursday , wednesday , friday
Book Now
Dr. Neeraj Joshi
MBBS , MD
Gastroenterologist
Nepal Police hospital
Availability day: monday , tuesday , saturday , sunday , wednesday
Book Now

V


Dr. Umid Kumar Shreshta
M.D, Ph.D, Scholar in Advanced Endoscopy
Gastroenterologist
Availability Time: 6 a.m. - 1 p.m.
Availability day: tuesday , thursday , wednesday , friday
Select Appointment Date: Tuesday, 2024-02-20
Select Appointment Time: 11:00
I have bloody stool and pain while pooping.
Reason for Appointment:
Upload Old Reports: Choose File pilesreport.docx
Book Now


I have bloody stool and pain while pooping.
Reason for Appointment:
Are you sure you want to book the appointment?
Yes
No


Welcome to H-MATE, Jyoti Bhusan
Appointment booked successfully.
Your Profile
View and update your patient profile details.
Go to Profile
View My Appointment
View my appointments with a specialist doctor.
View
Book An Appointment
Schedule an appointment with a specialist doctor.
Book Now
Some common diseases

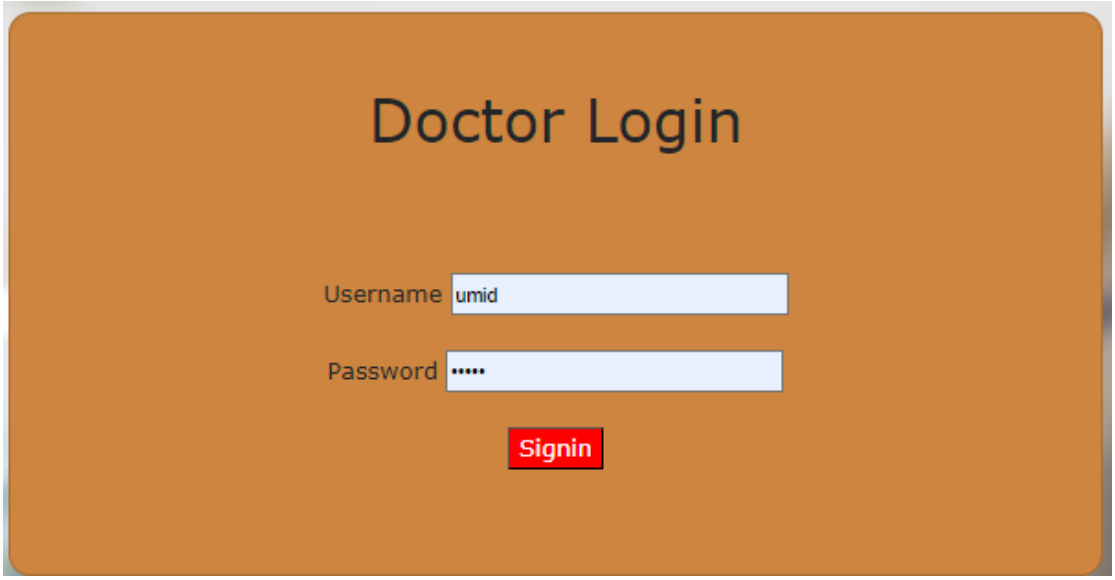

Jyoti Bhusan Dahal
Username: jyoti05
Email: jyoti@gmail.com
Contact: 9854852145
Age: 21
Sex: male
Address: Kathmandu
Joined Date: February 8, 2024
Back

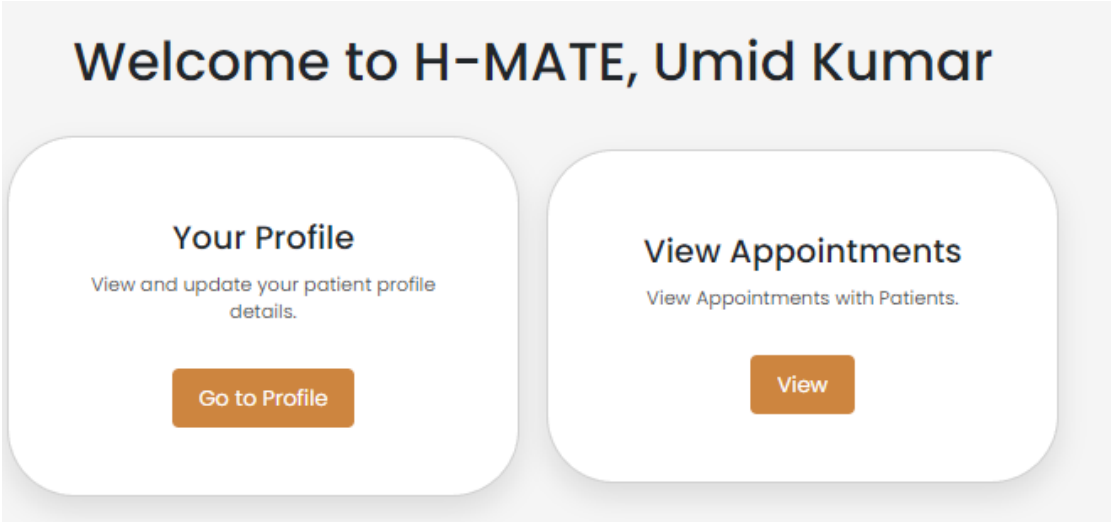
My Appointments

Upcoming Appointments

Appointment Date	Appointment Time	Doctor	Reason	Old Reports	
February 20, 2024	11 a.m.	Dr. Umid Kumar Shreshta	I have bloody stool and pain while pooping.	View Reports	Cancel

Appointments History



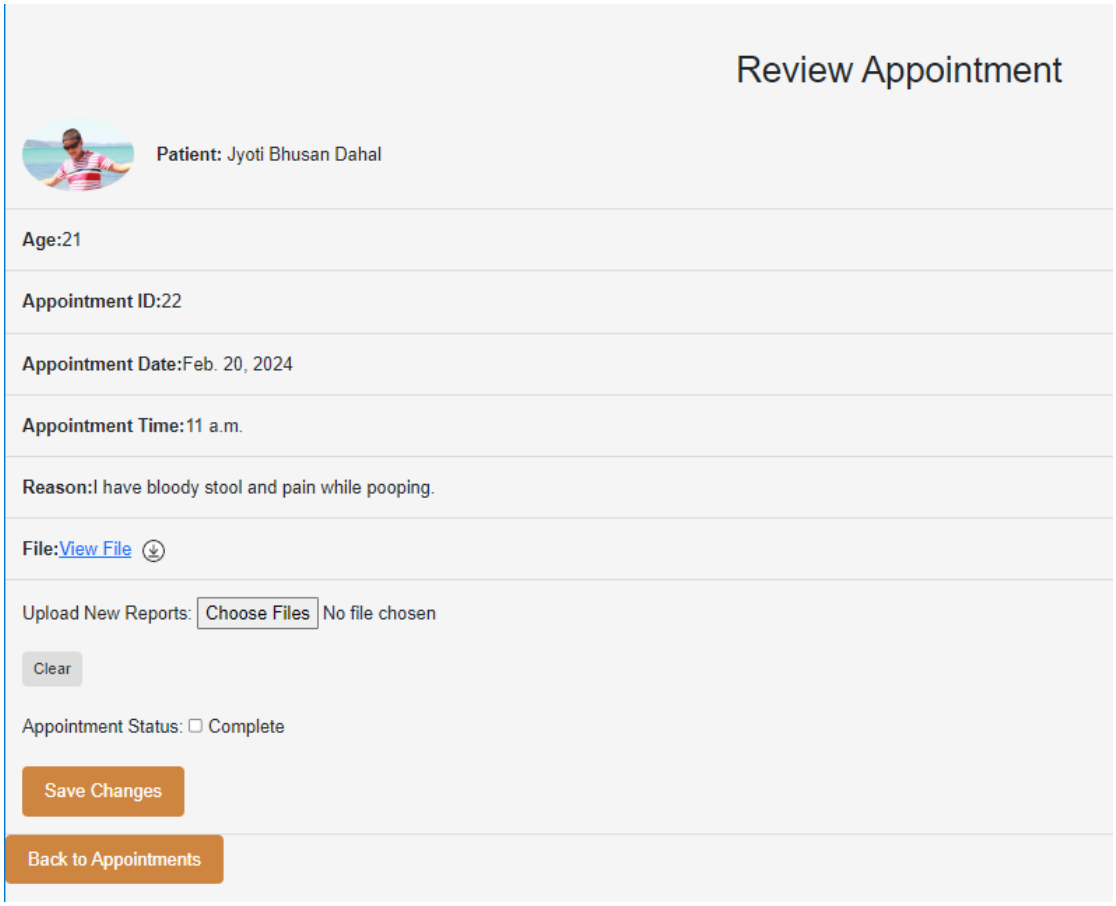


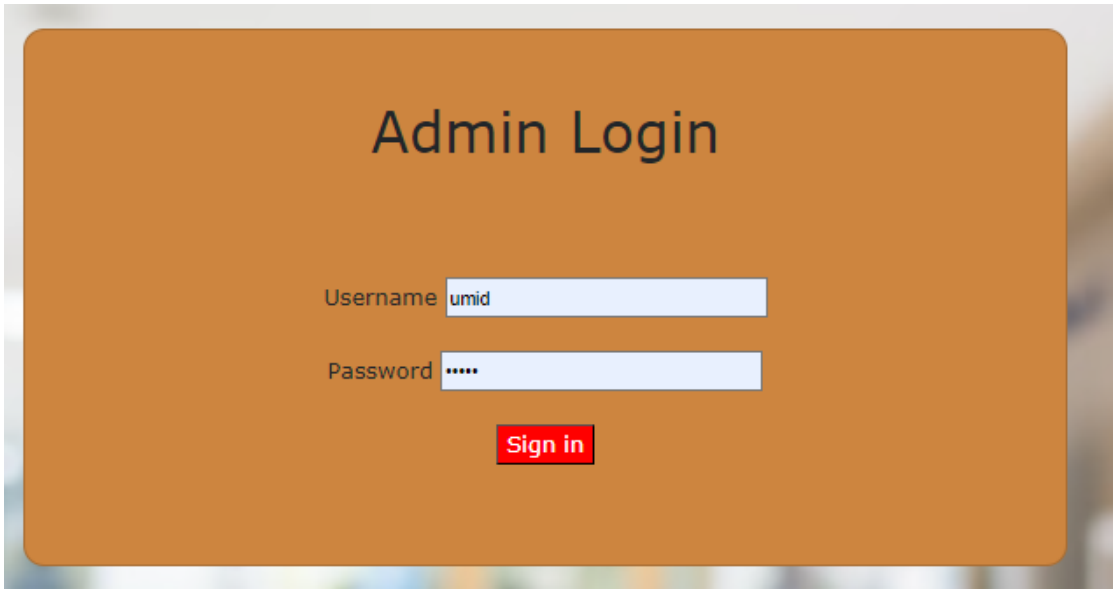
Doctor Appointments

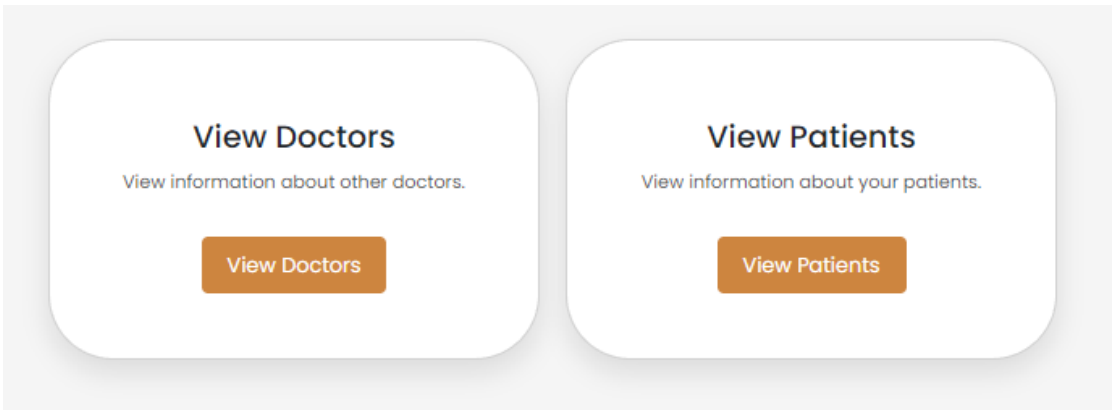
Remaining Appointments

Appointment ID	Patient Name	Age	Appointment Date	Appointment Time	Reason	File	Status	Action
19	srijana gautam	43	Feb. 16, 2024	7:30 a.m.	stomach pain	View File	remaining	Review Appointment
22	Jyoti Bhusan Dahal	21	Feb. 20, 2024	11 a.m.	I have bloody stool and pain while pooping.	View File	remaining	Review Appointment

No completed appointments available.


Review Appointment
Patient: Jyoti Bhusan Dahal
Age:21
Appointment ID:22
Appointment Date:Feb. 20, 2024
Appointment Time:11 a.m.
Reason:I have bloody stool and pain while pooping.
File:View File
Upload New Reports: Choose Files No file chosen
Clear
Appointment Status: Complete
Save Changes
Back to Appointments


Admin Login
Username umid
Password
Sign in


View Doctors
View information about other doctors.
View Doctors
View Patients
View information about your patients.
View Patients

Doctor List

Username	Email	Age	Contact	Sex	Qualification	Specialities	Hospital	Start Time	End Time	Profile Image
bipin	bipin18@gmail.com	44	9865858585	male	M.B.B.S., M.D., Clinical Fellowship	General Practitioner	Nepal Police Hospital	10 a.m.	2:30 p.m.	
ramkrishna	ramkrishna@gmail.com	52	9812345678	male	M.B.B.S. from Kathmandu Medical College M.D. from BP Koirala Institute of Health and Science, Dharan	Dermatologist	Nepal Police Hospital	9 a.m.	4:30 p.m.	
Sanju	sanjubabu@gmail.com	35	9846621789	male	MBBS , MD	Dermatologist	Nepal Police hospital	10 a.m.	5 p.m.	
Uma	uma@gmail.com	35	9745561384	female	MBBS , MD , Ph.D.	Dermatologist	Nepal Police hospital	11 a.m.	4 p.m.	
umid	umidkumar@hotmail.com	52	9861023745	male	M.D, Ph.D, Scholar in Advanced Endoscopy	Gastroenterologist	Nepal Police hospital	6 a.m.	1 p.m.	
Neeraj	neerajjoshi@hotmail.com	41	9875461234	male	MBBS , MD	Gastroenterologist	Nepal Police hospital	9:01 a.m.	4 p.m.	
Prasanna	prasanna@outlook.com	28	9840187932	female	MBBS, MD, PhD, Clinical Fellowship	Neurologist	Nepal Police hospital	11:30 a.m.	3 p.m.	
Gopal	gopalraman@gmail.com	60	9840187445	male	MBBS, MS	Neurologist	Nepal Police hospital	9 a.m.	5 p.m.	
Rabin	rabinsharma@gmail.com	31	9856213478	male	MBBS, MD, DM	Hepatologist	Nepal Police hospital	9:30 a.m.	3:30 p.m.	
Ranjit	ranjitkumar@gmail.com	45	9856642189	male	MBBS, MD, Clinical Fellowship	Cardiologist	Nepal Police hospital	1:30 p.m.	5:40 p.m.	

Patient List

Username	Email	Age	Contact	Sex	Joined Date	Address	Profile Image
jyoti05	jyoti@gmail.com	21	9854852145	male	Feb. 8, 2024, 8:41 p.m.	Kathmandu	
adsda	dadasdas@gmail.com	24	222	female	Feb. 9, 2024, 10:47 p.m.	Kathmandu	No Image
kasis	cooldudebhuwan@yahoo.com	21	9805466664	male	Feb. 9, 2024, 11:30 p.m.	Kathmandu	
bibek	bibekgt@gmail.com	22	9819171241	male	Feb. 12, 2024, 12:10 p.m.	Tokha	No Image
srijana	srijana@gmail.com	43	9876346523	female	Feb. 15, 2024, 3:21 p.m.	kalanki, kathmandu	No Image

APPENDIX

```python
doctor_specialists = {
    'Fungal infection': 'Dermatologist',
    'Allergy': 'Allergist/Immunologist',
    'GERD': 'Gastroenterologist',
    'Chronic cholestasis': 'Hepatologist',
    'Drug Reaction': 'Dermatologist',
    'Peptic ulcer disease': 'Gastroenterologist',
    'AIDS': 'Infectious Disease Specialist',
    'Diabetes': 'Endocrinologist',
    'Gastroenteritis': 'Gastroenterologist',
    'Bronchial Asthma': 'Pulmonologist',
    'Hypertension': 'Cardiologist',
    'Migraine': 'Neurologist',
    'Cervical spondylosis': 'Orthopedic Surgeon',
    'Paralysis (brain hemorrhage)': 'Neurologist',
    'Jaundice': 'Hepatologist',
    'Malaria': 'Infectious Disease Specialist',
    'Chicken pox': 'Infectious Disease Specialist',
    'Dengue': 'Infectious Disease Specialist',
    'Typhoid': 'Infectious Disease Specialist',
    'Hepatitis A': 'Hepatologist',
    'Hepatitis B': 'Hepatologist',
    'Hepatitis C': 'Hepatologist',
    'Hepatitis D': 'Hepatologist',
    'Hepatitis E': 'Hepatologist',
    'Alcoholic hepatitis': 'Hepatologist',
    'Tuberculosis': 'Pulmonologist',
    'Common Cold': 'General Practitioner/Internal Medicine Specialist',
    'Pneumonia': 'Pulmonologist',
    'Dimorphic hemorrhoids (piles)': 'Gastroenterologist/Colorectal Surgeon',
    'Heart attack': 'Cardiologist',
    'Varicose veins': 'Vascular Surgeon',
    'Hypothyroidism': 'Endocrinologist',
    'Hyperthyroidism': 'Endocrinologist',
    'Hypoglycemia': 'Endocrinologist',
    'Osteoarthritis': 'Rheumatologist/Orthopedic Surgeon',
    'Arthritis': 'Rheumatologist/Orthopedic Surgeon',
    '(Vertigo) Paroxysmal Positional Vertigo': 'ENT Specialist/Neurologist',
    'Acne': 'Dermatologist',
    'Urinary tract infection': 'Urologist',
    'Psoriasis': 'Dermatologist/Rheumatologist',
    'Impetigo': 'Dermatologist'
}
```

✓ 0.0s

Figure: Mapping disease to Specialty Doctor

```
['nodal_skin_eruptions',
 'shivering',
 'stomach_pain',
 'acidity',
 'ulcers_on_tongue',
 'muscle_wasting',
 'burning_micturition',
 'spotting_ urination',
 'weight_gain',
 'anxiety',
 'cold_hands_and_feets',
 'mood_swings',
 'weight_loss',
 'restlessness',
 'lethargy',
 'patches_in_throat',
 'irregular_sugar_level',
 'sunken_eyes',
 'breathlessness',
 'sweating',
 'dehydration',
 'indigestion',
 'dark_urine',
 'pain_behind_the_eyes',
 'mild_fever',
 'yellow_urine',
 'acute_liver_failure',
 'fluid_overload',
 'swelling_of_stomach',
```

Figure: Some symptoms in the dataset