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CMPE 491 / SENG 491

XAI Healthcare Bot

Project Analysis Report

by

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Revision History

Name	Date	Reason For Changes	Version
XAI Healthcare Bot First Version	22/11/2024	This is the first release of our program	1.0

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1. Introduction

The healthcare sector is quickly changing due to the growing need for faster, accurate, and easier-to-access medical services. However, understanding complex medical decisions is becoming harder with advancements in technology. Misunderstanding or not clearly explaining these decisions reduces patient trust and negatively affects the quality of care.

The XAI HealthCare Bot project aims to solve this problem by using explainable artificial intelligence (XAI). This AI-powered healthcare assistant provides real-time, easy-to-understand information about medical diagnosis and treatment plans. By offering clear and simple explanations for medical decisions, the system builds trust and supports both patients and healthcare providers.

This report explains the project's goals, design, and details in a simple and clear way. It helps the team work together and ensures stakeholders understand the solution.

2. Proposed System

2.1. Overview

The XAI HealthCare Bot system has three main components:

1. User Interface for Interaction
2. Explainable AI Module for Medical Insights
3. Data Integration and Decision Support System

Each component is explained in detail below:

1. User Interface for Interaction

The system provides a user-friendly interface for both patients and healthcare providers.

For Patients: The interface simplifies complex medical terms, giving clear explanations about diagnoses and treatment plans. This helps build trust and ensures patients understand their healthcare process.

For Healthcare Providers: Doctors and healthcare professionals can access detailed AI-generated insights and explanations about diagnoses, improving their decision-making.

Security and Access: The interface ensures only authorized users can access sensitive medical data by using a role-based system.

2. Explainable AI Module for Medical Insights

This module is the core part of the system, using explainable AI (XAI) to provide real-time insights.

The AI processes medical data, such as patient history and diagnostic results, to make accurate recommendations.

Unlike traditional AI, the XAI module explains its decisions clearly and transparently. This helps users

trust the system and verify its suggestions.

The module uses advanced algorithms to ensure fast and reliable analysis.

3. Data Integration and Decision Support System

The system integrates with healthcare databases to collect and analyze patient data.

Data Integration: The module gathers information from electronic health records (EHR), lab results, and imaging systems to create a full patient profile.

Decision Support: The system offers personalized explanations for diagnoses and treatments, helping healthcare providers validate the AI's recommendations.

Continuous Learning: The system learns from new data over time, improving its accuracy and decision-making abilities.

This design allows the XAI HealthCare Bot to provide reliable and actionable medical insights while building trust and enhancing collaboration between patients and healthcare providers. The detailed system structure helps the team work together and ensures stakeholders understand the solution clearly.

2.2. Functional Requirements

Notification:

Users should be provided with real-time notifications for diagnosis updates, medication reminders, and critical health indicators. Notifications should be customizable based on the user profile.

Detailed View:

Provide a detailed view of patient records. This view should include medical history, current status, and descriptions of diagnosis. Providers should be able to easily access these records during the encounter.

Diagnosis Assistance:

Provide a detailed view of patient records. This view should include medical history, current status, and descriptions of diagnosis. Providers should be able to easily access these records during the encounter.

Profile Switching:

Users should be able to easily switch between different profiles, such as patient and doctor.

Patient Record Management:

Healthcare professionals must be able to review and compare multiple patient records.

Medication Tracking:

The system should empower patients to effectively manage their prescribed medications by tracking dosage, schedule, and duration. It should also deliver timely reminders for each dose while enabling healthcare providers to monitor adherence, ensuring patients stay on track with their treatment plans.

Customizable Profiles:

Customizable profiles should be created for patients and healthcare professionals, and specific health information, areas of expertise, and historical data should be stored in these profiles.

2.3. Non-Functional Requirements

Performance:

The system should be able to respond to user queries in real time and manage interactions with multiple users simultaneously without delay.

Accuracy:

AI recommendations and explanations must have a high accuracy rate in line with the latest medical guidelines.

Reliability:

During times of heavy use, the system must operate without interruption and must be able to quickly return to its previous state.

Usability:

The user interface should be intuitive, enabling seamless navigation with clear instructions for all user profiles.

Security:

Patient information must be protected with strong encryption and secure access controls and comply with regulations such as HIPAA and GDPR.

Scalability:

The system must support an increasing number of users and features without compromising performance.

Maintainability:

The codebase should be modular and well documented, with regular updates that can be made with minimal user interaction.

Interoperability:

Must be compatible with existing healthcare systems and electronic health records (EHR).

Accessibility:

The system should adhere to accessibility standards, ensuring that users with disabilities can effectively interact with the bot. This includes support for screen readers and adaptable interface options.

Cost-Effectiveness:

The system must provide high value while keeping both development and operating costs low.

Adaptability:

It should be able to adapt to different environmental conditions and be updated according to changing health standards.

Responsiveness:

It should be able to adapt to different environmental conditions and be updated according to changing health standards.

2.4. Pseudo Requirements

No Offline Support:

To guarantee real-time access to medical data and updates, the system will need a steady internet connection and won't work offline.

Limited Role-Based Features:

User roles (such as doctor and patient) will be used to firmly segregate features, and improper authentication will prevent unwanted role swapping.

Exclusion of Wearable Device Integration:

To avoid relying on hardware, the system will not interface with wearable health monitoring devices.

No Support for External Database Updates:

The initial version of the system will not handle real-time changes to external healthcare databases.

Language Support Limitations:

At first, the system will only support English. Future iterations will take into account more languages.

Restricted Hardware Compatibility:

The system will only work with devices that fulfill certain performance and hardware requirements. Devices with poor performance won't be supported.

No Training or Educational Modules:

There won't be any user training or instructional material on medical procedures in the bot. Rather, it will concentrate on offering concise, useful ideas.

Fixed Update Schedules:

To reduce system interruptions, AI model changes will only be carried out during scheduled maintenance times.

No Direct Treatment Recommendations:

To avoid ethical and legal issues, the bot will help explain diagnoses but won't offer direct therapy recommendations.

No Multi-Profile Simultaneous Access:

To ensure data security and integrity, a single user profile cannot access several accounts or roles at once.

2.5. System Models

2.5.1. Scenarios

Patient Diagnosis Explanations

The system provides patients with clear and understandable explanations about their diagnosis and treatment plans. This simplifies complex medical terms and helps patients better understand their healthcare processes.

Medical Decision Support System

Doctors access AI-powered medical insights for their patients' diagnoses through the system. These insights facilitate decision-making and provide transparent explanations of recommendations.

Real-Time Notifications

Patients receive real-time updates on topics such as diagnosis results, medication reminders, and critical health alerts. This allows patients to be informed about their healthcare processes in a timely manner.

Day-Night Adaptation Ability

XAI HealthCare Bot adapts to changing usage habits at different times of the day. Thus, the system provides uninterrupted performance around the clock.

Scalability Test

Its performance is evaluated when new healthcare providers are added to the system or more patient records are integrated. This is done to measure the system's ability to handle increasing data loads.

High Traffic Management

The system seamlessly manages the increasing number of users during emergencies or when patient density increases. Even in these cases, it does not compromise on accuracy and responsiveness.

System Updates

Regular updates are made to increase the accuracy and reliability of the AI model. This process ensures that the system complies with the latest medical standards.

Solution Against Hardware Failures

In the event of hardware failure, the system continues to operate without interruption. The availability of the system is maintained thanks to backup techniques.

Alert Management

Doctors and patients receive real-time notifications about critical health situations or emergencies. This allows fast and effective interventions.

Data Privacy and Security Compliance

The system operates in full compliance with regulations such as HIPAA and GDPR to ensure the protection of patient data. Only authorized users are allowed to access sensitive data.

Customizable Profiles

Healthcare providers and patients have profiles that are customized to their needs. This makes the user experience more personalized.

Medication Tracking

Patients receive medication reminders and healthcare providers can track this process through the system. This feature helps patients stay on top of their treatment plans.

2.5.2. Use Case Model

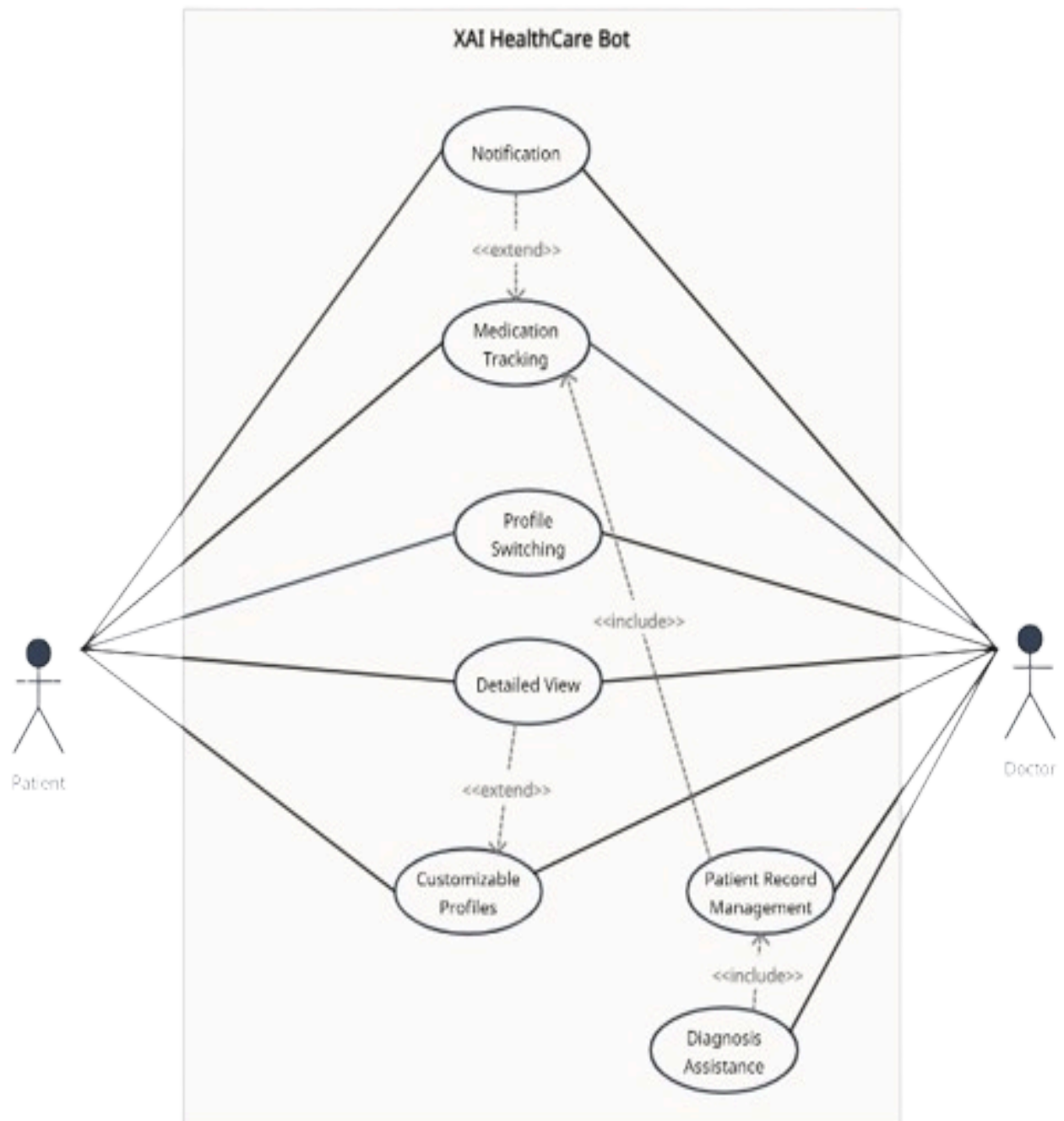


Figure 1: Use Case Diagram for XAI HealthCare Bot

2.5.3. Object and Class Model

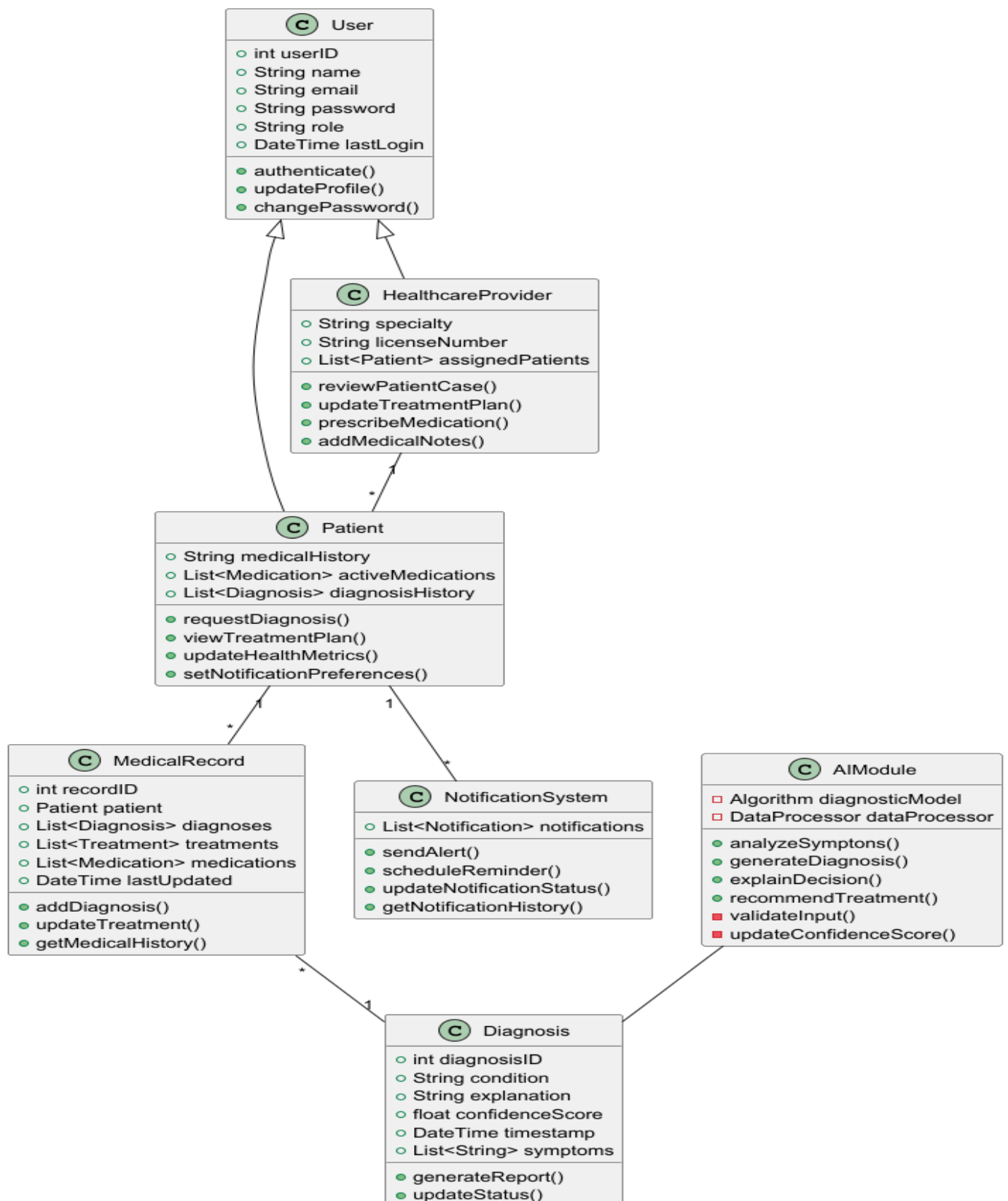


Figure 2: Object and Class Model for XAI HealthCare Bot

2.5.4. Dynamic Models

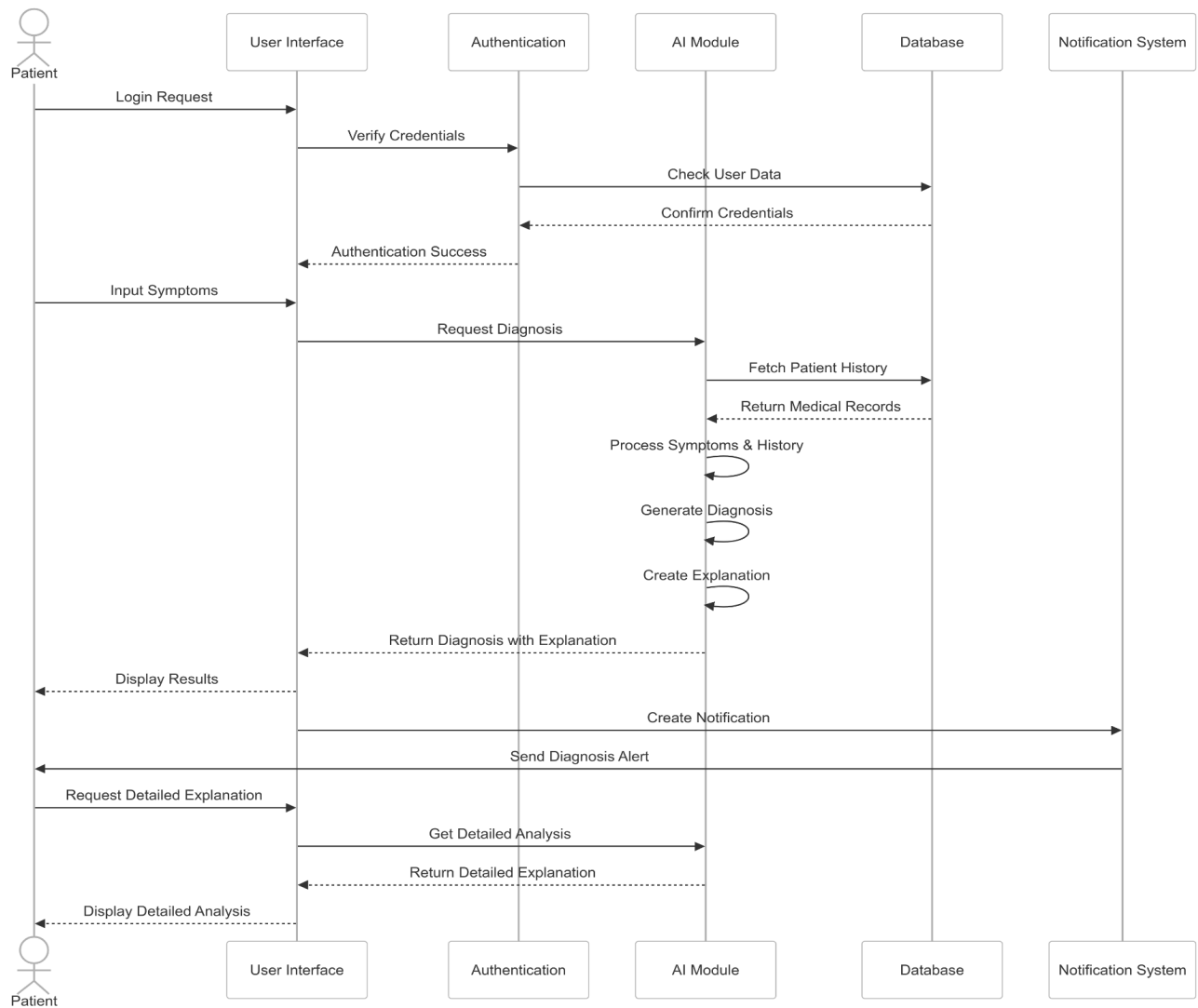


Figure 3: Sequence Diagram for XAI HealthCare Bot

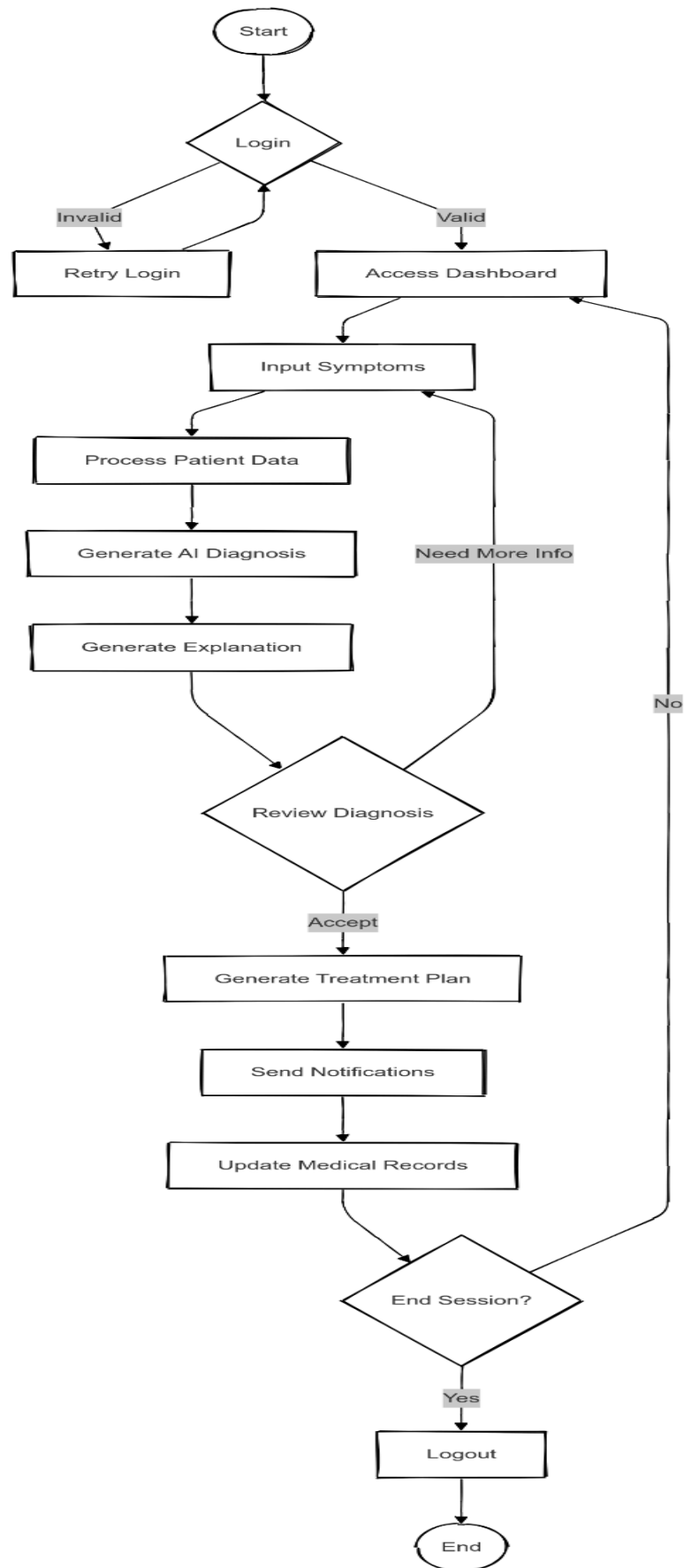


Figure 4: Flowchart diagram for XAI HealthCare Bot

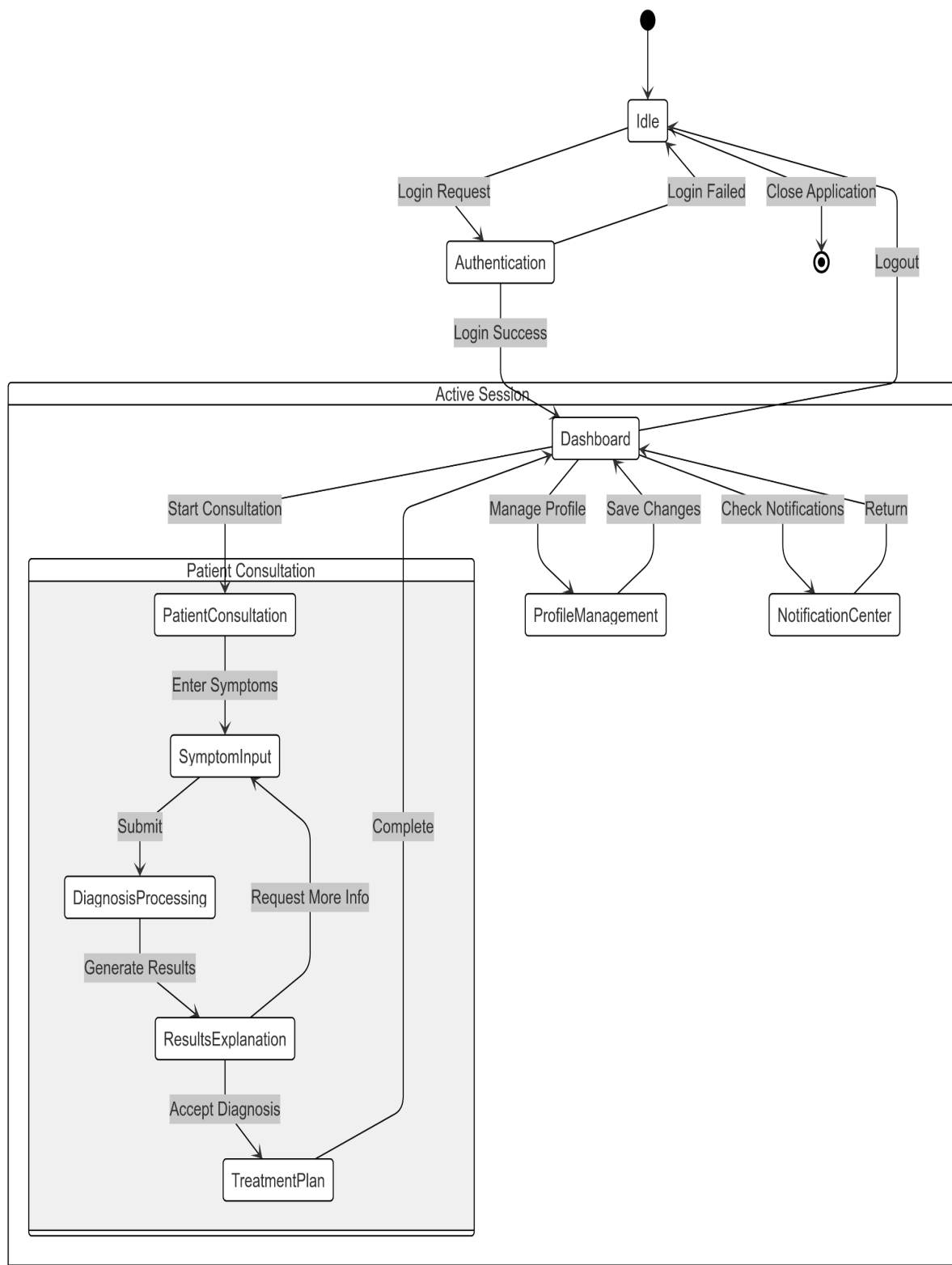
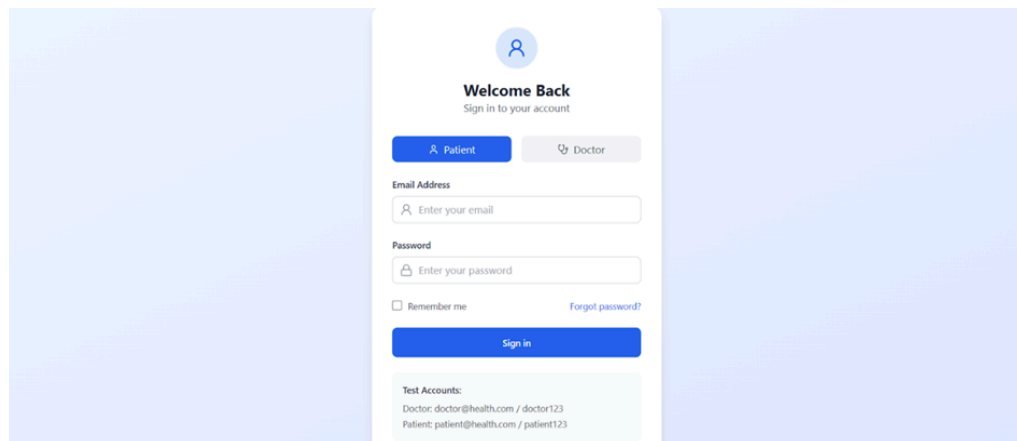


Figure 5: Activity Diagram for XAI HealthCare Bot

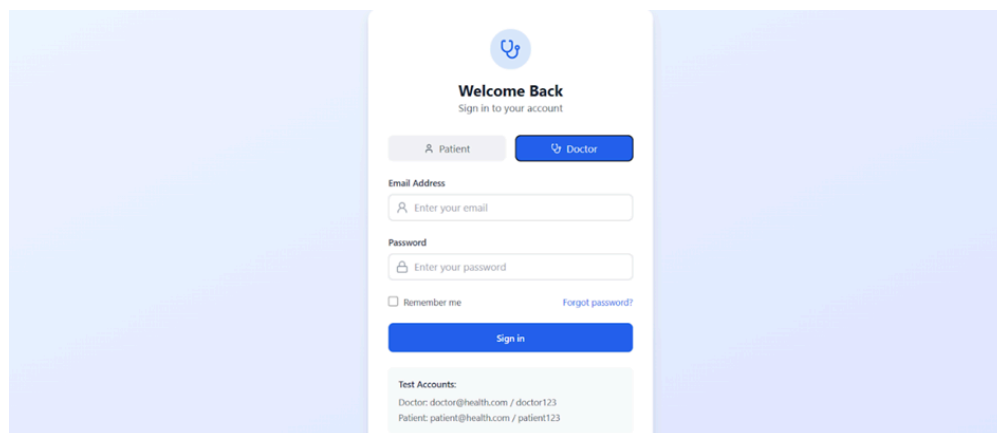
2.5.5. User Interface – navigational paths and screen mock-ups

The figures used in this section might change throughout the project, according to the design team's decisions and the improvement of the project.



The login screen for a patient features a central white card on a light blue background. At the top of the card is a blue circular icon with a white person silhouette. Below this is the text "Welcome Back" in bold, followed by "Sign in to your account" in a smaller font. There are two buttons: a blue "Patient" button with a person icon and a grey "Doctor" button with a stethoscope icon. Below these are two input fields: "Email Address" with a magnifying glass icon and "Password" with a lock icon. A "Remember me" checkbox and a "Forgot password?" link are positioned below the password field. A blue "Sign in" button is at the bottom of the input section. At the very bottom of the card, a "Test Accounts:" section lists "Doctor: doctor@health.com / doctor123" and "Patient: patient@health.com / patient123".

Figure 6: Login Screen for patient



The login screen for a doctor is similar to the patient screen but with the "Doctor" button highlighted in blue and the "Patient" button in grey. The "Welcome Back" text and "Sign in to your account" subtitle are present. The input fields for "Email Address" and "Password" are identical. The "Remember me" checkbox and "Forgot password?" link are also present. The blue "Sign in" button is at the bottom of the input section. The "Test Accounts:" section at the bottom lists "Doctor: doctor@health.com / doctor123" and "Patient: patient@health.com / patient123".

Figure 7: Login Screen for doctor

It is possible to choose one of the two account types in the login screen. Based on the account type you need to enter the valid email and password.

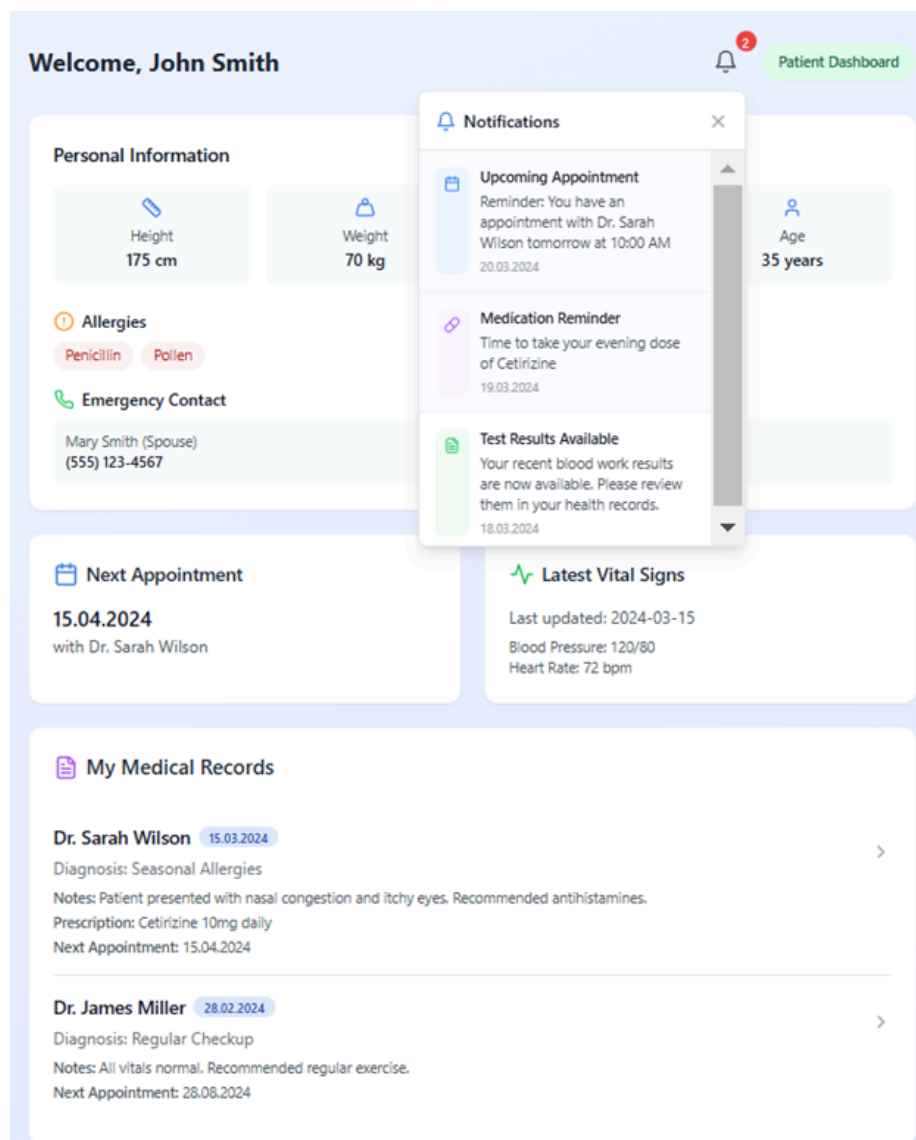


Figure 8: Patient Dashboard

When you choose the Patient account type and enter the valid email and password, you will have access to the patient dashboard. In this page you will be able to see only your medical records and no other patients'. You can see your medical information, allergy backgrounds, past and upcoming appointments and notifications.

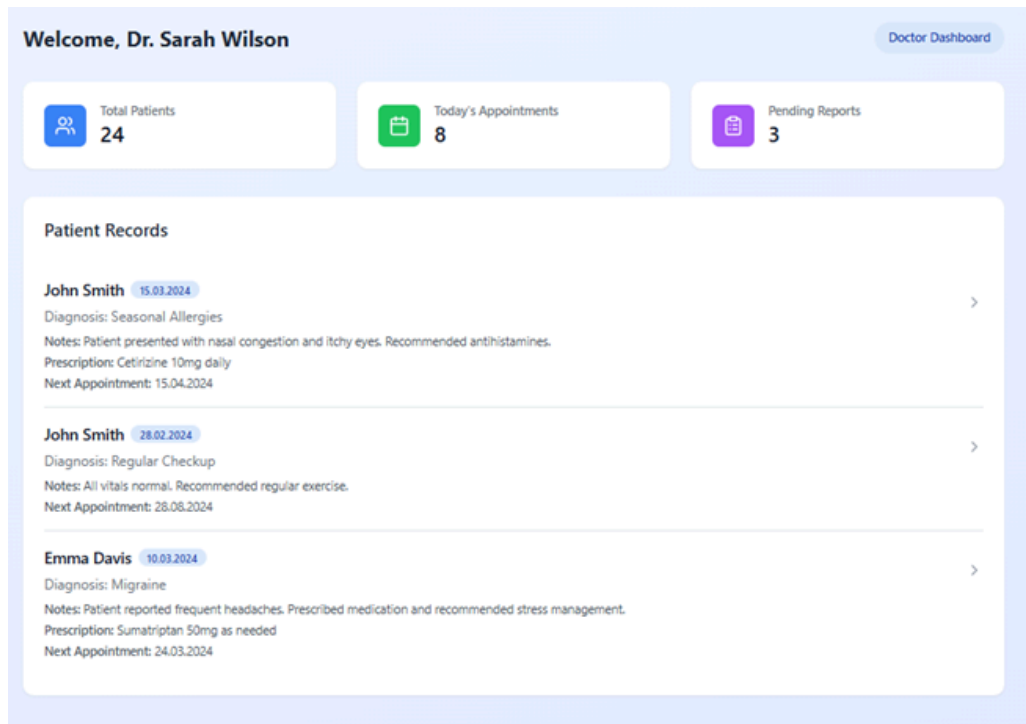


Figure 9: Doctor Dashboard

If you choose the doctor and enter the correct email and password, you will have access to the doctor dashboard. Unlike the patient dashboard now you can see all your patients' records. It is also possible to see your daily appointments and pending reports.


Welcome Back
Sign in to your account

Email Address

! Lütfen e-posta adresine bir "@" işareti ekleyin. "patient" adresinde "@" eksik.

☐ Remember me [Forgot password?](#)



Figure 10: Invalid Email or Password




Welcome Back

Sign in to your account


Invalid email or password for selected role

 Patient  Doctor

Email Address

 patient@gmail.com

Password



☐ Remember me [Forgot password?](#)

Sign in

Test Accounts:

Doctor: doctor@health.com / doctor123
Patient: patient@health.com / patient123

Figure 11: Invalid Email or Password

This screen appears when a user enters an invalid username or password during the login process. The system detects the incorrect input and displays a message to inform the user about the error, prompting them to re-enter their credentials correctly.

3. Glossary

Anomaly Detection: Process of identifying abnormal patterns from expected norm, such as unexpected image of the heart.

False Positive: In XAI Healthcare Bot, it means that the bot incorrectly diagnoses the illness while the patient was not sick.

Image Processing: Manipulation and analysis of visual information such as images or video frames to extract its features for the purpose of detection of safety violations.

Machine Learning: An AI field that enables systems to learn from data and experience.

Safety Compliance: Safety standards within the working environment.

Sensitivity: True Positive Rate. Meaning XAI Healthcare Bot correctly identified the illnesses.

Training Dataset: The dataset that is used to train the ML algorithms.

Validation Dataset: The dataset to test the system to ensure its reliability.

YOLO Architecture: You look only once. It is designed to detect objects in an image with high accuracy and real-time speed. It can perform detection in a single pass using a neural network.

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