RAJALAKSHMI ENGINEERING COLLEGE

RAJALAKSHMI NAGAR, THANDALAM – 602 105

RAJALAKSHMI
ENGINEERING COLLEGE
An AUTONOMOUS Institution
Affiliated to ANNA UNIVERSITY, Chennai

CS19442 SOFTWARE ENGINEERING CONCEPTS LAB

Laboratory Record
Note Book

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Semester : ……………02…………………….…………

Academic Year : …………2023 - 2024…………………………

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BONAFIDE CERTIFICATE

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Certified that this is the bonafide record of work done by the above student in the CS19442-Software Engineering Concepts Laboratory during the year 2023- 2024

Signature of Faculty-in-charge

Submitted for the Practical Examination held on --

Internal Examiner External Examiner

INDEX

OVERVIEW OF THE PROJECT:

What is the problem it is trying to resolve?

- The problem the ICU Patient Risk Level Monitoring System is trying to resolve is the real-time interpretation and decision-making in ICU settings, which is challenging due to the high volume of patient data and the need for prompt and accurate assessments to improve patient safety, optimize resource allocation, and enhance clinical decision-making.

Explanation with Respect to Data:

What data does it deal with?

The project deals with data related to ICU (Intensive Care Unit) patient monitoring using supervised machine learning techniques:

- Patient Records Data
- Data from Medical Information Mart for Intensive Care (MIMIC)
- Electronic Health Records (EHR)
- Clinical Variables and Treatment Outcomes
- Demographics, Vital Signs, Laboratory Results, Medical History

How is this data collected and processed?

- Data collection involves gathering historical and raw data which cannot be used directly, so it undergoes preprocessing to clean and transform it into a usable format. This cleaned data is then split into training and testing sets, enabling the development and evaluation of predictive models using various algorithms. The models are tuned over time to improve their accuracy and effectiveness in predicting outcomes.

User Benefits upon Implementation

How would it help users when we implement the system?

The ICU Patient Monitoring Dashboard provides several benefits:

- **Improved Accuracy in Predictions:** The system utilizes machine learning algorithms such as Random Forest and Cat Boost Classifier, which are known for their high accuracy in classification tasks. By employing these algorithms, the system ensures precise predictions, which is particularly beneficial in applications like predicting ICU patient risk levels
- **Enhanced Feature Selection:** With Random Forest's ability to assess feature importance, users can gain insights into which variables are most influential in the model's decision-making process. This can help in refining the model by focusing on the most critical features, leading to better understanding and improved accuracy in predictions.
- **Robust and Reliable Performance:** The ensemble approach of Random Forest, which combines multiple decision trees, reduces overfitting and enhances generalization. This leads to more reliable predictions, making the system suitable for a wide range of applications.

SOFTWARE REQUIREMENTS SPECIFICATION (SRS)

EXP.NO: 1 **DATE: 20.2.2024**

CONTENTS

SOFTWARE REQUIREMENTS SPECIFICATION

EX.NO.1 **DATE: 20-02-2024**

1. Introduction

1.1 Purpose

The purpose of this document is to provide a comprehensive description of the ICU Patient Risk Level Monitoring System. This system is designed to continuously monitor and evaluate the risk levels of patients in the Intensive Care Unit (ICU) to ensure timely interventions and improve patient outcomes.

1.2 Scope

The requirements, functionalities, and design considerations for the ICU Patient Risk Level Monitoring System. It includes the system's purpose, scope, definitions, overall description, product perspective, product functions, user characteristics, operating environment, design constraints, assumptions, dependencies, and appendices.

1.3 Definitions, Acronyms, and Abbreviations

- **ICU**: Intensive Care Unit
- **EHR**: Electronic Health Record

2. Overall Description

2.1 Product Perspective

The ICU Patient Risk Level Monitoring System is an integral part of the hospital's health management infrastructure. It integrates with existing Electronic Health Records (EHR) and patient monitoring devices to gather and analyze patient data in real-time.

2.2 Product Functions

- **Data Collection**: Interfaces with patient monitoring devices and EHR systems to collect vital signs and health data.
- **Risk Assessment**: Analyzes the collected data to determine the patient's risk level using predefined algorithms.
- **Alerts and Notifications**: Sends alerts to medical staff when a patient’s risk level reaches a critical threshold.
- **Reporting**: Generates reports on patient risk levels and trends over time.
- **User Interface**: Provides a user-friendly interface for medical staff to view patient data and risk levels.

2.3 User Classes and Characteristics

- **Doctors**: Require detailed patient data and risk analysis to make informed decisions.
- **Nurses**: Need real-time alerts and notifications to respond quickly to changes in patient status.
- **Administrators**: Use the system to generate reports and ensure compliance with healthcare regulations.

2.4 Operating Environment

- The system operates within the hospital's secure network environment and interfaces with various medical devices and EHR systems. It requires high availability and redundancy to ensure continuous monitoring without interruptions.

2.5 Design and Implementation Constraints

- **Compliance**: Must comply with healthcare regulations and standards, such as HIPAA.
- **Interoperability**: Must be compatible with a wide range of medical devices and EHR systems.
- **Data Security**: Must ensure the confidentiality, integrity, and availability of patient data.

2.6 Assumptions and Dependencies

- **Reliable Network**: Assumes a stable and secure network infrastructure within the hospital.
- **Device Compatibility**: Assumes that all patient monitoring devices are compatible and properly calibrated.

- **User Training**: Assumes that medical staff have received adequate training to use the system effectively.

3. Appendices

3.1 Appendix A: Glossary

- **Vital Signs**: Measurements of the body's basic functions, including heart rate, blood pressure, respiratory rate, and temperature.
- **Algorithm**: A process or set of rules followed in calculations or problem-solving operations.

3.2 Appendix B: Analysis Models

- **Data Flow Diagrams**
- **Use Case Diagrams**

3.3 Appendix C: Issues List

- **Issue 1**: A list of known issues, bugs, or limitations of the system. This section also includes plans for future enhancements and ongoing maintenance tasks.

4. References

- Healthcare Information and Management Systems Society (HIMSS) standards and guidelines.

- Health Insurance Portability and Accountability Act (HIPAA) compliance documents.
- Documentation from integrated EHR and medical device manufacturers.

SCRUM METHODOLOGY

EX.NO.2 **DATE: 01-03-2024**

1. Project Vision Vision Statement:

- To create a real-time ICU patient risk monitoring system using supervised machine learning that improves patient outcomes by enabling early intervention and personalized care plans.

Goals:

- Enhance Data-Driven Decision Making
- Improve Engagement and Audience Understanding
- Facilitate Competitive Benchmarking
- Optimize Resource Allocation
- Streamline Reporting and Monitoring

The Product Backlog

The product backlog is a prioritized list of features and functionalities that will be incorporated into the ICU patient risk monitoring system.

Product Backlog Items:

1. Monitor patient risk levels in real-time
2. Receive alerts for critical risk thresholds
3. Visualize patient data trends
4. Track intervention effectiveness
5. Manage feature selection for the machine learning model
6. Implement a caregiver portal
7. Advanced reporting functionalities

3. The Scrum Team

1. **Product Owner:** Represents stakeholder interests and prioritizes the product backlog.
2. **Scrum Master**: Facilitate the Scrum process, ensure the team follows Scrum practices, and remove any impediments that hinder progress.
3. **Development Team**: Composed of developers, data scientists, and engineers who build the system.

4. Planning the Sprints

- Sprint Duration: Typically 2-4 weeks.
- Sprint Planning Meeting: The team selects items from the product backlog to commit to during the sprint.

1. **Sprint Planning Meeting** - Goal: Define what will be delivered in the sprint and how it will be achieved. - Input: Product backlog, team capacity, past performance. - Output: Sprint backlog (tasks for the sprint), sprint goal.

2. **Daily Stand-up Meetings** - Duration: 15 minutes - Purpose: Discuss what was done yesterday, what will be done today, and identify any impediments.

3. **Sprint Execution** - Development: Team works on the tasks in the sprint backlog. - Testing: Continuous integration and testing of features.

4. **Sprint Review** - Purpose: Demonstrate the working product increment to stakeholders. - Activities: Team shows what was accomplished during the sprint. Stakeholders provide feedback.

5. **Sprint Retrospective** - Purpose: Reflect on the sprint and identify improvements for future sprints. - Activities: Discuss what went well, what didn’t, and how to improve.

6. **Release Planning** - Release Goal: Determine when and what features will be released to the users. - Activities: Prioritize features, finalize the release date, prepare for deployment.

Sprint Breakdown:

Sprint 1:

- Develop core functionalities for data ingestion and real-time risk score calculation.
- Data pipeline infrastructure, initial machine learning model prototype.

Sprint 2:

- Implement risk score display on the clinician dashboard and establish basic alert functionalities.
- Clinician dashboard with risk score display, basic alert generation system.

Sprint 3:

- Integrate data visualization tools to enable clinicians to view patient data trends.
- Data visualization dashboards for historical and real-time patient data.

Sprint 4:

- Develop functionalities to track interventions and analyze their impact on risk scores.
- Intervention tracking system, initial reports on intervention effectiveness.

Sprint 5:

- Implement features for data scientists to manage the machine learning model's feature set.
- User interface for feature selection and management, version control for feature sets.

Sprint 6:

- Integrate model performance monitoring tools and establish retraining procedures.
- Model performance dashboards, automated model retraining triggers based on pre-defined thresholds.
- Implement alert system for significant metric changes.
- Refine and optimize existing features.

USER STORIES

EX.NO.3 **DATE:12-03-2024**

1. Monitor Patient Risk Level

User Story

As an ICU clinician, I want to see a patient's real-time risk score

for complications so I can prioritize care and intervene early.

Acceptance criteria

The system displays a patient's current risk score on the clinician dashboard.

The risk score is updated automatically based on new patient data.

The risk score is categorized into different levels (e.g., low, medium, high) with clear definitions.

2. Receive Risk Level Alerts

User story

As an ICU clinician, I want to receive alerts when a patient's risk score reaches a critical threshold so I can take immediate action.

Acceptance criteria

The system generates alerts for clinicians when a patient's risk score exceeds a predefined threshold.

Alerts clearly identify the patient and the nature of the risk (e.g., high risk for sepsis).

3. View Patient Data Trends User story

As an ICU clinician, I want to visualize trends in a patient's vital signs and other relevant data over time to understand their health trajectory.

Acceptance criteria

The system allows clinicians to view historical and real-time patient data in charts and graphs.

Clinicians can easily compare current data against historical trends to identify changes in patient condition.

4. Track Intervention Effectiveness User story

As an ICU clinician, I want to track the effectiveness of interventions made based on risk scores to improve future care decisions.

Acceptance criteria

The system allows clinicians to document interventions taken for each patient. The system allows clinicians to analyze changes in risk scores after implementing interventions.

5. Manage Feature Selection User story

As a data scientist, I want to manage the selection and inclusion of features used by the machine learning model for risk prediction.

Acceptance criteria

The system provides a user interface for data scientists to manage the feature set used by the model.

The system tracks historical versions of the feature set for auditability and model retraining.

6. Monitor Model Performance User story

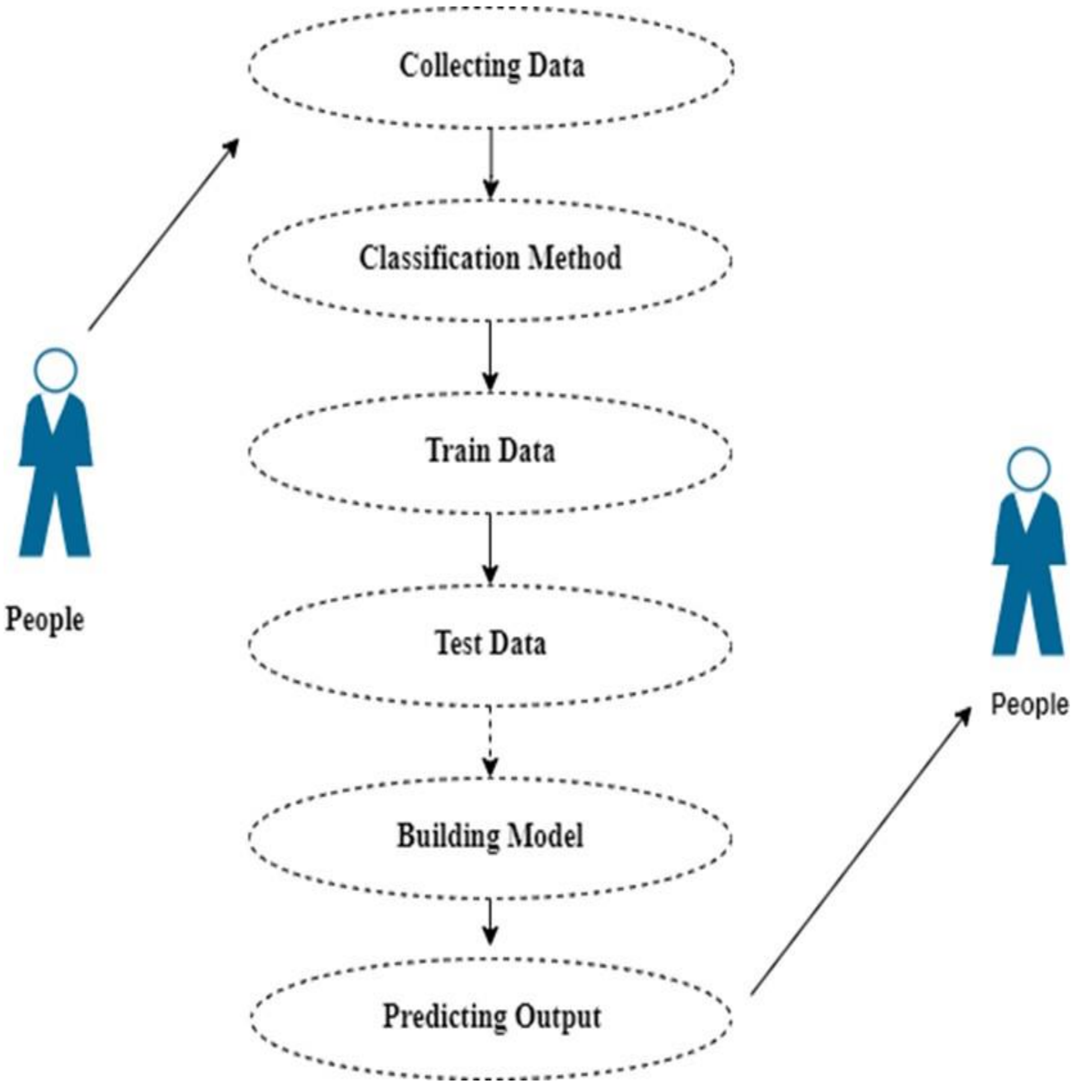
As a data scientist, I want to monitor the performance of the machine learning model used for risk prediction to ensure its accuracy and effectiveness.

Acceptance criteria

The system provides metrics to evaluate model performance, such as accuracy, precision, and recall. Data scientists can access and analyze historical model performance data to identify trends and potential degradation.

USE CASE DIAGRAM

EX.NO:4 **DATE:19-03-2024**



Use case diagrams are considered for high level requirement analysis of a system. So when the requirements of a system are analysed 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.

Non-Functional Requirement(NFR)

EX.NO:5 **DATE:29-03-2024**

1. **Performance:** The dashboard should be responsive and provide quick access to data and insights, even when handling large volumes of Patient data. It should be optimized for efficient data retrieval, processing, and visualization, ensuring minimal latency and fast response times.

2. **Scalability:** The dashboard should be scalable to accommodate increasing user loads and growing volumes of Patient data over time. It should be capable of handling concurrent user interactions and large datasets without experiencing performance degradation or downtime.

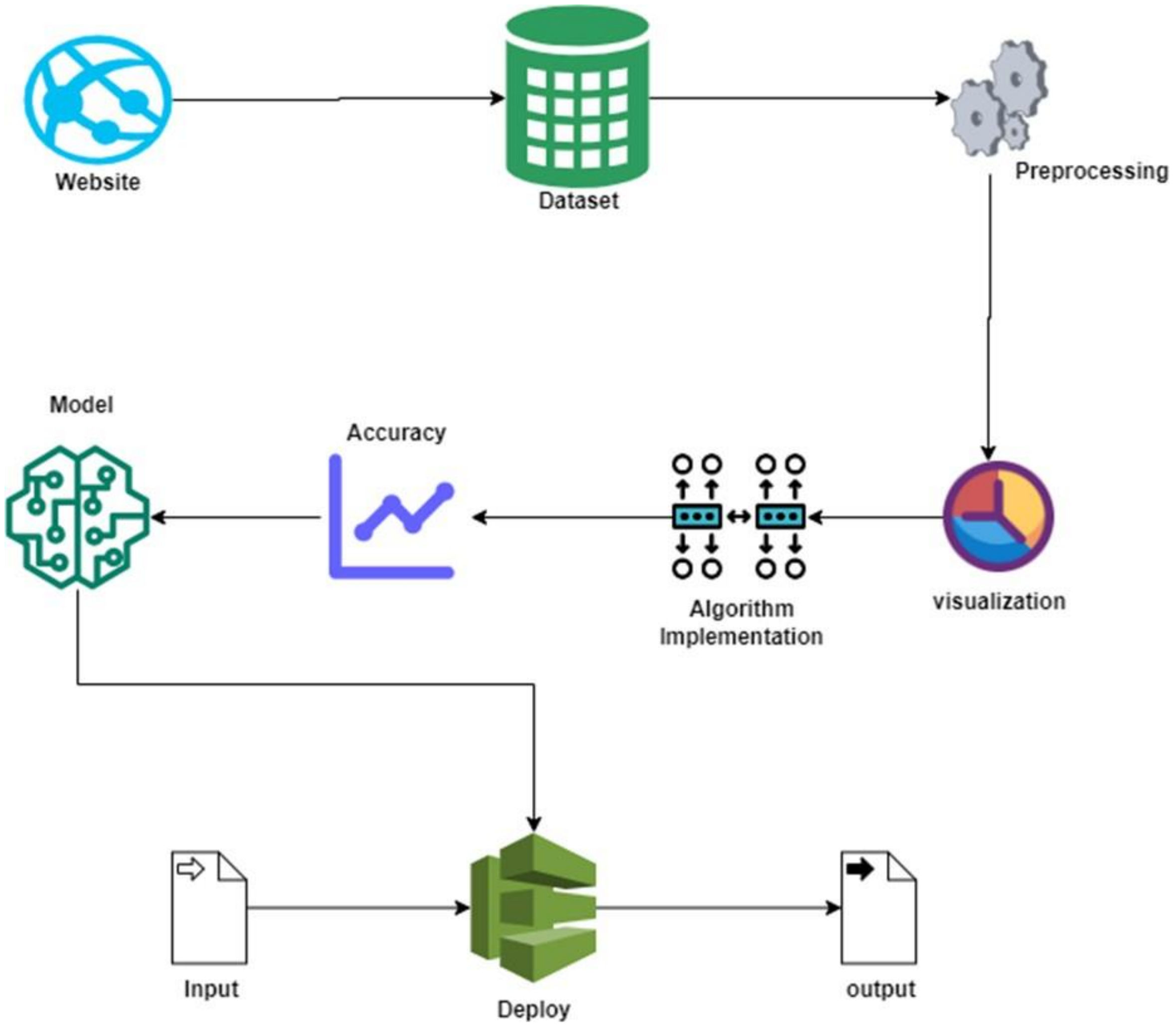
3. **Security:** The dashboard should enforce robust security measures to protect sensitive user data, including Patient credentials, analytics results, and user preferences. It should implement authentication, authorization, and encryption mechanisms to ensure data privacy, prevent unauthorized access, and mitigate security risks such as data breaches or cyber-attacks.

4. **Reliability:** The dashboard should be highly reliable and available, ensuring uninterrupted access to Patient data analytics functionalities for users. It should be resilient to failures and errors, with built-in mechanisms for error handling, fault tolerance, and disaster recovery to minimize service disruptions and data loss.

5. **Usability:** The dashboard should be user-friendly and intuitive, catering to the needs of both novice and experienced users. It should have a well- designed user interface with intuitive navigation, interactive visualizations, and customizable dashboards to enhance user experience and facilitate efficient data exploration, analysis, and decision-making.

OVERALL PROJECT ARCHITECTURE

EX.NO:6 **DATE:09-04-2024**



Data Source: This block likely refers to the real-time data that is collected from ICU patients. This data could include vital signs, lab test results, medication administration records, and physician’s notes.

Preprocessing: This stage refers to cleaning and preparing the data for use in the machine learning model. This may involve handling missing values, outliers, and scaling the data.

Model: This is the heart of the system. The machine learning model is trained on labeled data to learn how to identify patterns that are associated with patient risk. There are various supervised learning algorithms that can be used for this purpose, such as logistic regression, random forests, and gradient boosting.

Algorithm: This refers to the specific supervised learning model that is chosen to predict patient risk.

Implementation: This involves coding the machine learning model and integrating it into the overall system.

Visualization: This refers to the creation of data visualizations that can be used to understand the model's output and communicate risk to medical professionals.

Output: This refers to the risk score that is generated by the model. This score can be used to alert medical professionals to patients who are at high risk of complications.

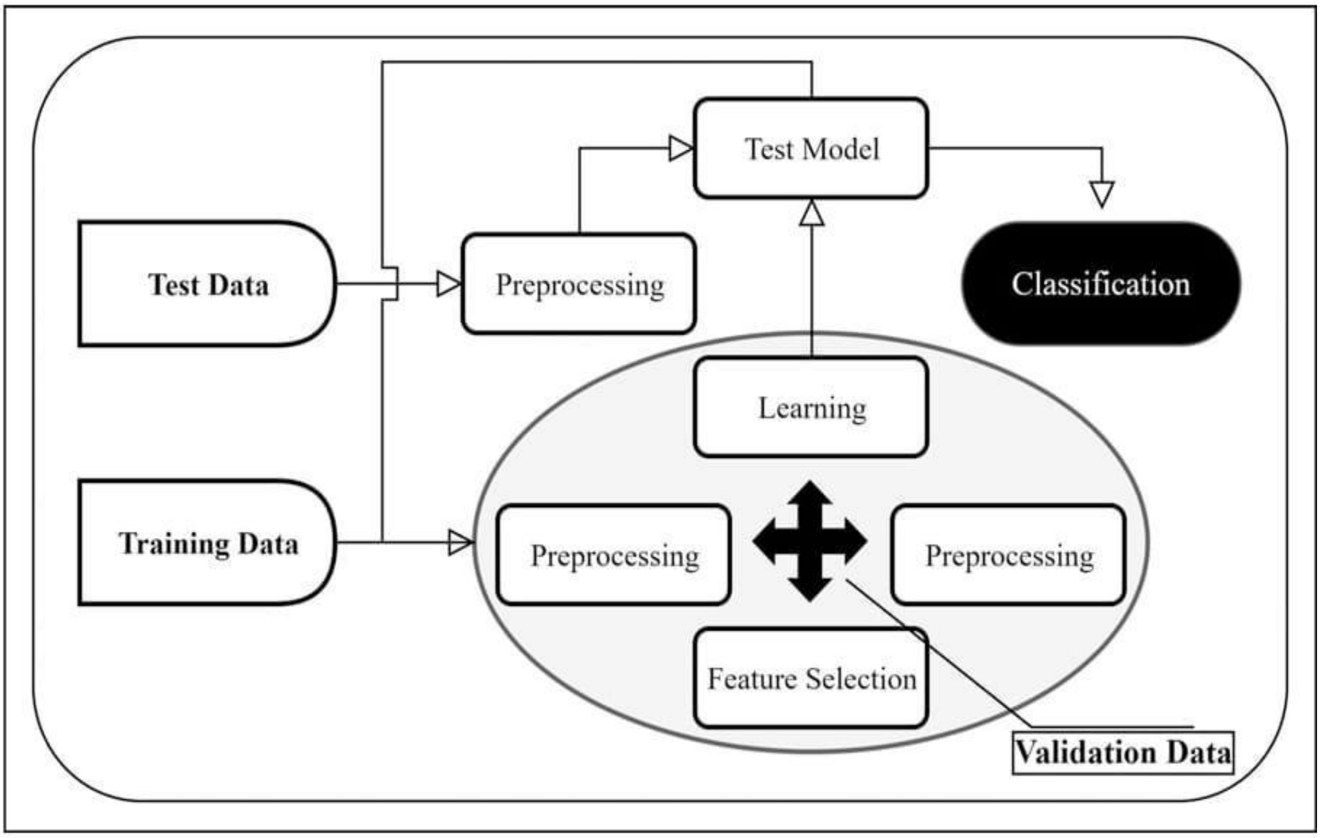
Improved accuracy: Supervised learning models can learn from large amounts of data to identify complex patterns that may be difficult for humans to detect. This can lead to more accurate risk assessments than traditional methods.

Early warning: By identifying patients at risk of complications early on, medical professionals can intervene sooner and potentially prevent those complications from occurring.

Better resource allocation : By focusing resources on high-risk patients, ICU staff can provide more efficient and effective care.

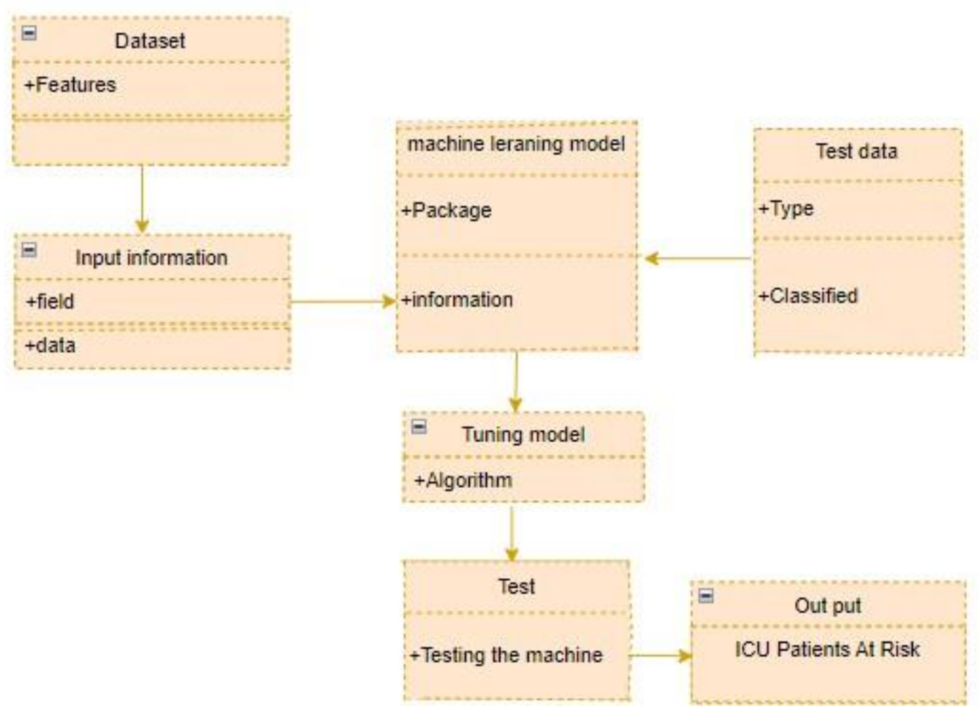
BUSINESS ARCHITECTURE

EX.NO:7 **DATE:19-04-2024**



CLASS DIAGRAM

EX.NO:8 **DATE:30-04-2024**

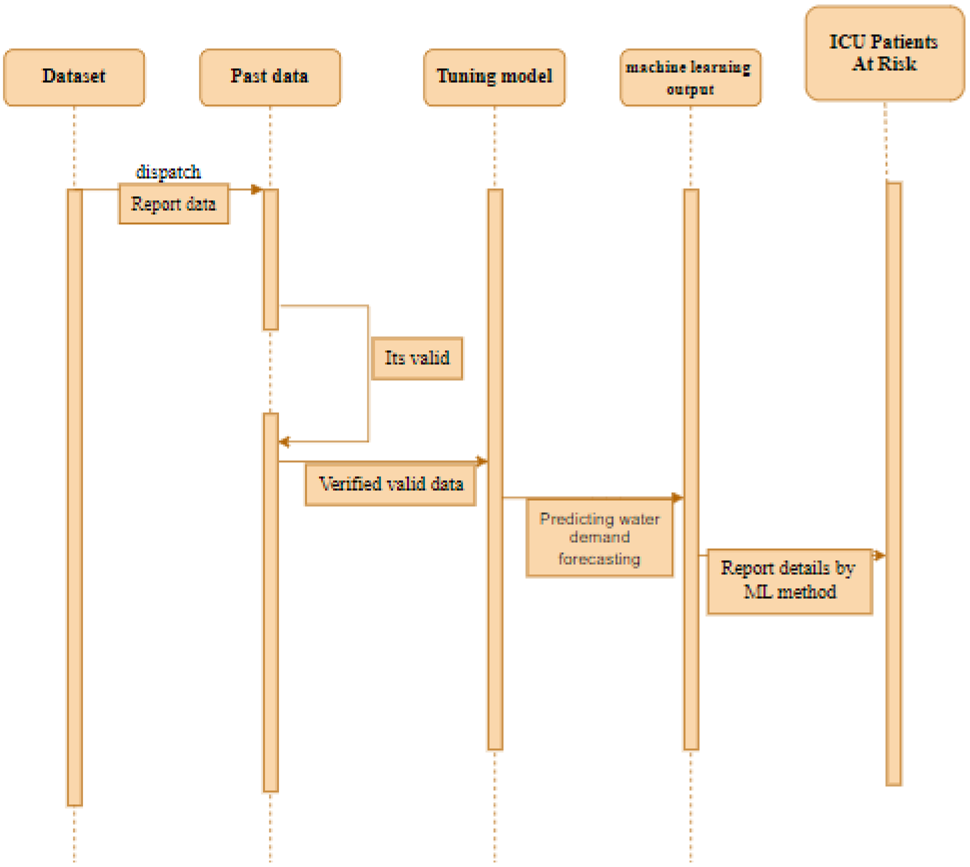


Class Diagram Overview:

Class diagram is basically a graphical representation of the static view of system and represents different aspects of the application. So a collection of class diagrams represents the whole system. 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 Responsibility of each class should be clearly identified for each class minimum number of properties should be specified and because unnecessary properties will make the diagram complicated. Use notes whenever required to describe some aspect of the diagram and at the end of the drawing it should be understandable to the developer/coder. Finally, before making the final version, the diagram should be drawn on plain paper and rework as many times as possible to make it correct.

SEQUENCE DIAGRAM

EX.NO:9 **DATE:10-05-2024**



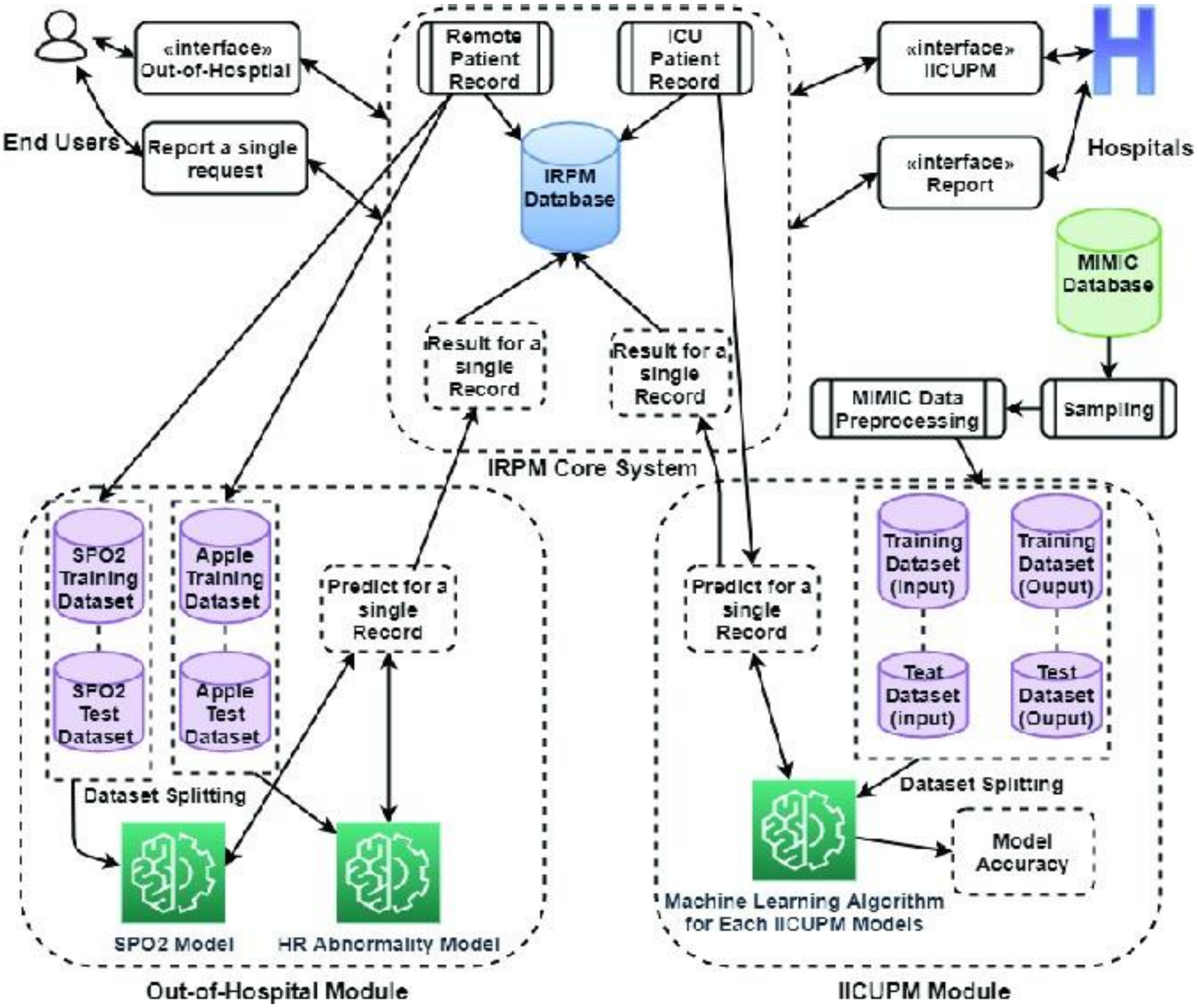
Sequence Diagram Overview:

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 behavior within your system. Other dynamic modelling techniques include activity_diagramming, communication_diagramming, timing__diagramming, and interaction overview diagramming. Sequence diagrams, along with class diagrams and physical_data_models are in my opinion the most important design-level models for modern business application development.

ARCHITECTURAL PATTERNS

EX.NO.10 DATE:17-05-2024

MODEL VIEW CONTROLLER ARCHITECTURE:



MODEL

Data Source Layer:

- Electronic Health Records (EHR) System
- Patient Monitoring Devices
- Clinical Laboratory Systems

Data Acquisition and Preprocessing Layer:

- **Data Ingestion Module:** This module, aligned with the Data Pipeline Pattern, gathers data from various sources like EHR systems, patient monitoring devices, and clinical laboratory systems using tools like Apache Kafka or Flume.
- **Data Cleaning Module:** This module ensures data quality by addressing missing values, outliers, and inconsistencies.
- **Feature Engineering Module:** This module, aligned with the Feature Store Pattern, transforms raw data into features suitable for machine learning models. This may involve creating new features based on existing data or selecting relevant subsets of data.

Machine Learning Layer:

- **Model Training Module:** This module trains a supervised machine learning model on the preprocessed data. The model is trained to predict patient risk levels based on various factors like demographics, vital signs, laboratory test results, and historical diagnoses.
- **Model Scoring Module:**This module applies the trained model tonew patient data to generate real-time risk scores. This aligns with the Model Serving Pattern, where the trained model is deployed and managed for production use.

Risk Stratification and Alerting Layer:

- **Risk Score Generation Module:** This module translates the model's output into a risk level (e.g., low, medium, high).
- **Alerting Engine:** This module generates alerts for healthcare providers based on predefined thresholds for risk levels. These alerts can be directed to clinicians or caregivers through various channels like the clinician dashboardor mobile notifications.

User Interface Layer:

- **Clinician Dashboard:** This provides a comprehensive view of patient data, risk scores, and trends over time. Clinicians can use this information to make informed decisions about patient care.
- **Caregiver Portal (optional):** This can provide limited access to patient data and risk score for authorized caregivers allowing them to stay informed about their loved one's condition.

Business Process Layer:

- **Patient Admission Process:** This incorporates initial data collection and risk assessment to determine the appropriate level of care.
- **Risk Level Monitoring Process:** This process continuously monitors patient data and generates alerts based on changes in risk scores, aligning with the Event-Driven Architecture Pattern. This allows for early intervention and improved patient outcomes.
- **Intervention Plan Management Process:** This facilitates the development and implementation of personalized care plan based on the patient's risk level and specific needs.