Utilizing Machine Learning for the Development of a Mobile Application and Web Extension for Predictive Mental Health Monitoring and Personalized Support

24-25J-293

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Research Problem

With the increasing reliance on digital technology, individuals' mental health is often influenced by their online interactions and behaviors. However, there is a lack of comprehensive tools that can accurately track and analyze these behaviors to provide timely and personalized mental health support.

Introduction to the project

- Develop a mobile application and web extension to track user behavior and patterns and support them to get ride of Depression and Anxiety.

Key Features:

- **Machine Learning Analysis:**
  - Analyzes digital interactions (emails, messages, social media, web searches, physical activities, songs, self-assessments, screen time) to assess mental health status.
- **Emotional State Assessment:**
  - Gauges emotional state based on behavior patterns.
- **Support Mechanism:**
  - Provides tailored support when mental health is not critical:
    - **Music**: Personalized playlists.
    - **Activities**: Engaging exercises.
    - **Meditation**: Guided sessions.

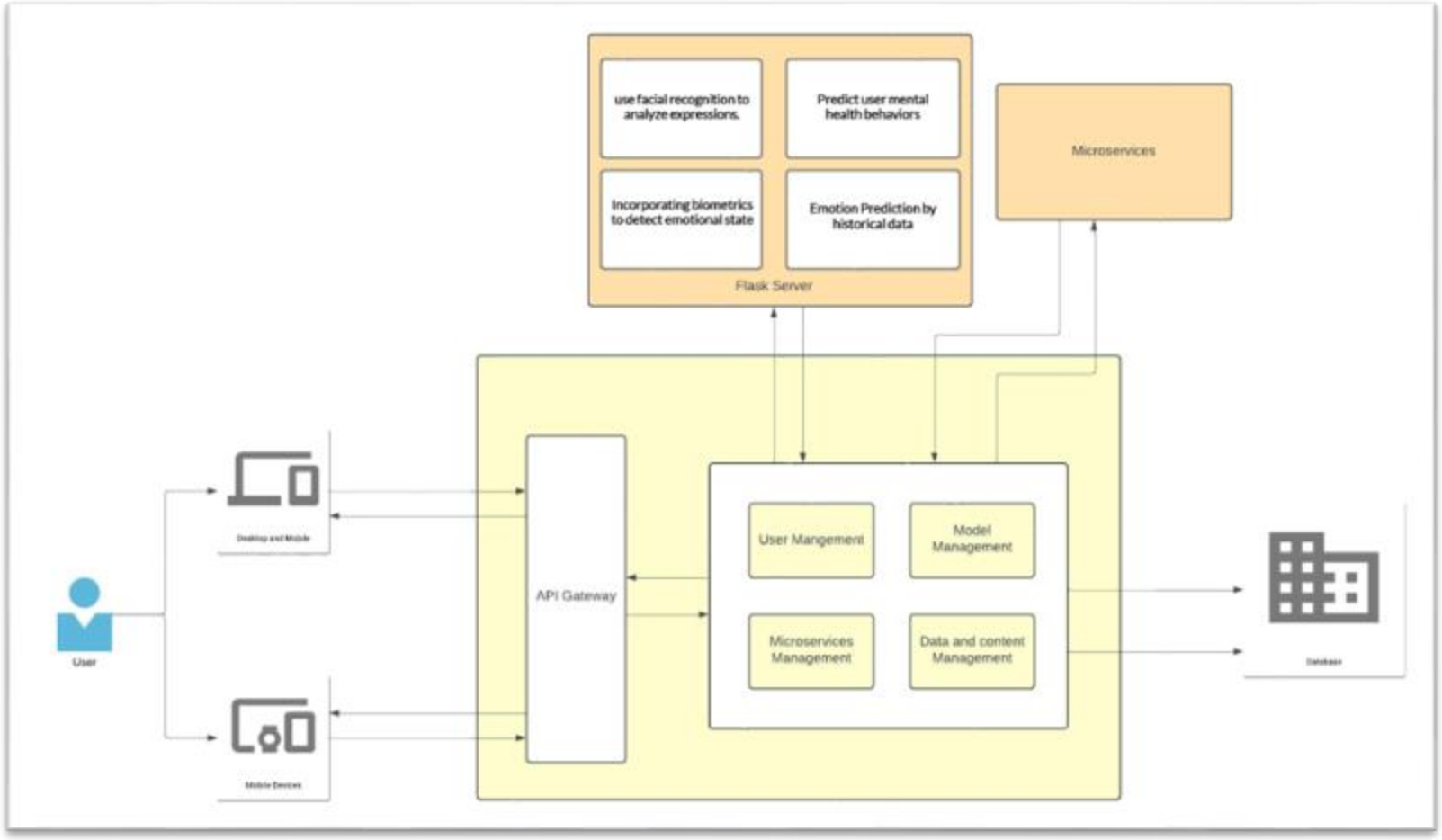
Goal:

- Manage stress and maintain a positive outlook for improved well-being.

Research Question

How can a mobile application and web extension effectively integrate analysis of digital interactions, emotion detection, physical data collection, and face recognition to provide personalized, real-time mental health support for users?

System Diagram



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Research Question

How can machine learning models be developed and integrated with a Gen AI-powered chatbot to accurately predict and analyze user mental health behaviors based on their web searches, social media posts, app usage, and online activities, while ensuring secure data handling and effective sentiment analysis?

Development of an Emotion/Mental Health Detection Machine Learning Model and Generative AI Chatbot for Personalized Mental Health Support in Critical Situations

- **Objectives**
  - ***Main Objective*** - Predict user mental health behaviors using machine learning by analyzing web searches, social media posts, app usage, and online activities, and create a chatbot to interact with users.
  - **Sub *Objective*** –
    - *Develop Models to detect user mental health behaviors using* web searches, social media posts, app usage, and online activities.
    - Integrate Gen AI powered Chatbot to interact with Mobile App and do sentimental analysis to understand emotions.
    - Develop Mobile app to scrap user's screentime and App Usage.
    - Develop Web Extensions to scrape data of user's online activities and social media posts.
    - Integrate Microservices of Payment Gateway, Gen AI and Flask Server with main NodeJS server.
    - Do API Security Risk Analysis to protect data and prohibited unauthorized access.

Research GAP

Research Gap	Existing Products	Existing Research & Products	Identified Gap
Limited Scope of Data Sources	**Moodpath, Sanvello, Unimate**	Rely on self-reports and mood tracking.	Lack of integration of diverse online behavior data (web searches, social media, app usage).
Contextual Understanding & Multimodal Data	**Wysa, Woebot**	Focus on text-based interactions without considering context	Need for integration of multimodal data (ScreenTime, Web Searches, Post Analysis) and contextual understanding.
Personalization of Models	**Moodpath, Sanvello**	Offer generalized insights without deep personalization.	Need for personalized models that account for individual differences in behavior and baseline mental health.

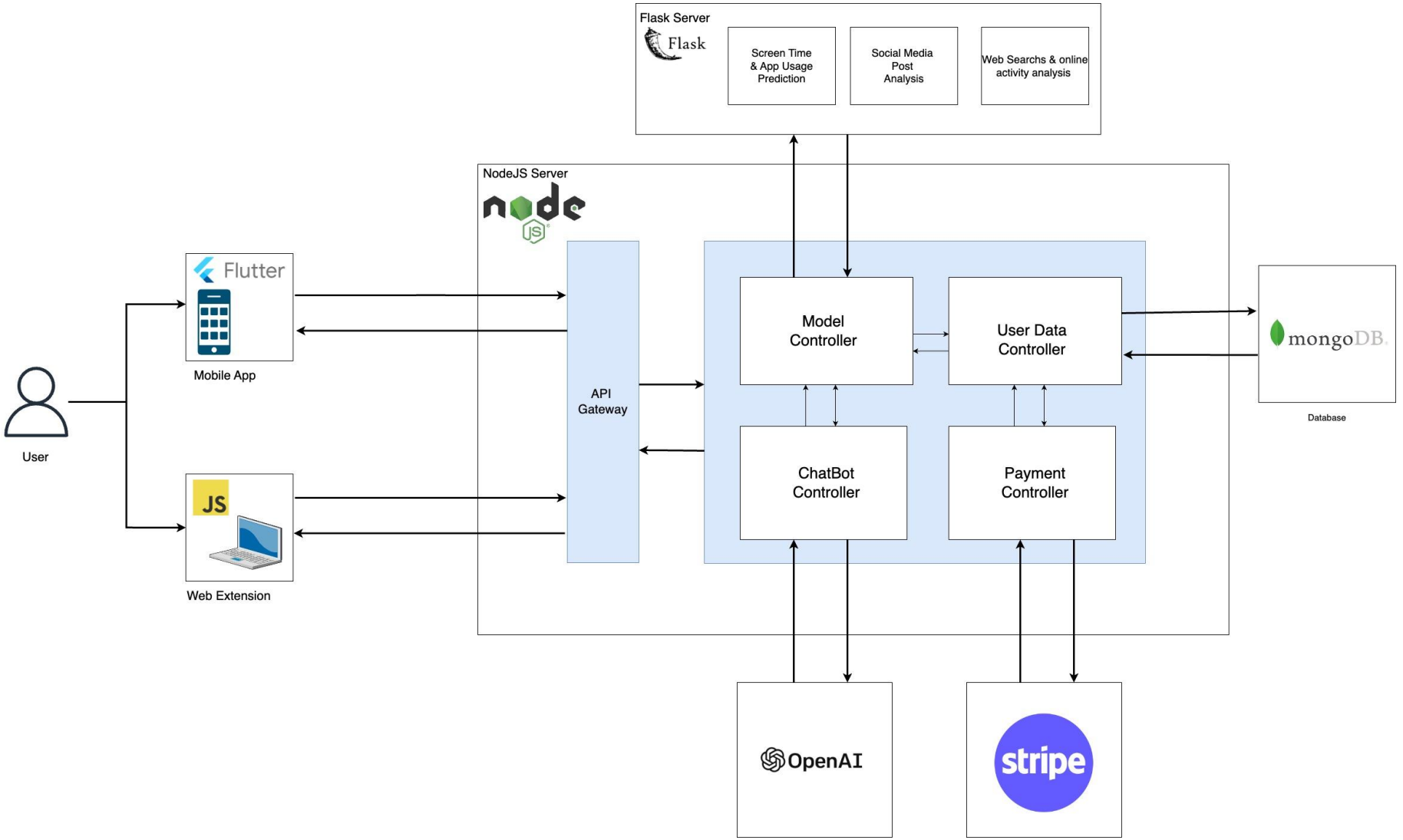
Research Requirements

Functional	Non Functional
User Data Collection and Analysis	Performance
Predictive Modeling	Performance
Chatbot Integration	Usability
Web Extension	Security
Microservices Integration (Stripe/OpenAPI)	Scalability
API Security	Legal and Ethical Compliance
User Profiling and Personalization	
Notification and Alerts	

Tools & Technology

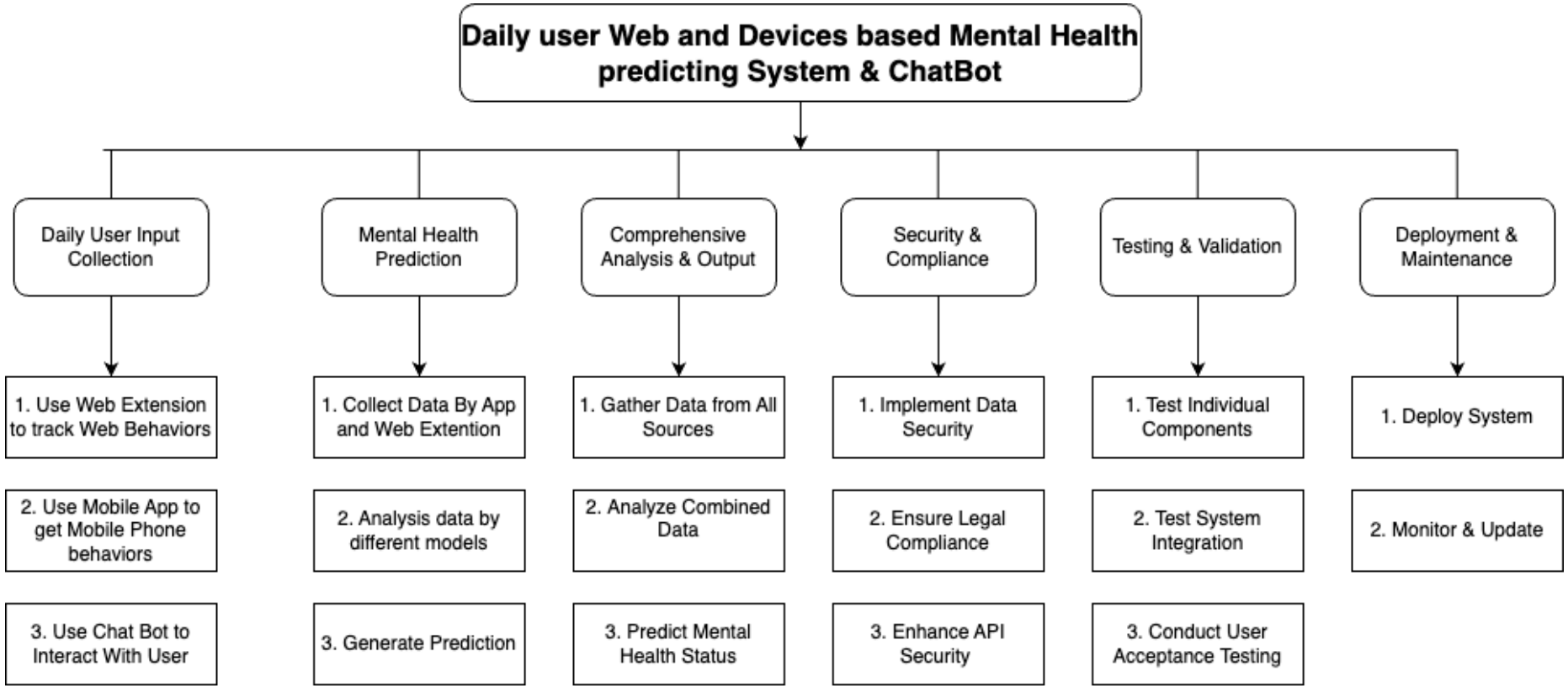
- **Model Development :** Scikit-Learn and TensorFlow
- **Mobile App:** Flutter
- **Web Extension**: Java Script
- **Backend:** Nodejs, Flask Server
- **Database: MongoDB**
- **Payment Gateway :** Stripe

System Architecture Diagram



Model Development

System Work Breakdown Structure Diagram



Completion of the project

- “Measuring Post Traumatic Stress Disorder in Twitter”, Glen Coppersmith, Mark Dredze, Craig Harman. 2014
- “Predicting Anxiety and Depression using Mobile Phone Behavioral Usage Data”, 2017
- “Characterizing Depression in College Students with Social Media Data”, 2017
- using Smartphones for Behavioral Monitoring of Depression

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Daily user emotion Data Collection, Voice, and Data Integration Mental Health System

Introduction and background

- This project introduces a system that leverages AI to continuously monitor and manage mental health by integrating routine data collection, voice analysis, and multi-source data integration. The goal is to provide personalized, real-time insights and proactive support to improve overall mental well-being.
- Advances in AI and ML have enabled new methods for mental health monitoring, such as voice analysis and data integration from wearables. However, these technologies often operate in isolation, leading to incomplete assessments. This system bridges that gap by combining various data sources and analyzing them with ML algorithms to predict mental health risks and offer timely, personalized interventions.

Research problem

- The project aims to develop an AI-based system that integrates multiple data sources such as voice recognition, facial expressions, heart rate, user inputs, internet history, and keyboard inputs to provide a comprehensive, real-time assessment of an individual's mental health.
- Current mental health apps often focus on isolated data points, leaving a gap in holistic and predictive mental health monitoring.
- This research seeks to address challenges related to data integration, real-time analysis, personalization, and accuracy, with the goal of offering proactive interventions and customized support to users.

Research gap

- **Limited Integration:** The research papers generally focus on specific aspects of mental health or voice recognition but do not effectively integrate multiple data streams like facial recognition, keyboard inputs, and daily user interactions.
- **Real-Time Analysis:** Few studies emphasize real-time mental health monitoring and assessment, which is crucial for timely intervention.
- **Holistic User Engagement:** The research lacks a comprehensive approach that engages users daily through direct inputs, which could lead to more accurate and personalized assessments.
- **Data Fusion Complexity:** There is a gap in how effectively data from various sources (like voice recognition, daily inputs, facial recognition, and keyboard history) can be fused into a single comprehensive assessment.

novelty

- **Comprehensive Data Integration**: Your function uniquely integrates diverse data sources, such as daily user inputs, voice recognition analysis, and outputs from other app functions (like facial recognition, keyboard inputs, and chat history), to provide a holistic assessment of the user's mental health state. This integration is more comprehensive than many existing apps, which often focus on isolated data points.

- **Adaptive and Proactive Support**: The integration of these features enables the system to not only assess the user's current state but also predict potential mental health issues before they escalate. This proactive approach to mental health monitoring and intervention is a significant advancement over traditional reactive methods.

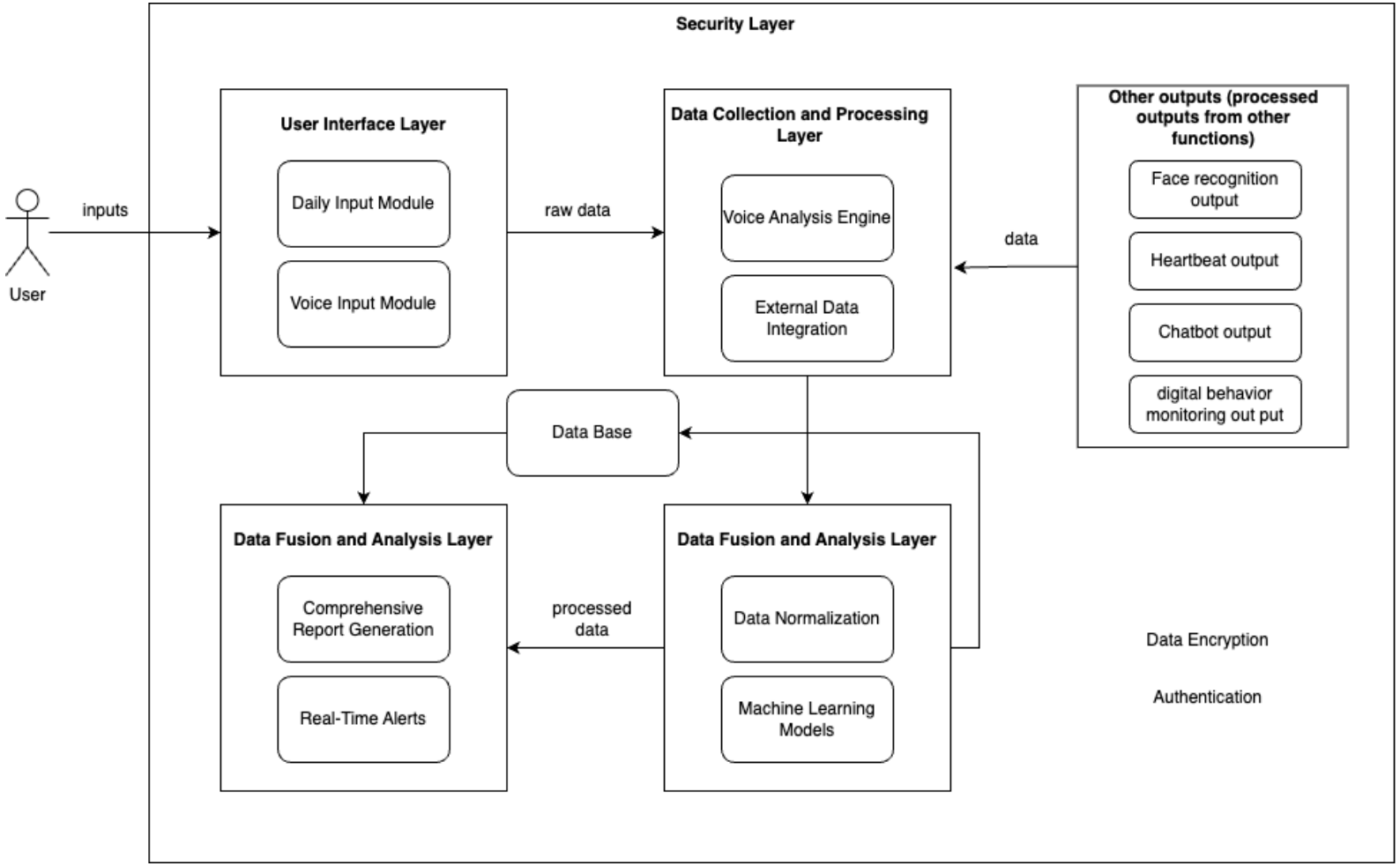
MAIN OBJECTIVE

- The primary objective of this function is to develop a comprehensive mental health assessment system that leverages daily user inputs, voice recognition, and integrated data from various sources including facial recognition and keyboard inputs to deliver real-time, personalized mental health insights and crisis predictions. This system aims to enhance the accuracy and timeliness of mental health monitoring, providing users with tailored support and interventions based on a holistic analysis of their behaviors and emotional states.

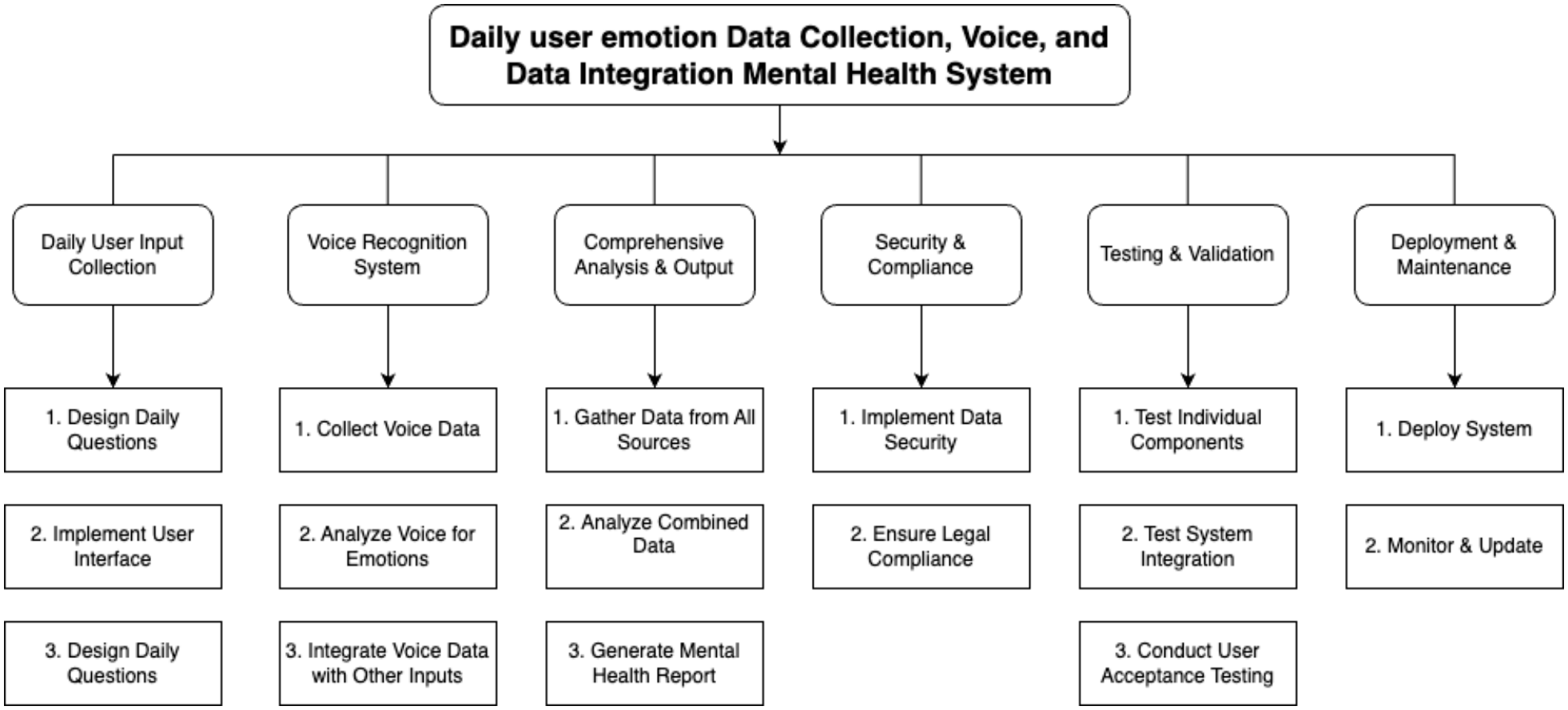
SUB OBJECTIVES

- ✓ **Comprehensive Analysis:** Integrate and analyze data from various sources, including routine inputs, voice, and behavioral data, to provide a thorough assessment of the user's mental health.
- ✓ **Daily User Emotion Input:** Implement a system for collecting and analyzing daily emotional inputs from users to track mood changes and detect patterns over time.
- ✓ **Voice Recognition Input:** Utilize voice analysis technology to assess emotional states and mental health conditions based on vocal patterns and features.
- ✓ **Addressing OWASP Top 10 Mobile Vulnerabilities:** Identify and mitigate selected five of the OWASP Top 10 mobile security vulnerabilities to ensure the system is secure and protects user data.
- ✓ **"Reverse Blue whale" therapeutical game**

System Diagram



Work Breakdown Structure



Tools & Technology

- **Voice Recognition Technology:**
  - **Libraries:** PyDub, Librosa for audio processing.
  - **Algorithms:** Support Vector Machine (SVM), Convolutional Neural Networks (CNN) for emotion recognition.
- **Daily User Input Interface:**
  - **Platform:** Flutter for mobile, React.js for web.
  - **Backend:** Node.js, Firebase for real-time database.
- **Data Integration and Analysis:**
  - **Tools:** TensorFlow, PyTorch for machine learning models.
  - **Database:** MongoDB for storing user inputs and outputs.
- **Comprehensive Output Generation:**
  - **Processing:** Pandas, NumPy for data processing.
  - **Visualization:** Matplotlib, Plotly for showing user insights.

Functional & Non Functional requirements

Functional requirements	Non Functional requirements
Daily User Input Collection	Performance
Voice Recognition	Scalability
Data Integration	Security
Comprehensive Analysis	Usability
Real-Time Insights	Reliability
User Feedback Loop	Accuracy
	Compliance

User Requirements

- Daily Emotion Check-in
- Real-time Feedback and Alerts
- Personalized Intervention Suggestions
- Data Privacy and Security
- User-friendly Interface
- Support for Multiple Devices
- Customization of Daily Questions
- Emergency Contact Notification

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4. "Speech Emotion Recognition using Supervised Deep Recurrent System for Mental Health Monitoring", DOI: 10.1109/WF-IOT54382.2022.10152117 , Nelly Elsayed

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Information Technology

FACIAL RECOGNITION AND MUSIC THERAPY TO ENHANCE MENTAL WELL-BEING

Research Gap

- Existing methods of music therapy often rely on generalized approaches without personalizing treatments.
- There is limited integration of technology in music therapy, specifically using solfeggio frequencies.
- Lack of real-time analysis of users' emotional states to guide therapy.
- Few solutions offer a comprehensive system that combines data from various sources (like voice recognition, daily inputs, facial recognition,biometrics and keyboard history) and provide therapeutic music.

FACIAL RECOGNITION TECHNOLOGY AND MUSIC THERAPY.

Main Objective

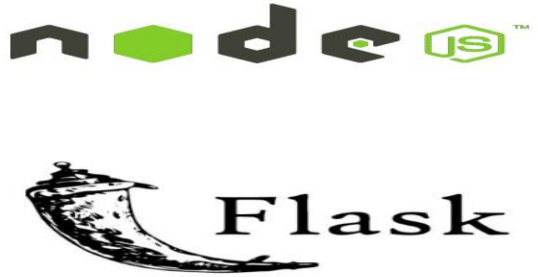
- Develop a mobile application that uses facial recognition to assess users' emotional states and provides personalized music therapy using solfeggio frequencies to enhance mental well-being.

Functional & Non Functional requirements

Functional requirements	Non Functional requirements
Other Data Input Collection	Performance
Facial Recognition	Scalability
Data Integration	Security
Comprehensive Analysis	Usability
Real-Time Insights	Reliability
User Feedback Loop	Accuracy
Integrating solfeggio frequencies into music	Compliance

Tools & Technology

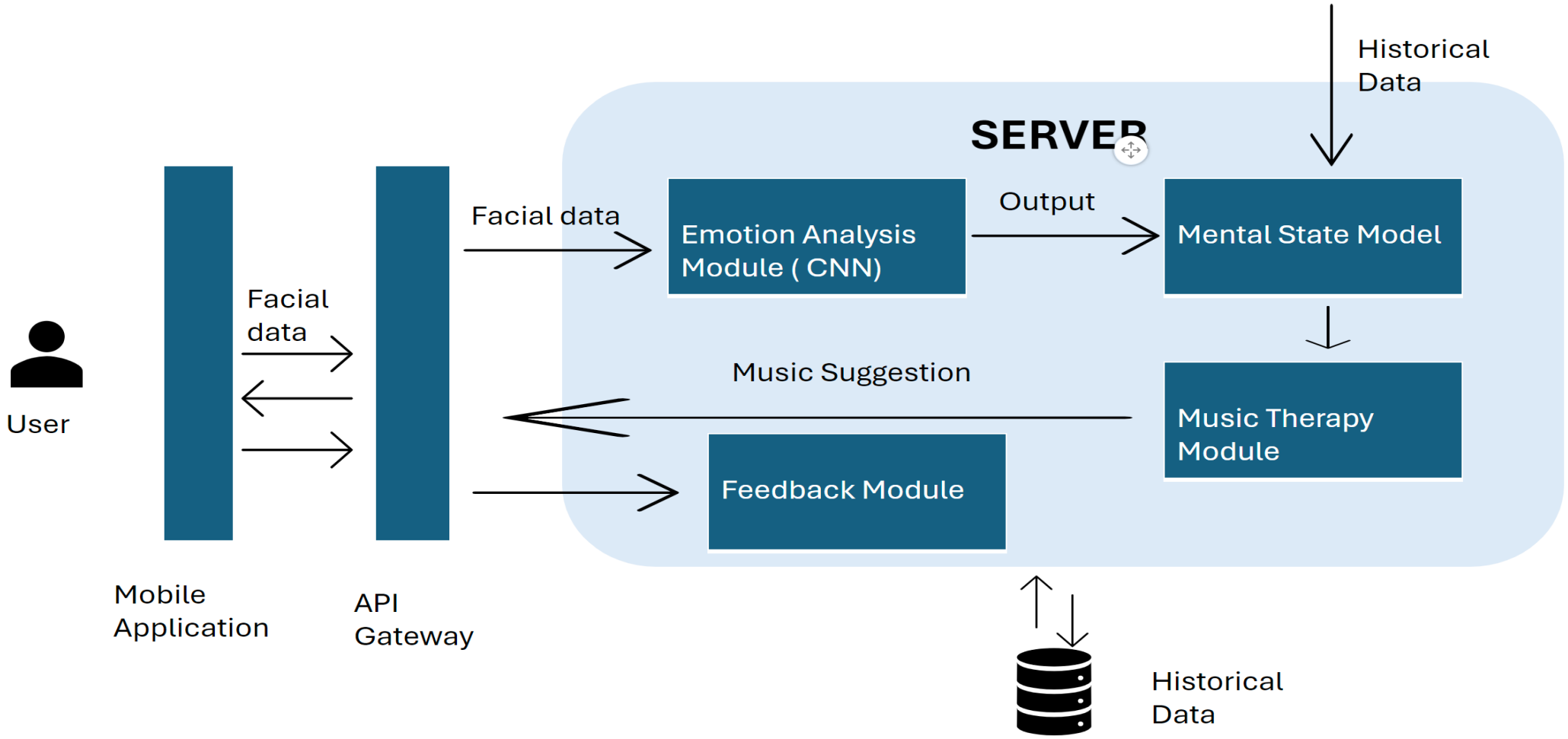
- **Libraries –** OpenCV,PyTorch,Scikit-learn,Pandas,Matplotlib,Solfeggio frequencies library, Tensoflow
- **Algorithms -** Convolutional Neural Networks (CNN),Attention Mechanisms,Reinforcement Learning.
- **App Development:** Cross platform.
- **Frontend:** Flutter
- **Backend:** Nodejs, Flask
- **Database:** MongoDB



Methodology

- **Step 1:** Capture facial expressions using the camera.
- **Step 2:** Analyze expressions using machine learning algorithms to determine emotional state.
- **Step 3:** Select and play music tracks incorporating solfeggio frequencies that correspond to the identified emotional state.
- **Step 4:** Monitor user feedback to refine therapy sessions.

System Diagram



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- **EEG Signal Classification and Feature Extraction Methods Based on Deep Learning: A Review**, IEEE Xplore (2022)
- **Electroencephalography Signal Analysis and Classification Based on Deep Learning**, IEEE Xplore (2021)
- **An Adaptive Deep Belief Feature Learning Model for Cognitive Emotion Recognition**, IEEE Xplore(2022)
- **Emotion Recognition and Discrimination of Facial Expressions using Convolutional Neural Networks**, IEEE Xplore(2020)
- **Emotion Recognition from Facial Expression Using Deep Learning Techniques**, IEEE Xplore (2024)

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Information Technology

INCORPORATING BIOMETRICS TO DETECT EMOTIONAL STATE AND ENHANCE MENTAL HEALTH SUPPORT

INTRODUCTION AND BACKGROUND

- By integrating heart rate data into mobile applications, users can gain real-time insights into their emotional well-being.
- This function enables more accurate self-monitoring and personalized feedback, helping individuals understand and manage their emotional health more effectively.

RESEARCH GAP

- Current research lacks comprehensive studies on the accuracy of heart rate variability (HRV) as an indicator of emotional states across diverse populations and contexts. The variability in individual responses and the influence of external factors need further investigation to ensure reliable interpretations.
- As heart rate data can be sensitive, there is a need for further research into best practices for data privacy and ethical considerations. Ensuring that users' biometric information is protected and used responsibly is essential for building trust and compliance with regulations.

NOVELTY

- **Real-Time Emotional Insights:** Provides immediate, data-driven feedback on emotional states by analyzing heart rate variability, offering users actionable insights on their mental health.
- **Enhanced Self-Awareness:** Empowers users with a deeper understanding of their emotional triggers and patterns through continuous biometric monitoring, supporting proactive mental health management.

Research problem

- The research problem in integrating heart rate monitoring into mobile apps for emotional well-being revolves around several key challenges.
- These include determining the accuracy of heart rate variability (HRV) as a reliable indicator of emotional states and how to effectively interpret this data. Long-term efficacy of heart rate monitoring in managing emotional health and ensuring data privacy and security are also critical issues.
- Research must address how well this technology performs across diverse user populations, including various age groups and mental health conditions, to ensure broad applicability and effectiveness

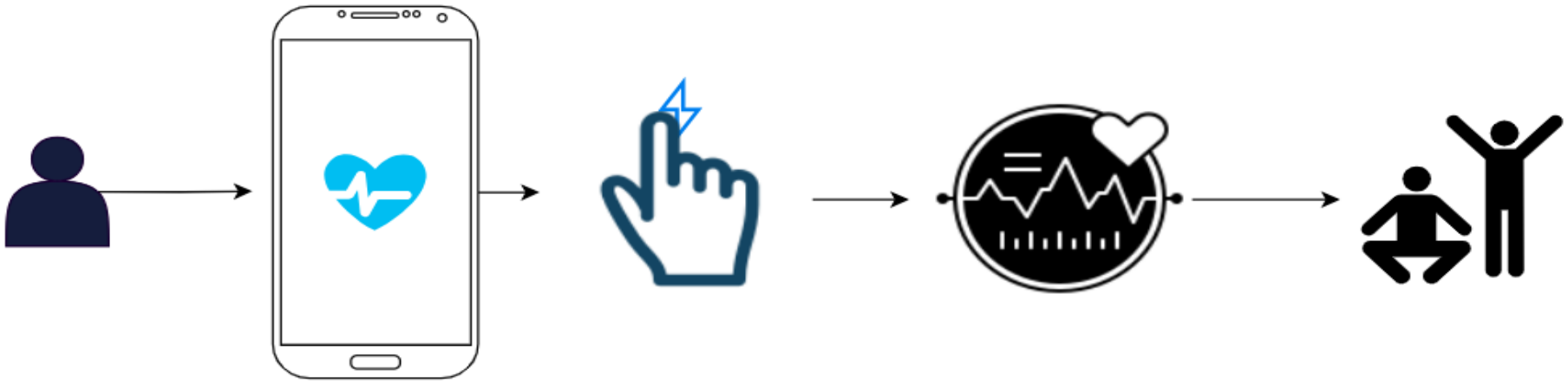
MAIN OBJECTIVE

- Build an app integrating heart rate monitoring for emotional well-being is **real-time emotional insight based on heart rate variability (HRV).** This feature continuously tracks and analyzes users' heart rate data to provide **immediate feedback** on their emotional states. By assessing fluctuations in HRV, the app can offer actionable insights into users' stress levels, mood changes, and overall emotional health. This **real-time analysis** enables users to better understand their **emotional patterns** and make informed decisions about their mental well-being, fostering **proactive management and support.**

SUB OBJECTIVES

- ✓ **Validate Accuracy:** To evaluate the accuracy of heart rate variability (HRV) measurements in reflecting different emotional states, ensuring that the data accurately represents users' emotional well-being.
- ✓ **Assess Long-Term Impact:** To investigate the long-term effects of using heart rate monitoring for emotional self-management, measuring its impact on users' mental health and emotional resilience over extended periods.
- ✓ **Ensure Data Privacy and Security:** To establish robust protocols for protecting sensitive biometric data, ensuring compliance with data privacy regulations, and addressing ethical considerations in handling user information.
- ✓ **Evaluate Across Diverse Populations:** To assess the performance and effectiveness of heart rate monitoring technology across different demographics, including varying age groups, cultures, and mental health conditions, ensuring broad applicability and inclusivity.

Methodology



Step 1: Obtain the heart rate by using Photoplethysmography.

Step 2: Analyze the heart rate and using machine learning algorithms determine emotional state.

Step 3: By identifying the emotional state provide feedback and exercises to the user accordingly.

Step 4: Monitor user heart rate for future analysis.

Tools & Technology

- **Heart Rate:** Photoplethysmography (PPG)
- **Generate health support:** Machine learning algorithms
- **App Development:** Cross platform.
- **Frontend:** Flutter
- **Backend:** Nodejs, Flask
- **Database:**MongoDB

FUNCTIONAL REQUIREMENTS

Real-Time Heart Rate Monitoring and Analysis:

- **Functionality:** Continuously tracks and analyzes heart rate data using built-in sensors or connected wearable devices.
- **Purpose:** Provides real-time feedback on heart rate variability (HRV) to assess users' emotional states and detect stress or mood changes.

Emotional Insights and Feedback:

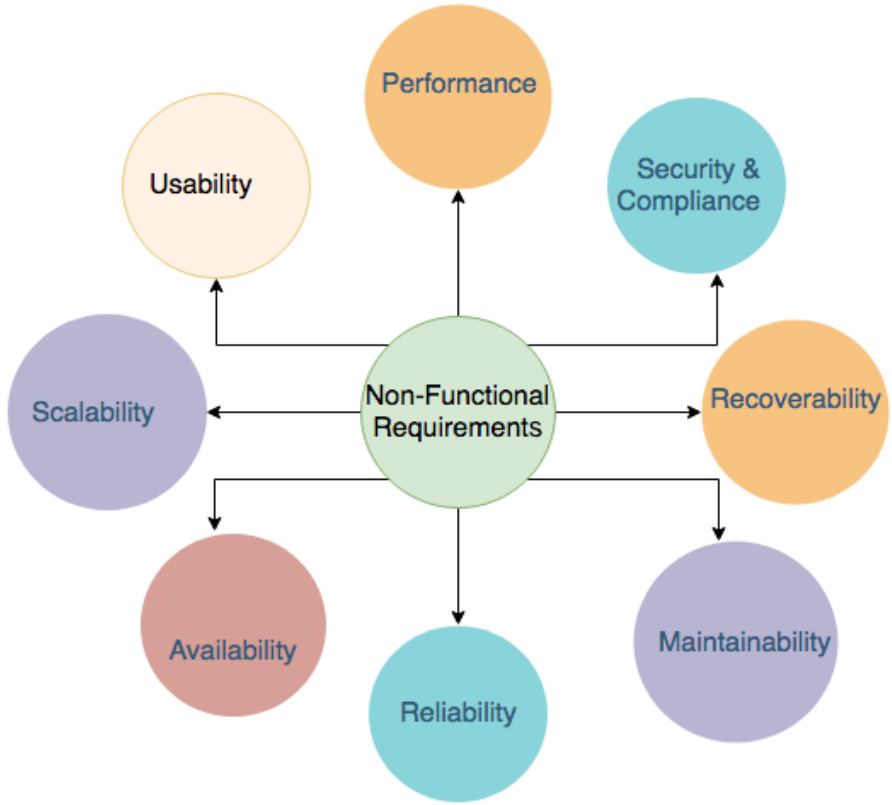
- **Functionality:** Translates heart rate data into actionable insights, such as mood tracking and stress level indicators, through data visualization (e.g., graphs, charts) and personalized recommendations.
- **Purpose:** Helps users understand their emotional patterns, manage their mental health proactively, and make informed decisions based on the feedback.

User Interaction and Self-Monitoring Tools:

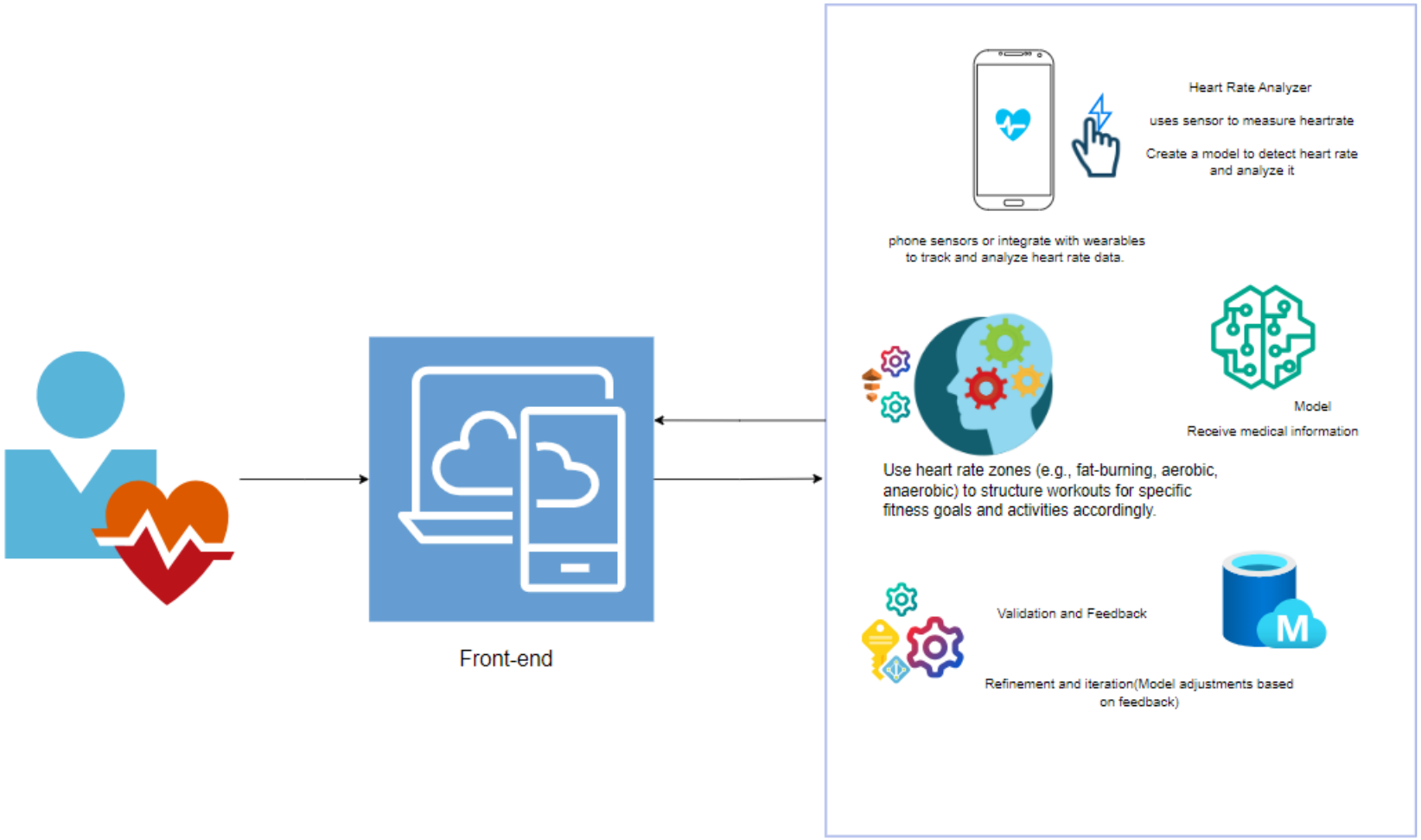
- **Functionality:** Includes features for users to log their emotions, set goals, track progress, and view historical data. It may also offer journaling options or integration with other mental health resources.
- **Purpose:** Facilitates self-monitoring, allows users to reflect on their emotional experiences over time, and supports personal growth and mental health management through interactive tools.

NON-FUNCTIONAL REQUIREMENTS

- ✓Performance
- ✓Reliability
- ✓Availability
- ✓Security
- ✓Scalability



System Architecture Diagram



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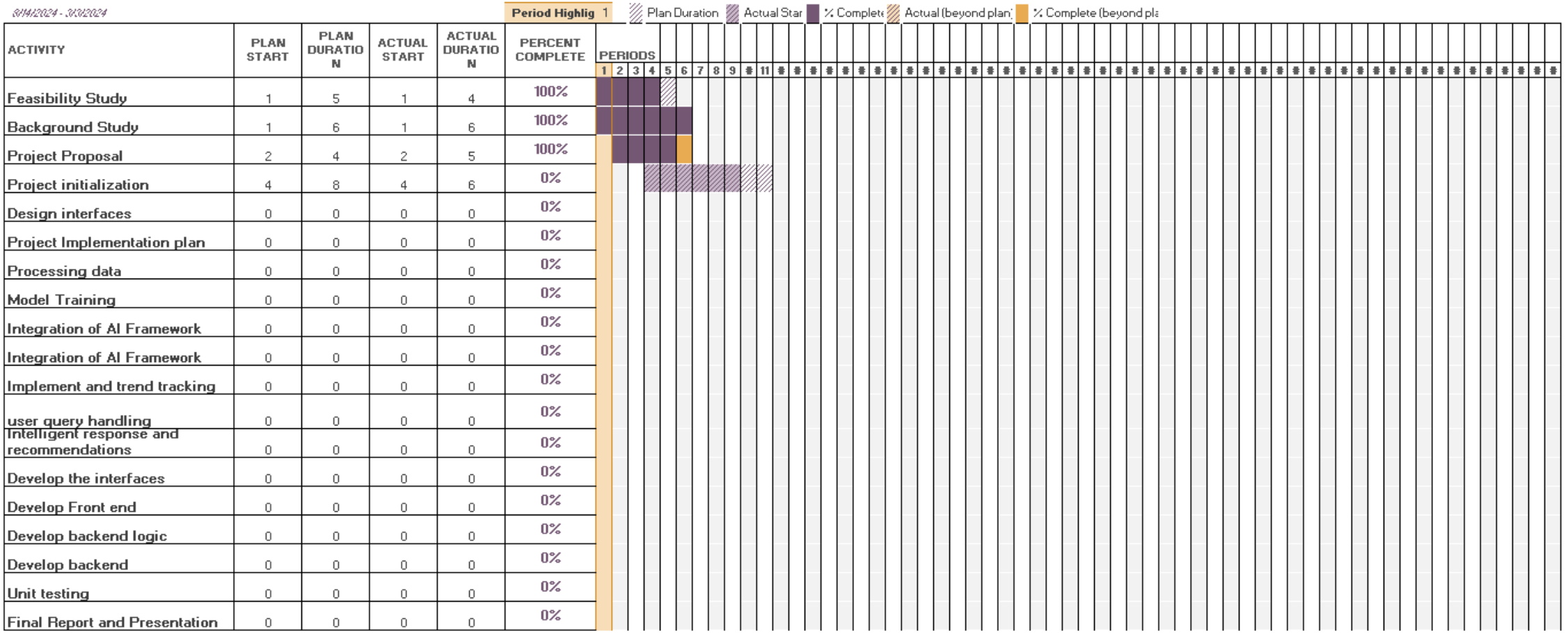
- ✓ Development of a Mobile Phone App to Support Self-Monitoring of Emotional Well-Being: A Mental Health Digital Innovation
- ✓ A meta-analysis on heart rate variability biofeedback and depressive symptoms

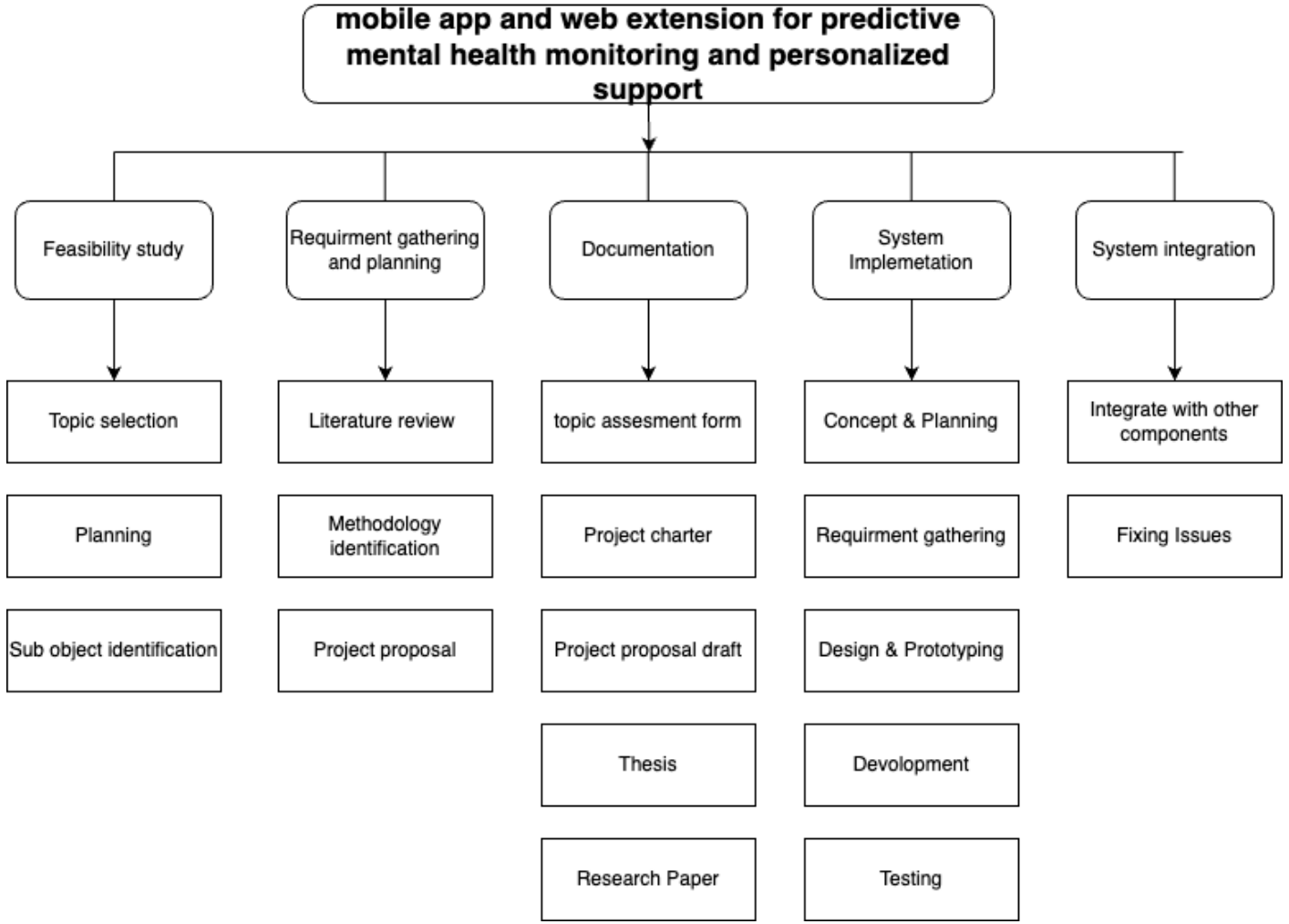
Gantt Chart

Utilizing Machine Learning for the Development of a Mobile Application and Web Extension for Predictive Mental Health Monitoring and Personalized Support



ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Feasibility Study	1	5	1	4	100%
Background Study	1	6	1	6	100%
Project Proposal	2	4	2	5	100%
Project initialization	4	8	4	6	0%
Design interfaces	0	0	0	0	0%
Project Implementation plan	0	0	0	0	0%
Processing data	0	0	0	0	0%
Model Training	0	0	0	0	0%
Integration of AI Framework	0	0	0	0	0%
Integration of AI Framework	0	0	0	0	0%
Implement and trend tracking	0	0	0	0	0%
user query handling	0	0	0	0	0%
Intelligent response and recommendations	0	0	0	0	0%
Develop the interfaces	0	0	0	0	0%
Develop Front end	0	0	0	0	0%
Develop backend logic	0	0	0	0	0%
Develop backend	0	0	0	0	0%
Unit testing	0	0	0	0	0%
Final Report and Presentation	0	0	0	0	0%

Work Breakdown Structure



Commercialization

- $9.99 dollars per month for a Pro version (Subscription Model).

Features	Free	Pro
Advertisements	Yes	No
Priority Support	No	Yes
Extended Historical Data	No(Short term)	Yes(Long Term)
Sync Among Devices	2 Devices	Unlimited

Thank you!

REFERENCES

Use IEEE referencing format