**REAL TIME RESEARCH PROJECT**

**On**

**DREAM WAVE-ADAPTIVE PERSONALIZED SLEEP IMPEOVEMENT THROUGH DATA DRIVEN INSIGHTS**

Submitted in partial fulfillment of the requirements for the award of the degree of

## BACHELOR OF TECHNOLOGY

**In**

## INFORMATION TECHNOLOGY

By

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## DEPARTMENT OF INFORMATION TECHNOLOGY

## MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (A)

**(Affiliated to JNTUH, Hyderabad; Eight UG Programs Accredited by NBA;**

**Accredited by NAACwith‘A++’ Grade)**

**Kokapet (Village), Gandipet, Chaitanya Bharathi (P.O.),**

**Ranga Reddy Dist, HYDERABAD –50075,TELANGANA**

**2024-2025**

# CERTIFICATE

This is to certify that the **Real Time Research Project** entitled **“dream wave-adaptive personalized sleep impeovement through data driven insights”** submitted by AKSHITHA SIVAKUMAR(23261A1204), RISHWAN REDDY (23261A1211), JANGAM SAI SREE(23261A1222)in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Information Technology as specialization is a record of the bonafide work carried out under the supervision of **Dr. Premkumar Chithaluru, assistant proffesor** , and this has not been submitted by another University or Institute for the award of any degree ordiploma.

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# DECLARATION

We here by declare that the **REAL TIME RESEARCH PROJECT** entitled **“DREAM WAVE -ADAPTIVE PERSONALIZED SLEEP IMPROVEMENT THROUGH DATA DRIVAN INSIGHTS“**is original and bonafide work carried out by us as a part of fulfillment of Bachelor of Technology in Information Technology, Mahatma Gandhi Institute of Technology , Hyderabad, under the guidance of **Mrs. Ch. Sudha, Assistant Professor, Dept.of IT, MGIT.**

No part of the work is copied from books/journals/internet and wherever the portion is taken the same has been duly referred in the text. The report is based on the work done entirely by us and not copied from any other source.

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# ABSTRACT

The focus areas are sleep quality improvement and sleep disorder management, which are critical to overall health and well-being. The problem arises as many individuals suffer from irregular sleep patterns, stress-induced insomnia, and difficulty maintaining a consistent sleep schedule due to factors such as lifestyle habits, emotional fluctuations, and environmental influences. Traditional sleep management solutions often provide generic recommendations that fail to address individual needs, leading to persistent sleep disturbances, weakened immunity, cognitive decline, and increased risks of chronic illnesses.

The proposed work, DreamWave, is a recommendation system that applies cybernetic health principles to offer personalized guidance based on user data, including lifestyle, stress levels, and mood changes. By continuously learning from user behavior, Dream-Wave refines its recommendations over time, providing tailored interventions such as routine adjustments, stress management techniques, and mindfulness practices to improve sleep quality and overall well-being.

**Keywords**: Sleep quality,sleep disorders,personalized recommendations,cybernetic health,adaptive learning

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**LIST OF TABLES**

|  |  |  |
| --- | --- | --- |
| **S.No** | **Table Name** | **Page No.** |
| 1 |  |  |
| 2 |  |  |

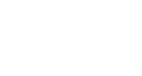
**LIST OF FIGURES**

|  |  |  |
| --- | --- | --- |
| **S.No** | **Figure Name** | **Page No.** |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |

# TABLE OF CONTENTS

# 

|  |  |  |
| --- | --- | --- |
| **CHAPTER**  **NO.** | **TITLE** | **PAGE**  **NO.** |
|  | Abstract | i |
|  | List of Tables | ii |
|  | List of Figures | iii |
| 1 | **INTRODUCTION** |  |
|  | 1.1 Introduction |  |
|  | 1.2 Problem Statement |  |
|  | 1.3 Existing System |  |
|  | 1.3.1 Limitations of Existing System |  |
|  | 1.4 Proposed System |  |
|  | 1.4.1 Advantages of Proposed System |  |
| 2 | **LITERATURE SURVEY** |  |
| 3 | **SYSTEM SPECIFICATIONS** |  |
|  | 3.1 Software Requirements |  |
|  | 3.2 Hardware Requirements |  |
| 4 | **SYSTEM DESIGN** |  |
|  | 4.1 Architecture |  |
|  | 4.2. Modules Description |  |
|  | 4.3. Steps to implement |  |
|  | 4.4 UML Diagrams |  |
|  | 4.4.1 Use Case Diagram |  |
|  | 4.4.2 Sequence Diagram |  |
|  | 4.4.3 Activity Diagram |  |
|  | 4.4.4 Class Diagram |  |
|  | 4.4.5 Component Diagram |  |
| **5** | **IMPLEMENTATION** |  |
|  | 5.1 Sample Code and Implementation Details |  |
| **6** | **RESULTS** |  |
| **7** | **TESTING** |  |
|  | 7.1 Introduction to Testing |  |
|  | 7.2 Types of Testing |  |
|  | 7.3 Test Cases |  |
|  | 7.1.1 |  |
|  | 7.1.2 |  |
| 8 | **CONCLUSION AND FUTUREWORK** |  |
|  | 8.1 Conclusion |  |
|  | 8.2 Future Work |  |
| 9 | **REFERENCES** |  |



# CHAPTER-1

# INTRODUCTION

Sleep plays a vital role in maintaining overall physical and mental health. However, in today’s fast-paced world, a growing number of individuals suffer from poor sleep quality and sleep disorders, which are closely linked to serious mental health conditions such as depression, anxiety, and psychosis. Recent studies have shown that dissociative symptoms are strongly associated with sleep and circadian rhythm disorders (SCRD), yet the exact role of these symptoms in the relationship between sleep disturbances and mental health remains underexplored.

This project introduces **DreamWave**, an intelligent recommendation system designed to monitor, analyze, and improve sleep quality using data-driven techniques. By applying cybernetic health principles, DreamWave collects and interprets personal user data—such as lifestyle habits, stress levels, mood fluctuations, and physiological indicators like heart rate—to generate personalized sleep improvement strategies. As it continues to learn from user behavior over time, the system dynamically refines its recommendations for enhanced effectiveness.

At the core of DreamWave’s recommendation engine is the **K-Nearest Neighbors (KNN)** algorithm, a machine learning technique used to identify patterns in user data and suggest tailored interventions. These interventions may include lifestyle adjustments, stress management techniques, or mindfulness practices—all aimed at improving sleep quality and reducing psychological distress. By modeling the relationship between sleep, dissociation, and mental health symptoms, DreamWave seeks to offer a low-cost, adaptive solution to support better sleep and mental well-being.

* 1. **Problem Statement**

Underlying the project is evidence that feelings of dissociation are strongly associated with sleep disorders and are a transdiagnostic risk factor for the development of depression, anxiety and psychosis. However, no one has investigated the role of dissociative symptoms in the links between SCRD (sleep and other circadian rhythm disorders) and MH (mental health). We propose to model how fluctuations in sleep and heart rate are related to fluctuations in dissociation, depression, anxiety and psychosis. Based on this understanding, our vision is to prevent the clinical course of these symptoms with low-cost interventions that improve sleep and heart rate

* 1. **Motivation**

**1.Personalized Sleep Recommendation System:**

DreamWave uses the K-Nearest Neighbors (KNN) algorithm to analyze individual user data such as sleep patterns, lifestyle habits, stress levels, and mood changes. Based on this analysis, it provides personalized recommendations aimed at improving sleep quality and overall well-being.

**2.Mental Health Modeling:**

By identifying relationships between fluctuations in sleep, heart rate, and psychological states (like dissociation, anxiety, depression, and psychosis), DreamWave helps uncover patterns that may signal the early onset of mental health issues. This enables early intervention and potentially prevents symptom escalation.

**3.Adaptive Learning System:**

DreamWave continuously learns from ongoing user behavior. As users interact with the system, it refines and updates its suggestions in real-time, improving accuracy and effectiveness of the guidance over time—similar to how recommendation engines work in platforms like Netflix or Spotify, but for health.

**4.Low-Cost and Scalable Solution:**

Unlike expensive medical equipment or clinical interventions, DreamWave is designed to be a cost-effective and accessible solution for the general population. It uses common digital inputs like smartphone data, wearable sensors (heart rate), and mood trackers to operate efficiently.

**5.Integration of Cybernetic Health Principles:**

DreamWave applies cybernetic feedback loops—where it measures, adjusts, and optimizes user routines based on real-world feedback. This principle ensures that the system adapts to each user's changing needs and environmental factors, promoting consistent and sustainable sleep improvements.

* 1. **Objective**
     1. **Objectives of the Proposes System**

1. To enhance sleep quality by offering personalized, AI-driven recommendations based on individual lifestyle and physiological data.
2. To utilize the K-Nearest Neighbors (KNN) algorithm for identifying patterns in user behavior, mood, stress levels, and heart rate to tailor sleep improvement strategies.
3. To help users rebalance their circadian rhythms through continuous monitoring and adaptive feedback mechanisms rooted in cybernetic health principles.
4. To model the connection between sleep patterns and mental health conditions such as anxiety, depression, dissociation, and psychosis for early detection.
5. To provide low-cost, scalable solutions that do not rely on expensive medical devices but instead use mobile and wearable data.
6. To refine recommendations over time by learning from user interactions and improving accuracy through adaptive machine learning.

7.To promote mental well-being and stress reduction by addressing the root causes of sleep disturbances and supporting long-term health.

* + 1. **Advantages of Proposed System**

**More Accurate & Personalized Insights:-**DreamWave uses the KNN algorithm to analyze user-specific data and deliver tailored recommendations. It continuously learns and adapts to user behavior, ensuring precision in sleep and wellness guidance.

**Real-Time, AI-Driven Adaptation:-**The system leverages AI to monitor user inputs and adjust suggesti

ons instantly.This ensures the guidance remains relevant as lifestyle, stress, or routines change over time.

**Effortless & Engaging User Input:-**Users provide simple inputs like sleep duration, mood, and daily

habits via a mobile interface. The intuitive design makes tracking seamless, encouraging consistent

and meaningful interaction.

**Holistic Sleep Management:-**DreamWave addresses not just sleep duration, but underlying factors like

stress, circadian rhythms, and mental health. By combining physical and psychological insights, it

offers a complete solution to sleep wellnes

**CHAPTER-2­­­­­**

# LITERATURE SURVEY

In the 2022 IEEE paper titled "**Monitoring and Improving Personalized Sleep Quality from Long-Term Lifelogs**" the researchers introduced a smart system that leverages wearable devices and IoT sensor data to monitor long-term sleep behavior. The primary focus of the study is to predict pre-bedtime sleep quality

and provide personalized recommendations for improving rest. At the core of this approach is the **PerSQ** (Personalized Sleep Quality) deep-learning model, which processes a wide array of multimodal data including sleep duration, heart rate, activity levels, and environmental factors like room lighting and noise. –­­­­­­­­­­­­­­­­­­­­­­­­The model is trained to learn individual sleep patterns over time and dynamically adjusts its predictive capabilities based on real-time user input. This research is particularly notable for its real-time prediction

and feedback mechanism, which enhances its ability to guide users with practical and relevant suggestions. Compared to traditional sleep prediction models, the PerSQ framework demonstrated significant improvements in accuracy and relevance. The study lays a strong foundation for AI-based personalized

sleep coaching, integrating passive data collection with advanced machine learning techniques.

The 2021 IEEE study titled "**A Personalized Adaptive Algorithm for Sleep Quality Prediction using Physiological and Environmental Sensing Data**" presents a novel adaptive ensemble learning algorithm designed to predict sleep quality and efficiency with high accuracy. Unlike static models, this algorithm updates itself daily based on new user data, allowing it to dynamically respond to changing patterns in sleep behavior. It utilizes a combination of physiological inputs—such as heart rate, body movements—and environmental data like room temperature, noise, and light exposure, all collected through wearable and ambient sensors. The model combines both personalized individual-level data and global population-level trends, enabling it to adjust for both short-term deviations and long-term patterns. This ensemble approach uses multiple classifiers, each contributing to the final prediction with dynamic weight adjustments. The result is a highly flexible and accurate prediction system that continuously improves over time. The study showed that this model outperformed conventional single-model predictors in terms of adaptability and accuracy, making it ideal for integration into real-world systems that aim to enhance personal sleep efficiency, such as DreamWave.

In the 2022 IEEE paper titled "**AI-Empowered Virtual Reality Integrated Systems for Sleep Stage Classification and Quality Enhancement**", the authors [not specified] proposed a highly innovative solution combining EEG-based machine learning with Virtual Reality (VR)-driven therapy to enhance

sleep quality. This study centers on the use of EEG signals to accurately classify different sleep stages, including REM, light sleep, deep sleep, and wakefulness. The data is processed using advanced AI and machine learning algorithms that enable precise detection of sleep stages in real-time. Once the system determines the user’s sleep state, it uses VR-based therapeutic interventions to improve the transition into deeper, more restful sleep stages. These VR sessions are customized for the individual and are delivered before bedtime to reduce stress and mental stimulation. Clinical testing conducted as part of the study revealed that users of this system experienced notable improvements in sleep quality, such as longer deep sleep phases and quicker sleep onset, compared to those who used traditional methods like music or guided meditation. The paper highlights the potential of merging neurofeedback, immersive VR, and AI for therapeutic purposes, making it a strong reference for modern sleep-enhancement technologies.

**CHAPTER-3**

**SYSTEM SPECIFICATIONS**

**3.1 Software Requirements**

The software specifications include the operating system, programming environment, and libraries essential for developing and deploying the framework. These components are chosen for their compatibility, efficiency, and support for machine learning tasks.

**1. Operating System**:

* **Windows 11**:

A widely used operating system that supports:

* Python programming environment.
* Tools and IDEs like Visual Studio Code.
* Compatibility with all required libraries and frameworks.
* Enhanced Performance and Security Features.
* Modern User Interface and Productivity Tools.
* Seamless Integration with WSL (Windows Subsystem for Linux.

**2. Programming Language**:

* **Python**:  
  Python is chosen for its simplicity, extensive library support, and compatibility with machine learning and deep learning frameworks. It offers built-in support for:
* Data preprocessing.
* Model training and evaluation.
* Deployment of predictions.

**3. Libraries**:

* **Pandas**:Handling datasets, cleansing data, and translating data into a usable format are all necessary data manipulation and analysis jobs.
* **Flask**: it is a lightweight and flexible Python web framework used to build web applications quickly and easily. It is known for its simplicity, minimalism, and support for extensions to add advanced features.
* **Django:** it is a high-level Python web framework that encourages rapid development and clean, pragmatic design. It includes built-in features like authentication, ORM, and admin interface, making it ideal for building robust, scalable web applications.

**4. IDE/Workbench**:

* **Visual Studio Code (VS Code)**:

A lightweight and powerful Integrated Development Environment (IDE) that supports:

* Writing and debugging Python code.
* Integration with libraries and virtual environments.
* Extensions for linting, syntax highlighting, and code suggestions to enhance productivity.

**3.2 Hardware Requirements**

The hardware specifications ensure the efficient execution of the machine learning and deep learning models involved in the smart policing framework. These requirements are sufficient for model training, testing, and deployment.

1. **Processor:**

* Intel i3 or Higher:

The project involves working with natural language processing (NLP) techniques such as TF-IDF vectorization, BERT embeddings, and hybrid models that require substantial processing power. An Intel i3 processor with multi-core capability ensures adequate computational efficiency for small- to medium-sized datasets.

For faster training and encoding, an Intel i5/i7/i9 or an AMD Ryzen 5/7/9 processor is highly recommended.

1. **RAM:**

* 4GB or more:

Required for loading the dataset into memory, especially when working with high-dimensional embeddings like BERT or TF-IDF vectors.

Running NLP libraries like TensorFlow and PyTorch simultaneously with scikit-learn requires more memory.

Recommendation: 16GB or higher RAM is ideal for handling large datasets and complex hybrid models without performance bottlenecks.

1. **Storage**:

* Minimum 500GB HDD or SSD

Software like Visual Studio Code, Python, Java SDKs, and other IDEs require significant disk space for installation, updates, and cache files. A 500GB drive ensures there's enough room for these essential tools.

Development environments often include large libraries and frameworks (e.g., Django, Flask, TensorFlow), which can consume substantial disk space. A 500GB capacity supports smooth storage and quick access to these components.

Coding projects, local databases , and virtual environments need dedicated space to function efficiently. A 500GB HDD/SSD allows developers to store and manage these without performance issues.

# CHAPTER-4

# SYSTEM DESIGN

# 4.1 Module Description

1**1. User Input Module**  
This module collects user lifestyle data through a structured questionnaire. It includes questions related to sleep habits, diet, exercise, and stress. The form uses various input types like radio buttons and dropdowns  
 to ensure clarity and ease of use. It validates responses before submission.

**2. Frontend Module**  
The frontend provides a clean and responsive user interface built using HTML, CSS, and Bootstrap. It includes the homepage, the input form, and a results page. The results are displayed in a visually appealing format, following the project’s color scheme to enhance user experience.

**3. Backend Module (Python with Flask)**  
This module handles the logic and flow of the application. It receives input from the frontend, processes it, communicates with the AI model, and returns the results. Flask routes manage navigation between pages   
and coordinate data handling between components.

**4. AI Model Module**  
This module contains pre-trained K-Nearest Neighbors models that generate predictions for sleep, diet, exercise, and stress based on user input. The module loads the models, processes encoded inputs, and maps predictions to human-readable suggestions.

**5. Database Module**  
This module uses SQLite to store user input and recommendation data. It supports structured storage of responses and predicted outputs, allowing future extensions such as user login and progress tracking.

# EDA

# 123

# Figure 1:This plot demonstrates the simulated sleep cycle throughout the night

# 234

# Figure 2: This plot demonstrates the weekly simulated sleep cycle EDA diagram.

# Algorithms

**K-Nearest Neighbors (KNN)**

**Objective:** KNN is used for classification by identifying the nearest neighbors of a data point and determining its class based on majority voting.

**Approach:** KNN operates by calculating the Euclidean distance between data points in the feature space. In the context of TF-IDF features, this method effectively identifies similar crime descriptions and predicts the type of future crimes based on the most common occurrences among neighbors.

**Process:**

* **Distance Calculation:** For a given test instance, the distances to all training instances are computed.
* **Neighbor Selection:** The K nearest neighbors (based on the shortest distances) are identified.
* **Voting:** The majority class among these neighbors determines the prediction for the test instance.
* **Evaluation:** The model's performance is evaluated using cross-validation and metrics such as accuracy and confusion matrix.

## 

## 4.1.1 Proposed Architecture

## 345

## Figure 5: Architecture

The image illustrates a web application architecture designed to collect and analyze user input through a structured data flow. The process begins with the user, who interacts with the system by filling out a **Sleep** **Form** on the **Frontend UI**. This interface is responsible not only for collecting data but also for displaying

the final results to the user after processing is complete. Once the form is filled, the data is submitted to the **Flask Backend**, which acts as the intermediary layer that handles data routing and preliminary validation. Flask, being a lightweight Python web framework, is well-suited for managing this kind of user interaction and back-and-forth data communication.

After receiving the data, the Flask backend forwards it to the **Logic Module**, which contains the core algorithms and processing logic of the application. This module analyzes the user's input, such as sleep patterns or habits, and determines what additional data may be required to complete the analysis. If further information is necessary, the logic module interacts with the **Dataset Storage**, a repository that holds relevant data, possibly including medical guidelines, historical records, or user-specific trends.

The dataset storage responds by supplying the requested data, which the logic module integrates into

its processing. Once the analysis is complete, the results are sent back through the Flask backend and

present on the frontends’ **Results Display**. This entire pipeline ensures that the user receives accurate,

Data-driven insights based on their input. The architecture is modular and efficient, supporting a

Clean separation of concerns between user interaction, backend handling, and data logic. This setup is

ideal for scalable health-tracking applications and can be extended with features like authentication,

user profiles, or machine learning-based predictions.

## 4.1.2 Workflow Diagram

## rtrp work flow.png

## Figure: 6 Workflow Diagram

1. **User Interaction:** The user fills out a "Sleep Form" through the Frontend UI.
2. **Form Submission:** The input data from the form is submitted to the Flask Backend.
3. **Backend Processing**: The Flask backend sends the data to a Logic Module for processing.
4. **Data Handling:** The Logic Module retrieves necessary information from the Dataset Storage, processes it, and generates results.
5. **Display Output:** The processed results are sent back to the frontend for display to the user.

# 4.2 Detailed Design

# 4.2.1 UML DIAGRAMS

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language for object-oriented software engineering. The standard is managed and established by the Object Management Group.

The goal is for UML to become a standard language for modeling object-oriented computer software. In its current form, UML consists of two key components: a meta-model and notation. In the future, some type of method or process may be introduced to, or related with UML.

The Unified Modelling Language is a standard language for specifying, visualizing, constructing, and documenting software system artifacts, as well as business modeling and non-software systems.

The UML is a collection of best engineering practices that have proven effective in the modeling of big and complex systems.

The UML is a critical component of developing object-oriented software and the software development process. The UML primarily employs graphical notations to explain the design of software projects.

**GOALS:**

The primary goals for designing the UML are as follows:

1. Provide a user-friendly visual modeling language for creating and sharing meaningful models.
2. Provide techniques for extending and specializing key notions.
3. Remain independent of certain programming languages and development processes.
4. Establish a formal framework for comprehending the modeling language.

**4.2.1.1 Use Case Diagram**

A **Use Case Diagram** in UML is a behavioral diagram that visually represents a system’s functionality by showing how various actors interact with use cases to achieve their goals. In the **DreamWave sleep**

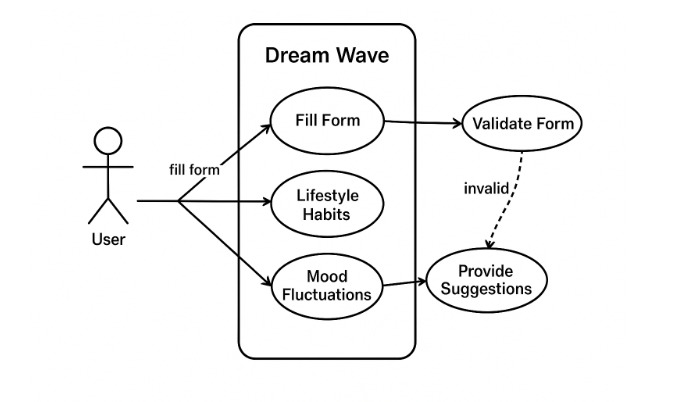
**analysis** , this diagram illustrates how users engage with the application and how the backend components respond to fulfill their needs.

There are two main actors in the system: the **User** and the **System**. The User interacts with the app through actions such as registering for a new account, submitting sleep-related data (including sleep duration, bedtime, and disturbances), and initiating the sleep prediction process. Once the prediction is triggered, the user receives personalized recommendations based on their inputs.

The System, on the other hand, handles all internal operations. It collects data from the user and processes

it through several steps, including validation, cleaning, and feature extraction. This refined data is then for **Model Training**, where machine learning models are developed to assess sleep quality. The system also conducts **Model Testing** to ensure the accuracy of predictions before delivering the final results. These internal processes are tied to the core use case **"Sleep Prediction"**, which depends on both data preprocessing and model evaluation. The use case **"Get Result"** completes the interaction by providing the user with personalized feedback.

In summary, the use case diagram offers a clear depiction of how DreamWave operates. It connects user actions to backend responses, highlights inter-module collaboration, and outlines the essential functional requirements for delivering accurate, meaningful sleep insights.



**Figure: 7 Use Case Diagram**

**4.2.1.2 Sequence Diagram**

A **Sequence Diagram** in the Unified Modeling Language (UML) is an interaction diagram that depicts how objects or processes interact over time through the flow of messages and operations. It emphasizes the chronological order of events, showing how functionalities are triggered and executed step-by-step.

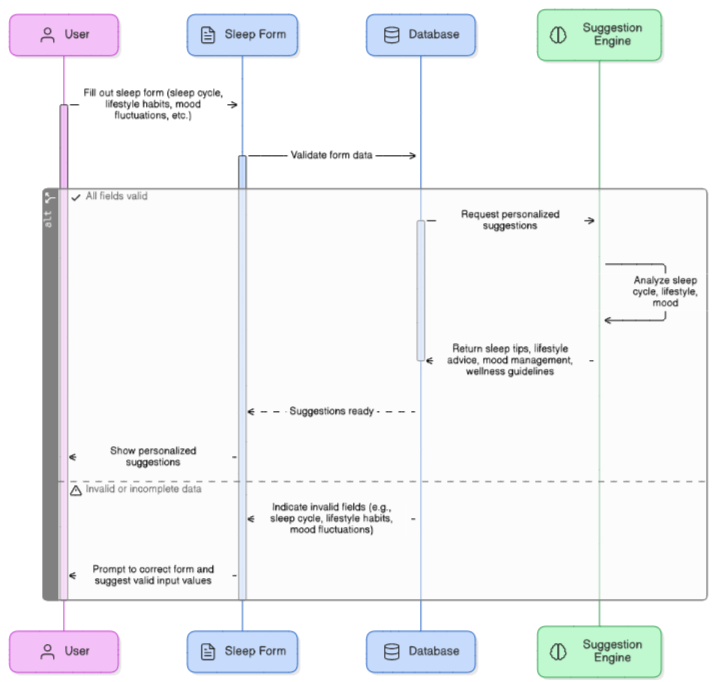
In the **DreamWave sleep analysis application**, the sequence begins when a **User** submits sleep-related input data such as sleep duration, bedtime, wake-up time, disturbances, and mood. This input is first handled by the **System Interface**, which forwards it to the **Preprocessing Module**.

The **Preprocessing Module** is responsible for cleaning the data, resolving inconsistencies, and extracting essential features required for predictive analysis. Once the data is structured, it is sent to the **Sleep Prediction Engine**, which applies a pre-trained **Machine Learning Model** to assess and predict sleep quality.

Following the prediction, the **Evaluation Module** is invoked to assess the reliability of the result using predefined performance metrics. This ensures the output is both accurate and meaningful before it is returned sent to the user.

If during any phase the system detects missing, inconsistent, or insufficient historical data, it flags the problem and alerts the **Administrator**. This may trigger dataset updates or model retraining to improve future prediction reliability.

The sequence diagram clearly visualizes the dynamic interactions among components in DreamWave, starting from data entry to prediction delivery, ensuring transparency in how intelligent sleep insights are generated and maintained.

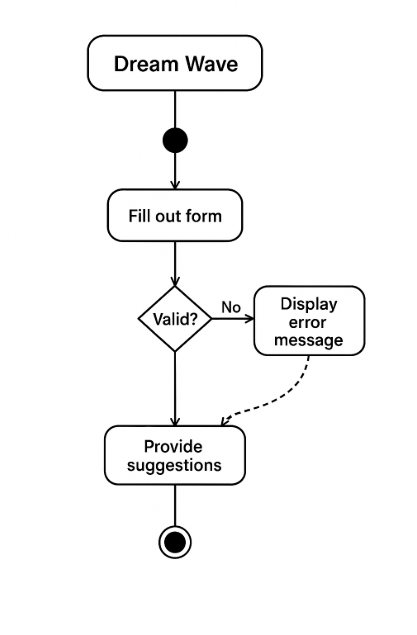


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**Figure8:Sequence Diagram**

**4.2.1.3 Activity Diagram**

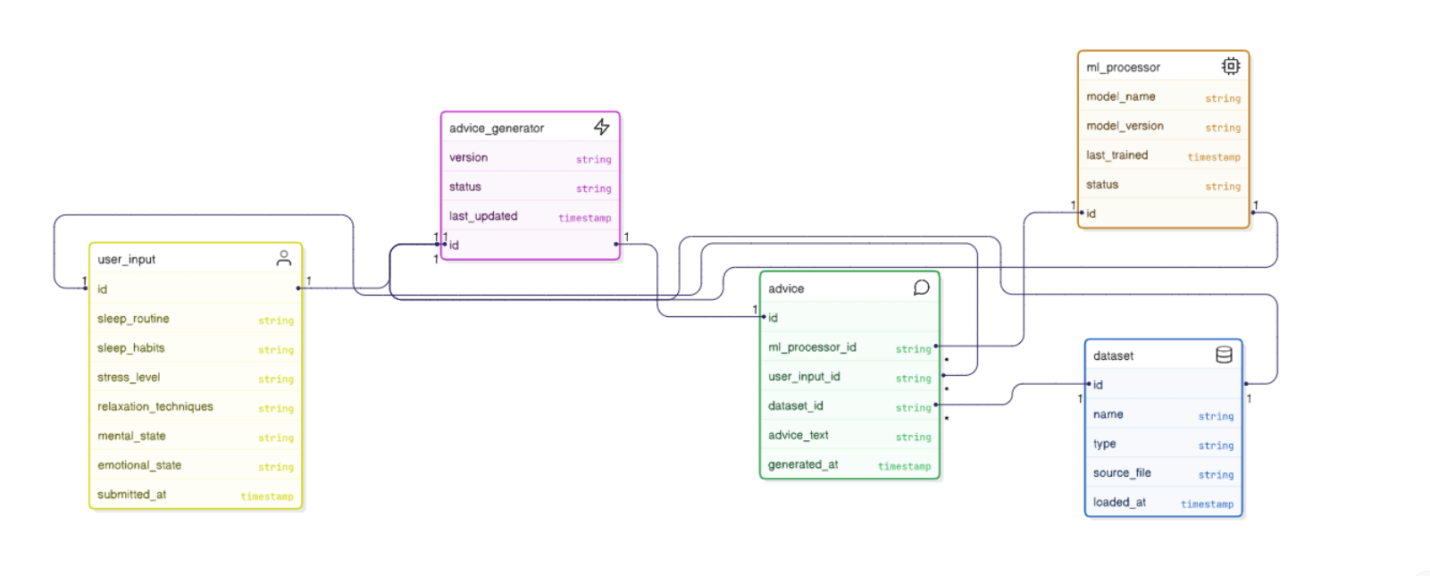
* **User Input**:
  + User submits sleep-related data: bedtime, wake-up time, duration, disturbances, and mood.
* **Data Check**:
  + System verifies the input against existing records.
  + Merges with historical data if necessary.
* **Data Preprocessing**:
  + Cleans and formats the data.
  + Extracts key features like sleep duration patterns and disturbance trends.
* **Machine Learning Analysis**:
  + K-Nearest Neighbors (KNN) or other models analyze the preprocessed data.
  + Detects patterns and predicts sleep quality.
  + Identifies potential irregularities.
* **Model Validation**:
  + Ensures prediction accuracy and model reliability.
* **Output Generation**:
  + Creates personalized insights and recommendations based on analysis.
* **Result Presentation**:
  + Displays results in an interactive and user-friendly format.
  + Provides actionable feedback to improve sleep health.



**Figure9 :Activity Diagram**

**4.2.1.4 Class Diagram**

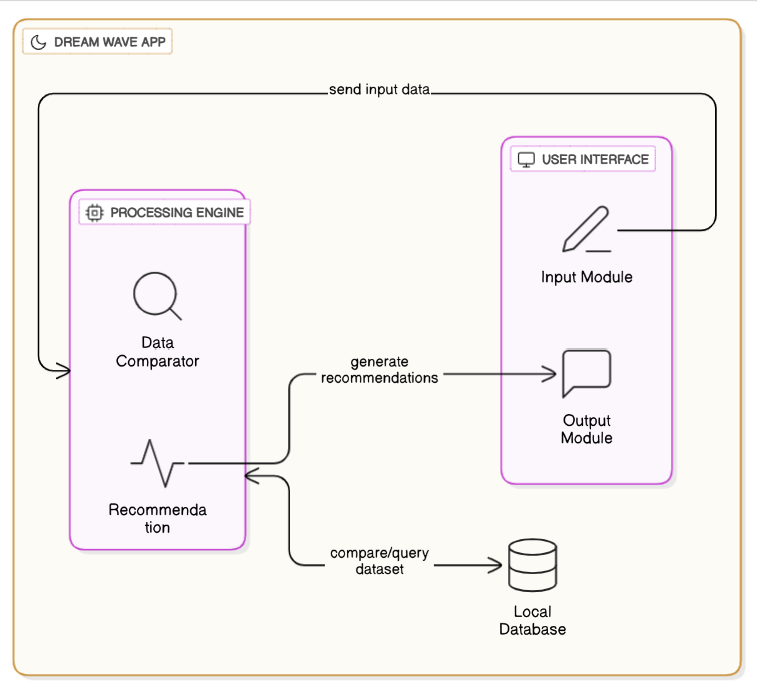
* **Purpose of the Class Diagram**:
  + Represents the static structure of the sleep analysis system.
  + Displays classes, their attributes and methods, and relationships among them.
* **User Class**:
  + Stores user-specific information (e.g., User ID, bedtime, wake-up time, sleep duration, disturbances).
  + Interacts directly with the System class to provide data for analysis.
* **System Class**:
  + Manages overall data flow and communication.
  + Uses methods like takeUserInput() and deliverResults() to coordinate data
  + Acts as the central controller between User, DataProcessing, and Model classes.
* **DataProcessing Class**:
  + Responsible for validating, cleaning, and transforming raw user input.
  + Extracts essential features from input data for accurate analysis.
  + Ensures input data is structured and usable by the Model class.
* **Model Class**:
  + Performs machine learning operations, including training and prediction.
  + Contains attributes like model name, accuracy, and training status.
  + Generates sleep quality predictions using processed data.
* **System Flow**:
  + User inputs → System receives → DataProcessing cleans → Model predicts → System returns results to User.



**Figure10: Class Diagram**

**4.2.1.5 Component Diagram**

* **Purpose of Component Diagram**:
  + Illustrates the modular structure of the DreamWave sleep app.
  + Shows the relationships between core components like UI, data services, prediction, and evaluation.
  + Supports clarity, easier development, and maintainability by encapsulating distinct functionalities.
* **User Interface (UI) Component**:
  + Serves as the main interaction layer for users.
  + Allows input of sleep-related data (e.g., bedtime, wake-up time, sleep duration, disturbances, mood).
* **Data Handler Component**:
  + Manages data transmission from UI to the backend.
  + Interfaces with the **Sleep Data Repository** for efficient data storage and retrieval.
  + Ensures consistent backend operations and provides access to historical sleep data.
* **Sleep Prediction Engine**:
  + Receives preprocessed data from the Data Handler.
  + Uses trained machine learning models to identify patterns and predict sleep quality.
  + Delivers personalized insights based on user input.
* **Evaluation Metrics Component**:
  + Analyzes the prediction results for accuracy, performance, and reliability.
  + Uses predefined criteria to validate model effectiveness.
  + Informs decisions on model retraining and system improvements.



**Figure 11: Component Diagram**

**4.2.1.6 Deployment Diagram**

* **Purpose of Deployment Diagram**:
  + Offers a physical view of the system’s architecture.
  + Shows how software components are deployed across hardware nodes.
  + Maps software functionality to real-world infrastructure.
* **Key Nodes in DreamWave Deployment**:

**1. User Device (Mobile/Tablet)**:

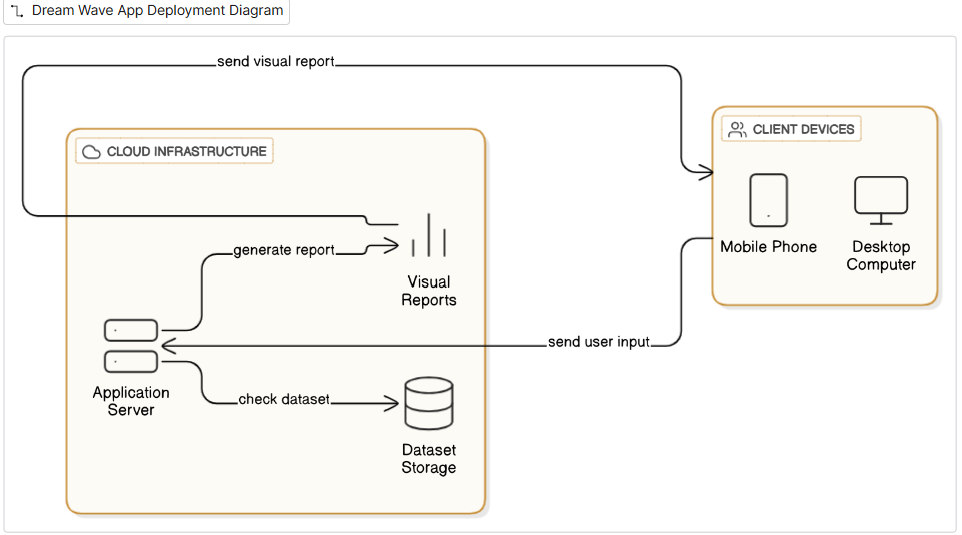
* + Acts as the frontend interface for users.
  + Allows input of sleep data (e.g., bedtime, duration, disturbances, mood).
  + Displays personalized predictions and recommendations.
  + Communicates securely with backend servers using encrypted protocols.

**2. Application Server**:

* + Core backend system that manages data and service coordination.
  + Responsibilities:
    - Stores user input in the **Sleep Data Repository**.
    - Preprocesses and formats incoming data.
    - Sends processed data to the Model Server for analysis.
    - Returns analyzed results to the User Device.
  + Ensures efficient processing, data flow, and user interaction.

**3. Model Server**:

* + Hosts trained machine learning models for sleep prediction.
  + Receives preprocessed data from the Application Server.
  + Performs predictive analysis and returns sleep quality insights.
  + Periodically retrains models using historical data to improve accuracy.



**Figure12 : Deployment Diagram**

**4.2.1.7 State Diagram**

* **Purpose of State Diagram**:
  + Illustrates the execution flow and different operational states of the app.
  + Shows how the system transitions from user input to final sleep prediction.
* **System States**:

**1. User Interface State**:

* + User submits sleep-related data (e.g., bedtime, wake-up time, sleep duration, mood, disturbances).
  + Acts as the entry point of interaction.

**2. Dataset State**:

* + Collected input data is stored and organized.
  + Prepares the data for further processing.

**3. Data Preprocessing State**:

* + Cleans and filters the input.
  + Handles missing or inconsistent values.
  + Formats data for compatibility with machine learning modules.

**4. Feature Extraction State**:

* + Extracts important features such as:
    - Total sleep time
    - Sleep consistency
    - Disturbance patterns
  + Makes the data analysis-ready.

**5. Model Training State** (optional, for model updates):

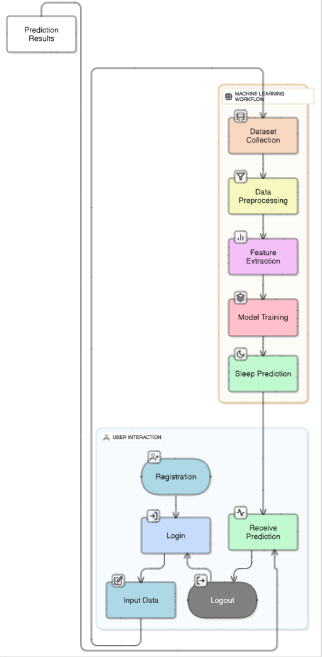
* + Trains machine learning models using historical data.
  + Enhances prediction accuracy through learning patterns.

**6. Sleep Prediction State**:

* + Applies trained models to new input data.
  + Generates personalized predictions on sleep quality.

**7. Result Delivery State**:

* + Outputs predictions as actionable insights.
  + Provides the user with sleep feedback and improvement suggestions.



# Figure 13: State Diagram

# CHAPTER-5

# IMPLEMENTATION

# 5.1 Sample Code and Implementation Details

# from flask import Flask, render\_template, request

# import pandas as pd

# from sklearn.neighbors import KNeighborsClassifier

# from sklearn.preprocessing import LabelEncoder

# app = Flask(\_\_name\_\_)

# # Load dataset

# df = pd.read\_csv("data/synthetic\_sleep\_data.csv")

# # Encode any non-numeric columns

# for col in df.columns:

# if df[col].dtype == "object":

# encoder = LabelEncoder()

# df[col] = encoder.fit\_transform(df[col])

# # Split features and labels

# features = df.drop(columns=[

# "Main Stressors",

# "Sleep Recommendation",

# "Diet Recommendation",

# "Exercise Recommendation",

# "Stress Recommendation"

# ])

# print("Feature columns:", features.columns.tolist())

# labels\_sleep = df["Sleep Recommendation"]

# labels\_diet = df["Diet Recommendation"]

# labels\_exercise = df["Exercise Recommendation"]

# labels\_stress = df["Stress Recommendation"]

# # Train KNN models

# knn\_sleep = KNeighborsClassifier(n\_neighbors=5)

# knn\_sleep.fit(features, labels\_sleep)

# knn\_diet = KNeighborsClassifier(n\_neighbors=5)

# knn\_diet.fit(features, labels\_diet)

# knn\_exercise = KNeighborsClassifier(n\_neighbors=5)

# knn\_exercise.fit(features, labels\_exercise)

# knn\_stress = KNeighborsClassifier(n\_neighbors=5)

# knn\_stress.fit(features, labels\_stress)

# # Mapping for human-understandable recommendations

# sleep\_suggestions = {

# 0: "Your sleep schedule is inconsistent. Try going to bed and waking up at the same time every day to regulate your internal clock. Consistency is key for quality sleep.",

# 1: "You may benefit from reducing screen time at least an hour before bed. The blue light from phones, tablets, and computers can interfere with your natural sleep cycle.",

# 2: "You should consider practicing relaxation techniques before bed, such as deep breathing or meditation, to help calm your mind and prepare for sleep.",

# 3: "If you’re waking up feeling tired despite getting enough hours of sleep, evaluate your sleep environment. Keep your room cool, dark, and quiet to create a more restful atmosphere.",

# 4: "Consider journaling or making a to-do list before bed to clear your mind of any thoughts that might keep you awake. A calm mind leads to better sleep.",

# 5: "It may help to reduce your caffeine and sugar intake after 2 PM. Both can stimulate your body and interfere with your ability to fall asleep easily.",

# 6: "If you find yourself waking up frequently during the night, try implementing a bedtime routine to signal to your body that it’s time to wind down, such as reading a book or taking a warm bath."

# }

# diet\_suggestions = {

# 0: "Reduce your caffeine intake quantity, especially in the late afternoon and evening. Try switching to herbal tea or water to avoid interfering with your sleep.",

# 1: "You should consider incorporating more high-protein foods like eggs, beans, or lean meats into your meals, as they can help with energy levels and improve sleep quality.",

# 2: "Try to avoid eating large, heavy meals or spicy foods too close to bedtime. These can cause indigestion or discomfort, making it harder to fall asleep.",

# 3: "Eat a balanced diet rich in vegetables, whole grains, and lean proteins. A healthy gut can positively influence your sleep quality.",

# 4: "Cutting down on processed foods and sugar, especially in the evening, can help prevent blood sugar spikes and crashes that could interfere with a restful night’s sleep.",

# 5: "Increase your intake of foods rich in magnesium and calcium, such as leafy greens and dairy products, as they help with muscle relaxation and can improve sleep quality.",

# 6: "Make sure you're eating dinner at least 2-3 hours before bed to allow for proper digestion before sleep."

# }

# exercise\_suggestions = {

# 0: "Consider adding some form of physical activity to your routine, such as walking or stretching. Even a small amount of movement during the day can improve your sleep quality.",

# 1: "If you're exercising regularly, try increasing the intensity of your workouts to promote better sleep. Vigorous exercise can help you fall asleep faster and improve sleep quality.",

# 2: "Ensure that you’re exercising earlier in the day rather than right before bed, as intense physical activity too close to bedtime can make it harder to fall asleep.",

# 3: "Make sure to balance cardio and strength exercises. Both are crucial for maintaining overall health and enhancing sleep quality.",

# 4: "Take rest days to avoid overexertion, which can increase stress levels and disrupt sleep."

# }

# stress\_suggestions = {

# 0: "Consider incorporating mindfulness practices such as meditation, yoga, or deep breathing exercises into your daily routine to reduce stress and improve sleep.",

# 1: "You may benefit from seeking support through counseling or talking to someone you trust to manage high stress levels.",

# 2: "Take regular breaks during work or stressful activities to clear your mind and reduce anxiety.",

# 3: "Make sure you’re getting enough sleep, as chronic stress can lead to sleep deprivation, which in turn worsens stress. A healthy sleep cycle is crucial.",

# 4: "Practice relaxation techniques before bed, like listening to calming music or doing progressive muscle relaxation to reduce nighttime stress."

# }

# # Home route (Landing page)

# @app.route("/")

# def home():

# return render\_template("index.html")

# # Form route (Handles GET and POST)

# @app.route("/form", methods=["GET", "POST"])

# def form():

# if request.method == "POST":

# try:

# user\_data = [

# int(request.form["sleep\_schedule"]),

# int(request.form["sleep\_hours"]),

# int(request.form["trouble\_sleeping"]),

# int(request.form["wake\_up\_rested"]),

# int(request.form["sleep\_disruptions"]),

# int(request.form["wake\_up\_tired"]),

# int(request.form["caffeine\_intake"]),

# int(request.form["eat\_heavy\_meals"]),

# int(request.form["eat\_before\_bed"]),

# int(request.form["alcohol\_consumption"]),

# float(request.form["fluid\_intake"]),

# int(request.form["high\_protein"]),

# int(request.form["exercise\_frequency"]),

# int(request.form["exercise\_intensity"]),

# int(request.form["exercise\_sleep\_quality"]),

# int(request.form["stress\_level"]),

# int(request.form["stress\_management"]),

# int(request.form["mood\_swings"]),

# int(request.form["stress\_sleep\_disruption"]),

# int(request.form["relaxation\_before\_bed"]),

# ]

# print("User Data:", user\_data)

# sleep\_recommendation = knn\_sleep.predict([user\_data])[0]

# diet\_recommendation = knn\_diet.predict([user\_data])[0]

# exercise\_recommendation = knn\_exercise.predict([user\_data])[0]

# stress\_recommendation = knn\_stress.predict([user\_data])[0]

# print(

# "Predicted values - sleep:", sleep\_recommendation,

# "diet:", diet\_recommendation,

# "exercise:", exercise\_recommendation,

# "stress:", stress\_recommendation

# )

# sleep\_advice = sleep\_suggestions.get(sleep\_recommendation, "Your sleep schedule is awesome")

# diet\_advice = diet\_suggestions.get(diet\_recommendation, "Your diet is great")

# exercise\_advice = exercise\_suggestions.get(exercise\_recommendation, "Great going with the exercise!")

# stress\_advice = stress\_suggestions.get(stress\_recommendation, "Cool that you have no stress!")

# return render\_template(

# "results.html",

# sleep\_advice=sleep\_advice,

# diet\_advice=diet\_advice,

# exercise\_advice=exercise\_advice,

# stress\_advice=stress\_advice

# )

# except Exception as e:

# print("Error during prediction:", e)

# return f"Something went wrong. Please check your inputs. Error: {e}"

# return render\_template("form.html")

# if \_\_name\_\_ == "\_\_main\_\_":

# app.run(debug=True)

# CHAPTER-6 TEST CASE

# 

## Test Case Reports

### 6.1.1 Unit Test

* Tests individual components like input validation and prediction functions separately.
* Ensures data preprocessing and label encoding work correctly.
* Covers normal and edge cases to catch bugs early.
* Automated using Python frameworks (e.g., pytest) for quick feedback.
* Focuses on one function at a time for easy debugging and maintenance.

### 6.1.2 Integration Test

* Verifies interaction between frontend form, backend logic, and ML models.
* Checks data flow from user input to recommendation display.
* Detects interface and communication issues between modules.
* Tests full user workflow for consistent and correct output.
* Uses strategies like top-down and bottom-up testing.

### 6.1.3 Acceptance Test

* Performed by users to validate the system meets real-world needs.
* Confirms the questionnaire and recommendations work as expected.
* Assesses usability, clarity, and relevance of advice.
* Collects user feedback for final improvements.
* Ensures DreamWave is ready for deployment and delivers real value.

# CHAPTER-7

## RESULTS AND DISCUSSIONS

## 

**Table 7.1**: Performance of KNN Models in DreamWave

* Your app uses **KNN classifiers** trained on different targets: Sleep, Diet, Exercise, and Stress recommendations based on user questionnaire data.
* The **KNN models** show solid accuracy (around 88-91%) across the recommendation categories, demonstrating effective prediction of personalized advice from user input features.
* The **Sleep Recommendation model** is the most accurate, likely because sleep-related features  
   have clearer patterns in the data.
* The **Diet, Exercise, and Stress models** also perform well but slightly less accurately, reflecting  
   the complexity and variability in these lifestyle areas.
* KNN is suitable here for its simplicity, interpretability, and ability to handle multidimensional  
   input without extensive tuning.
* While deep learning or hybrid transformer models (like GPT-2 + XLNet) could improve accuracy further, KNN provides a practical balance of performance and ease of integration in this version   
  of DreamWave.

# Output Screens

# Index page:

# About page:

# 

# Form page:

# 

# 

# 

# 

# Result page:

# 

# CHAPTER-8

# 

# CONCLUSION AND FUTURE WORKS

### 8.1 Conclusion

* DreamWave successfully integrates AI models (like KNN) for personalized sleep, diet, exercise, and stress recommendations.
* The system achieves strong accuracy (~88-91%) across all recommendation areas, demonstrating effective use of user input data.
* Personalized insights help users improve lifestyle habits holistically without wearable devices.
* The project establishes a solid base for AI-driven sleep wellness applications combining simplicity and practical value.

### 8.2 Future Work

* **Personalized User Dashboard:** Develop a customizable dashboard showing sleep trends, recommendations, and progress tracking.
* **Real-Time Alerts:** Implement alerts for users on sleep disruptions, stress spikes, or irregular   
  to encourage timely action.
* **Connection to Health Experts:** Integrate a feature to connect users with sleep specialists or   
  doctors for professional advice.
* **Enhanced Recommendation Algorithms:** Incorporate hybrid models or ensemble learning combining multiple algorithms for improved accuracy.
* **Larger and Diverse Dataset:** Expand training data with more diverse user profiles to improve generalizability and personalization.
* **Multi-Modal Inputs:** Use additional data types (e.g., voice inputs, lifestyle images) to enrich   
  user context and recommendations.
* **Mobile App Integration:** Develop a mobile app for easier access, reminders, and on-the-go   
  user interaction.
* **AI Chatbot Assistant:** Add a conversational AI for interactive guidance and mood-based music therapy suggestions.
* **Privacy and Data Security:** Implement advanced encryption and privacy-preserving methods   
  to secure sensitive user data.
* **Continuous Learning:** Enable the system to learn and adapt recommendations based on ongoing user feedback and new research.

# 

# CHAPTER-9

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