Predicting Sleep Quality from Physical Activity Patterns Using Machine Learning: Integrating Geographic, Physical, and Lifestyle Factors from the All of Us Dataset

Team 06

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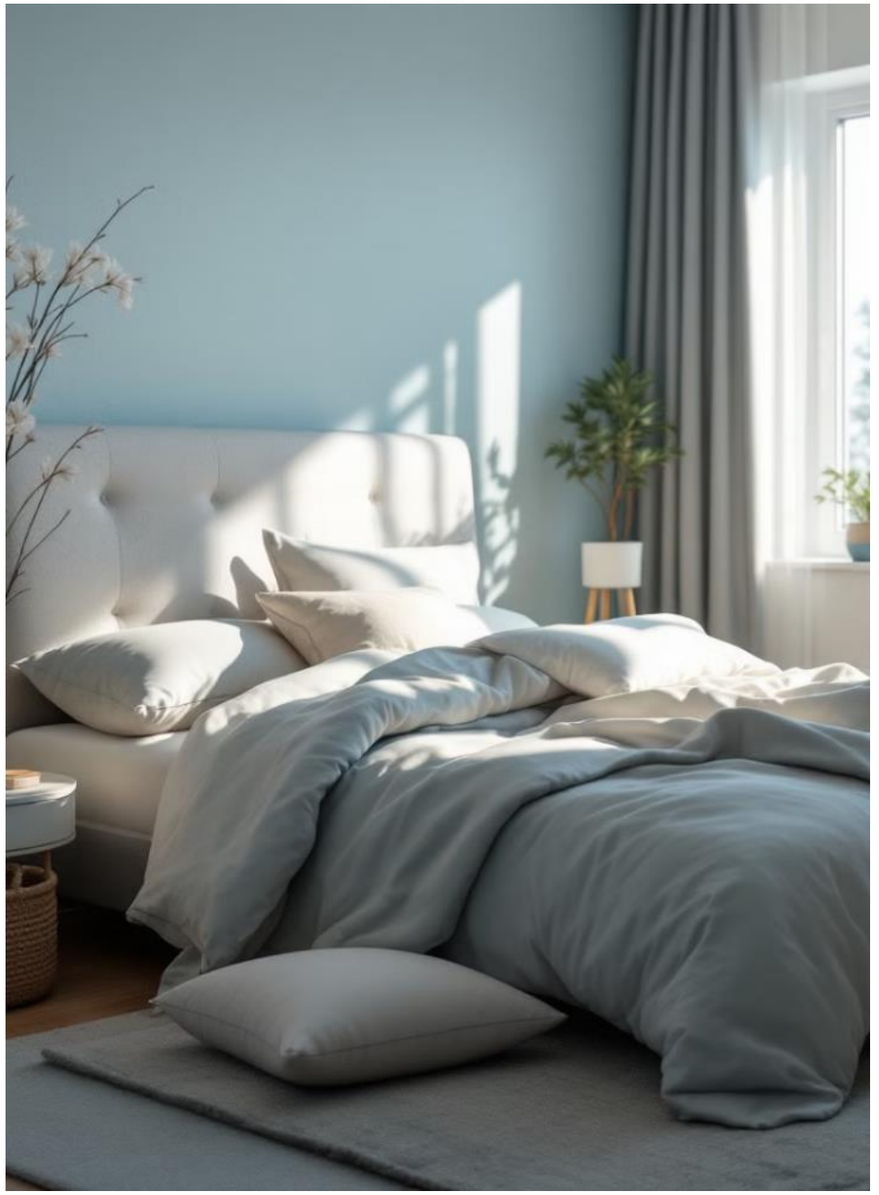


Motivation

Precision Medicine?

Precision medicine is a medical approach that considers individual variability in genes, environment, and lifestyle for each person.

Sleep and Health: Sleep quality is a critical component of overall health. Poor sleep is linked to a range of conditions like cardiovascular diseases, obesity, and mental health disorders.

Goal of Precision Medicine in Sleep Health: Tailor sleep improvement strategies based on **personalized data**, including physical activity, location, and lifestyle.

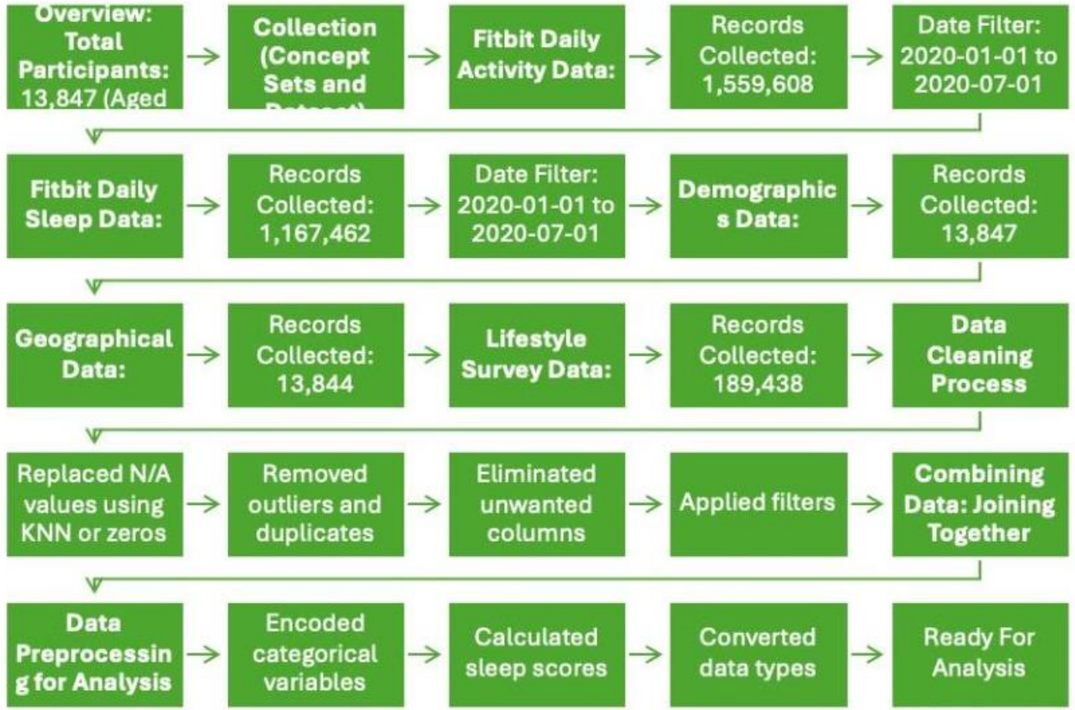
Key Problem:

How can **machine learning models** integrate individual geographic, physical, and lifestyle factors to predict sleep quality for personalized health recommendations?

Specific Challenges:

- Variability in sleep patterns across different demographics and geographic regions.
- Complex relationships between physical activity levels and sleep outcomes.
- Identifying key predictors for **restful sleep efficiency** in diverse populations.

Data Preprocessing



Data Collection and Cleaning: Gathers data from various sources and sources and ensures data quality.

Data Preparation: Transforms raw data into a structured format for format for analysis, including feature engineering and encoding. encoding.

Data Filtering: Applies consistent date filters to all datasets for a focused a focused analysis period.

Data Integration: Combines data from different concept set into a unified dataset for comprehensive analysis.

Understanding Sleep Stages and Cycles

Light Sleep
The initial stage of sleep, where the body begins to relax and transition into deeper sleep stages.

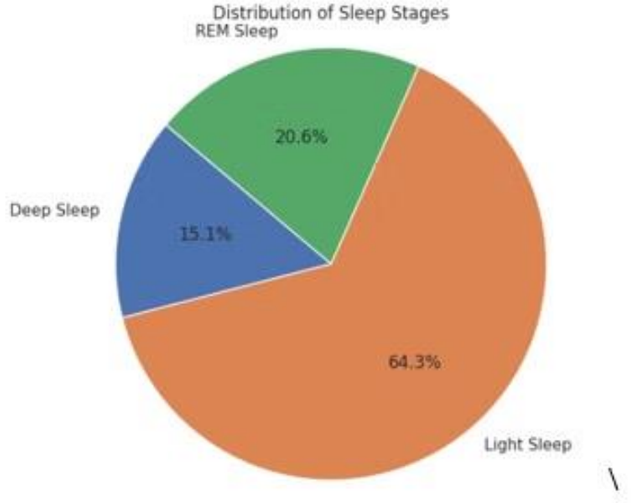
Deep Sleep
The most restorative stage, where the body repairs and rejuvenates, and memory consolidation occurs.

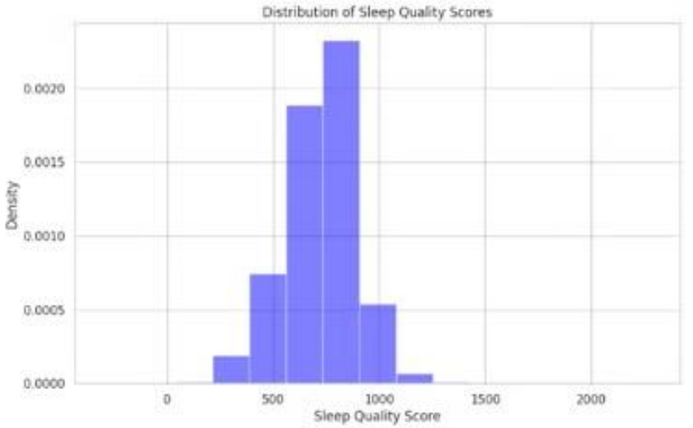
REM Sleep
The stage associated with dreaming, where the brain is active and the body is temporarily paralyzed.

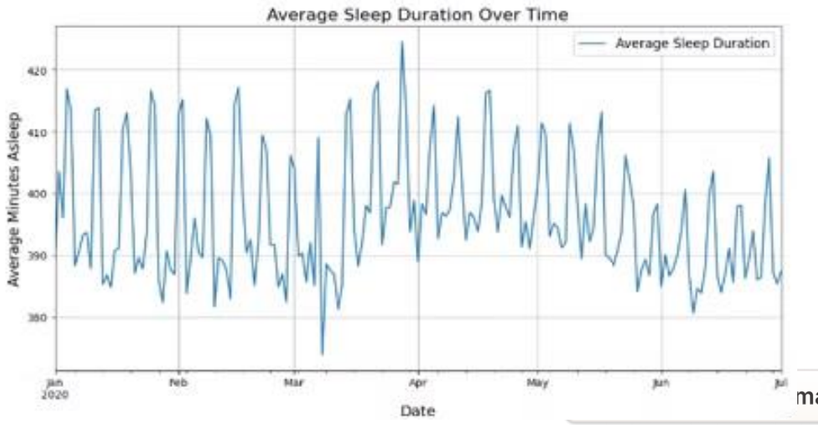
Restless Sleep
This metric quantifies the total time spent in a restless state during sleep, providing insights into sleep disturbances that can impact overall sleep quality and recovery.

Time Taken to Fall sleep
This metric indicates the duration it took for the user to fall asleep. A longer time may signal difficulties in initiating sleep, which can be influenced by factors such as stress, environment, or sleep disorders.

Custom Sleep Quality Metric
Combines various sleep stages (minute_asleep, minute_deep, minute_light, minute_rem) and subtracts disturbances (minute_awake, minute_restless) to provide a holistic measure of sleep quality.







Building a Machine Learning Model for Model for Sleep Prediction

1 Data Preprocessing

Clean and transform the collected data to prepare it for model training.

2 Model Architecture

Leverage Random Forest Regressor and XGBoost for feature importance to capture the complexity of sleep patterns.

3 Model Training

Train the model using Fitbit data to improve its predictive accuracy over over time.

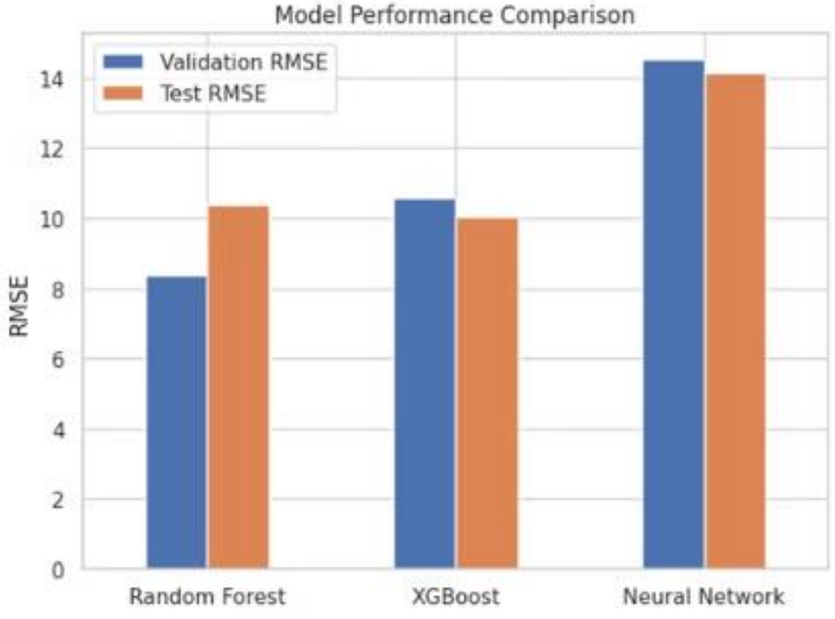
4 Model Evaluation

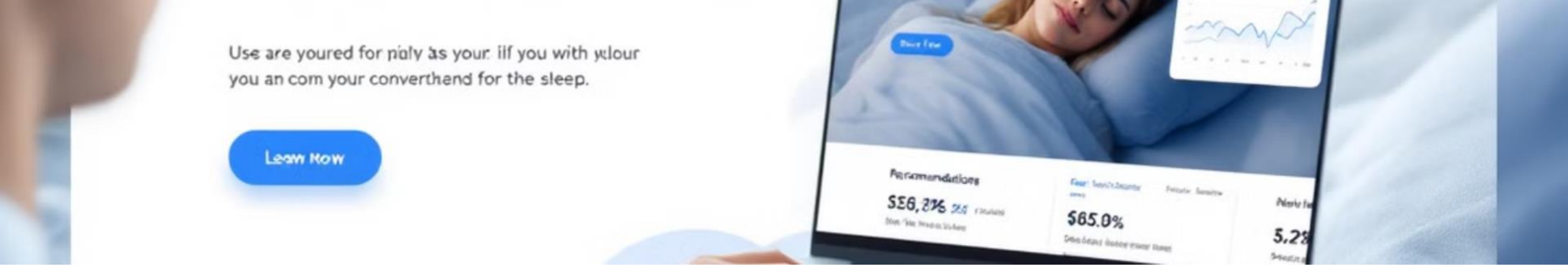
Continuously assess and refine the model to ensure optimal performance performance and reliability.

5 Metrics

RMSE of **5.8753** and Accuracy of **91%**

The model's predictions are off by an average of approximately 5.88 units.





Leveraging User Data to Provide Personalized Recommendations Recommendations

Sleep Insights

Analyze user data to provide personalized insights into sleep patterns and patterns and factors affecting sleep quality.

Tailored Recommendations

Suggest customized strategies and interventions to help users improve their improve their sleep, based on their unique needs and preferences.

Behavior Change Support

Incorporate techniques to encourage and motivate users to adopt healthier sleep habits and routines.

Continuous Optimization

Continuously refine the recommendations based on user feedback and updated and updated data to ensure maximum effectiveness.

Designing an Intuitive User Interface for the Web App

Sleep Tracking

Intuitive dashboards to monitor monitor sleep patterns and quality.

Data Visualization

Engaging graphs and charts to to present sleep insights.

Personalized Tips

Tailored suggestions for improving improving sleep habits.

Scheduling

Tools to help users plan and maintain healthy sleep routines. routines.

Conclusion: Empowering Users to Achieve Optimal Sleep

By combining the power of AI, machine learning, and behavior change techniques, this web application aims to empower users to achieve optimal sleep and enhance their overall well-being. Through personalized insights and recommendations, the app will guide users on their journey to improved sleep quality and better health.