

Single-Device Multimodal Solution for Predicting Sleep Efficiency and Anticipating Next-Day's Mood

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Problem Statement

$$\text{Sleep Efficiency} = \frac{\text{TotalSleepTime}}{\text{TotalMinutesinBed}}$$

- Sleep efficiency is one of the many measures used to determine how well or how poorly we sleep.
- In this project, we aim to predict a user's sleep efficiency using their activity data, location data, and screen time data collected over the time period.
- Personalized recommendations to enhance sleep efficiency, while also anticipating the next day's stress and anxiety levels.

Related Work

Sleep Quality Prediction from wearable data [1]

- Predict sleep efficiency based solely on physical activity data from actigraphy
- Incorporating multimodal data

Sleep Trackers

- Sleep trackers monitor movement and heart rate, analyze sleep patterns, and provide insights on sleep duration and efficiency.
- Single device solution

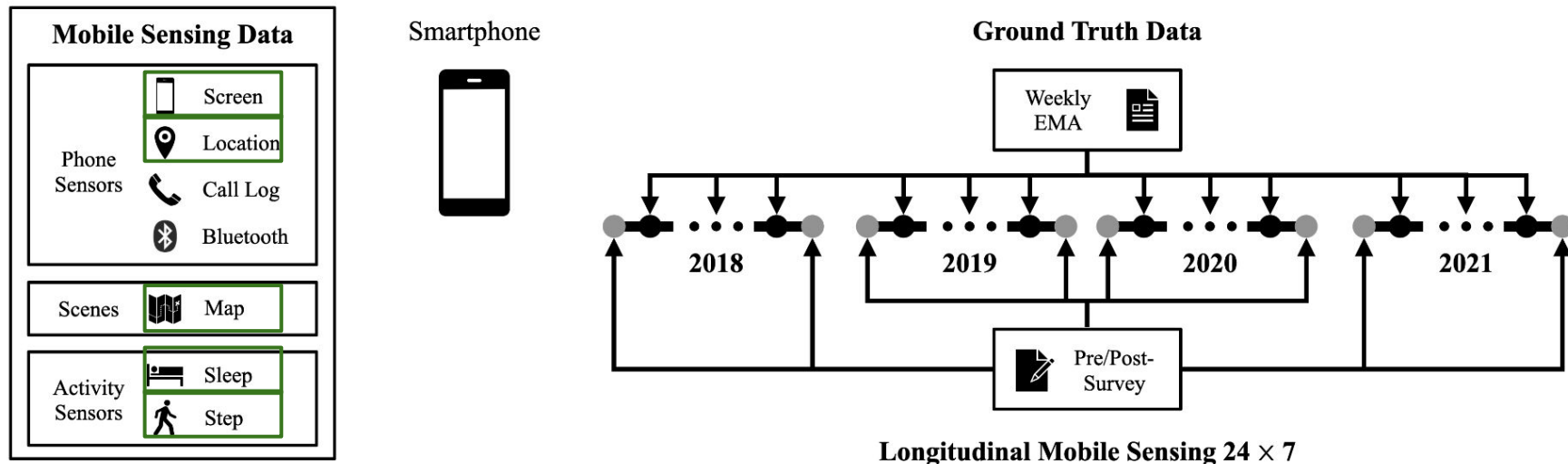
Bidirectional Associations of Sleep with Activities [2][3]

- Correlations between sleep quality and daily activity levels
- Observational analysis rather than predictive modeling.

Dataset

GLOBEM Dataset: Multi-Year Datasets for Longitudinal Human Behavior Modeling Generalization (<https://physionet.org/content/globem/1.1/>)

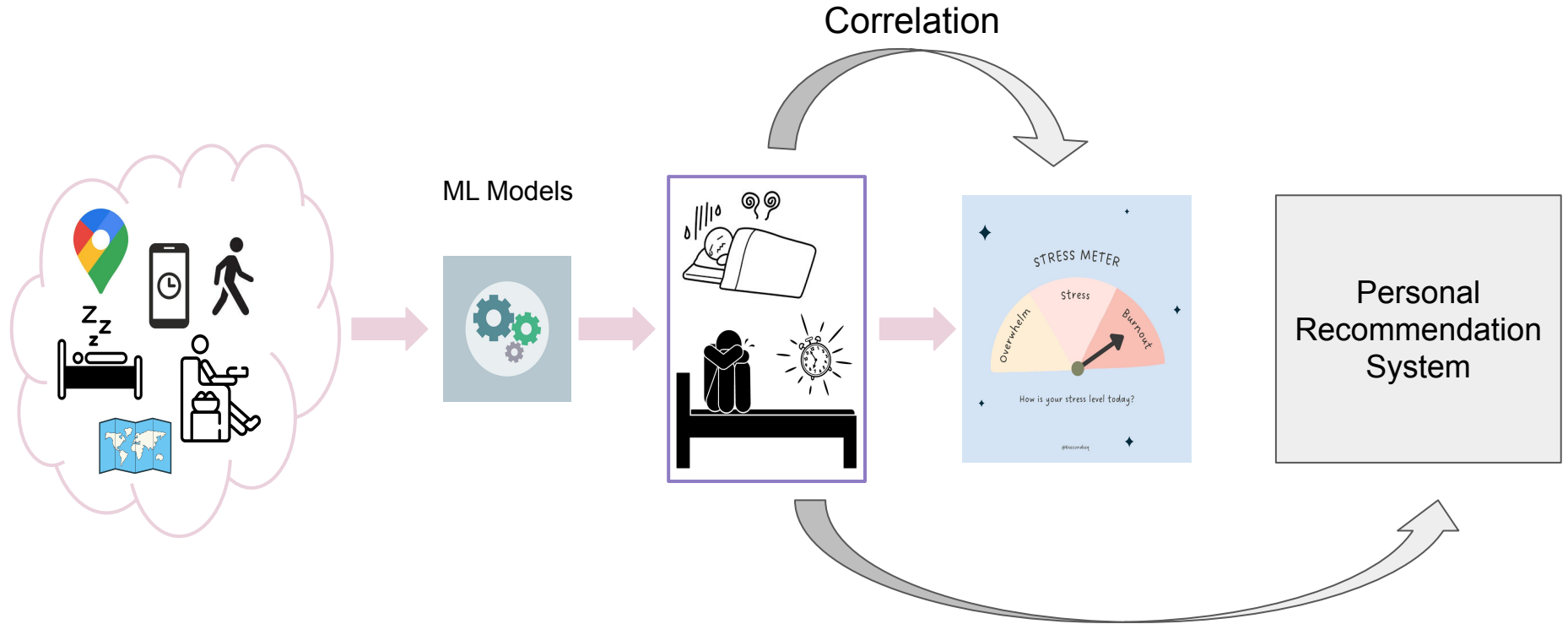
- The dataset captures **continuous, multimodal sensor data** from mobile apps and wearable devices, including phone usage, location, Bluetooth scans, physical activity, and sleep patterns from 497 participants.



Proposed Solution

1. Using Multi-Modal Data to predict bed time using ML model.
2. We are using Number of steps, Number of sedentary bouts, Number of active bouts, home time, distance traveled, Number of places traveled in one day, average screen time to predict the summation in bed time (time to fall asleep, time to wake up)
3. Show correlation between sleep efficiency score and the bedtime duration.
4. Based on the sleep efficiency and bed time, we predict the next day's stress and anxiety label.

Proposed Solution



Evaluation

For Sleep Efficiency Prediction: RMSE

For Sleep Efficiency and Stress Level Correlation: P value

For Predicting Stress Levels: Accuracy (Low, Moderate, High, Overwhelm)

For Stress Class: AUC Score

Milestone

- Identifying the most relevant factors affecting sleeping efficiency.
(1-2 weeks)
- Developing and testing models to predict sleeping efficiency using mobile-derived data.
(2 weeks)
- Develop a model to predict the next day's stress and anxiety levels based on the predicted bedtime and sleep efficiency.
(2-3 weeks)
- Providing actionable insights and recommendations based on predicted sleep quality and bedtime.
(3 weeks)

Reference

1. <https://jcsn.aasm.org/doi/pdf/10.5664/jcsn.9872>
2. <https://academic.oup.com/sleepadvances/article/2/1/zpab004/6189362>
3. <https://academic.oup.com/aje/article/192/4/665/6901500?login=true>