AIN3002 - Alma Alftayeh

AI-POWERED SMART ALARM CLOCK

Introduction

This project introduces a smart alarm clock system powered by Deep Learning, designed to optimize wake-up times based on sleep efficiency, rather than relying on a fixed time. The system integrates data from the Apple Watch dataset, capturing sleep patterns such as sleep duration, REM, deep, and light sleep stages. Using AI techniques, specifically an ensemble of Neural Networks (NN) and Long Short-Term Memory (LSTM) models, the system analyzes this data to predict the most optimal wake-up time within a user-defined window, improving both sleep quality and daily productivity.

Motivation and Exisiting Challenges

Traditional alarm clocks wake users at fixed times, which often disrupts their natural sleep cycle, leaving them feeling groggy. This project aims to create an intelligent system that adjusts wake-up times to ensure users wake up during the lighter stages of sleep, enhancing their energy levels throughout the day. Existing challenges include the limited integration of wearable device data with AI models to predict the optimal wake-up time and the absence of systems that combine wearable data with advanced deep learning techniques such as ensemble models and LSTMs. This gap presents an opportunity to develop a more accurate and personalized solution.

Contributions

The primary contribution of this project is the development of an AI-powered smart alarm clock system that integrates data from wearable devices and deep learning models to optimize wake-up times. By using an ensemble model that combines Neural Networks (NN) and Long Short-Term Memory (LSTM) networks, the system analyzes various sleep metrics and predicts the optimal time for users to wake up based on sleep efficiency. This approach not only improves wake-up accuracy but also enhances sleep quality, productivity, and overall well-being by ensuring users are awakened at the most suitable time in their sleep cycle.

Methodology

The system functions by collecting data from the Apple Watch, which is then processed using deep learning models to predict the optimal wake-up time within a user-defined window. The user sets a desired wake-up time window, and the model calculates sleep efficiency in five-minute intervals within this window, identifying the best time for the user to wake up. Data preprocessing includes encoding categorical variables (e.g., gender and smoking status), handling missing values, and scaling features to improve model performance. Three models were used: a fully connected Neural Network (NN), an LSTM model, and an Ensemble model that combines both NN and LSTM outputs. These models were trained using Python, TensorFlow, and Pandas.

Results

The performance of the models was evaluated based on Mean Squared Error (MSE) and R^2 score. All models (NN, LSTM, and Ensemble) showed identical performance, with an MSE of 0.0028 and an R^2 score of 0.85, demonstrating their ability to accurately predict the optimal wake-up time based on sleep efficiency. Although the models performed similarly, the Ensemble model was selected for future use due to its potential to combine the strengths of both NN and LSTM models as more data is integrated.

Model	MSE	R^2
NN	0.0028	0.85
LSTM	0.0028	0.85
Ensemble	0.0028	0.85

```
Enter bedtime (HH:MM): 01:00
Enter desired wakeup start time (HH:MM): 07:00
Enter desired wakeup end time (HH:MM): 09:00
Enter Age: 21
Enter Gender (0 for Female, 1 for Male): 0
Enter REM sleep percentage: 28
Enter Deep sleep percentage: 22
Enter Light sleep percentage: 50
Enter Awakenings: 0
Enter Caffeine consumption: 2
Enter Alcohol consumption: 1
Enter Smoking status (0 for No, 1 for Yes): 1
Enter Exercise frequency: 0

All calculated sleep efficiencies:
Time                Efficiency
------------------------------
07:00               0.6114
07:05               0.6071
07:10               0.6027
07:15               0.5993
07:20               0.5968
07:25               0.5952
07:30               0.5938
07:35               0.5935
07:40               0.5936
07:45               0.5954
07:50               0.6007
07:55               0.6064
08:00               0.6025
08:05               0.5970
08:10               0.5918
08:15               0.5863
08:20               0.5810
08:25               0.5785
08:30               0.5767
08:35               0.5765
08:40               0.5766
08:45               0.5781
08:50               0.5837
08:55               0.5936
09:00               0.5866
```