INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

CSE-4878
MACHINE LEARNING & DATA MINING LAB

PROJECT REPORT

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Sleep Disorder Detector using Supervised Machine Learning

PREPARED BY:

Team Name: SleepyHeads

Members Info:

C213031 Abdur Rahman

C213034 Mutasim Hossain

C213106 Abdullah Al Azad

Section: 7AM

PREPARED FOR:

Mr. Md. Mahiuddin
Associate Professor
Dept. of CSE, IIUC

1. Introduction

Sleep disorders significantly impact an individual's physical and mental well-being, affecting daily life and overall quality of life. This project investigates the potential of machine learning to assist in early detection and personalized sleep health management. By analyzing a comprehensive dataset of user information, including lifestyle habits and sleep patterns, we aim to develop a predictive model that can identify individuals at risk of sleep disorders. This research leverages machine learning algorithms to address the growing need for accessible and efficient sleep health assessments, offering a potential alternative to traditional diagnostic methods.

2. Problem Definition and Algorithm

2.1 Task Definition

Given a dataset containing user information (age, occupation, sleep habits, etc.), the task is to develop a model that predicts the presence of a sleep disorder (Insomnia and Sleep Apnea).

2.2 Algorithm Definition

We implemented and evaluated several Machine Learning algorithms, including:

- K-Nearest Neighbors (KNN)
- Gaussian Naive Bayes
- Support Vector Machine (SVM)
- AdaBoost ensemble classifier with Decision Trees

3. Methodology

- Data Acquisition
  - ✓ Collect relevant sleep and lifestyle datasets from Kaggle, a public repository of datasets.
- Data Cleaning
  - ✓ Combine and merge datasets for a comprehensive analysis.
- Data Preprocessing
  - ✓ Save the cleaned data as a binary file in Colab for efficient access.
- Model Training
  - ✓ Select the algorithm with the best classification accuracy.
- Model Serialization
  - ✓ Use pickle to save the trained model as "classifier.pkl".
- Website Development
  - ✓ Build the interface, which is user-friendly and have dedicated output pages.

4. Results

The KNN model achieved the highest accuracy of 87.85% in detecting sleep disorders. Other models performed with varying degrees of accuracy:

- ✓ AdaBoost: 77.41%
- ✓ Naive Bayes: 66.94%
- ✓ SVM: 51.61%

The results support our hypothesis that machine learning can be effective for sleep disorder detection. KNN outperformed other models, likely due to its ability to capture complex relationships in the data. Further investigation is needed to optimize the performance of other algorithms.

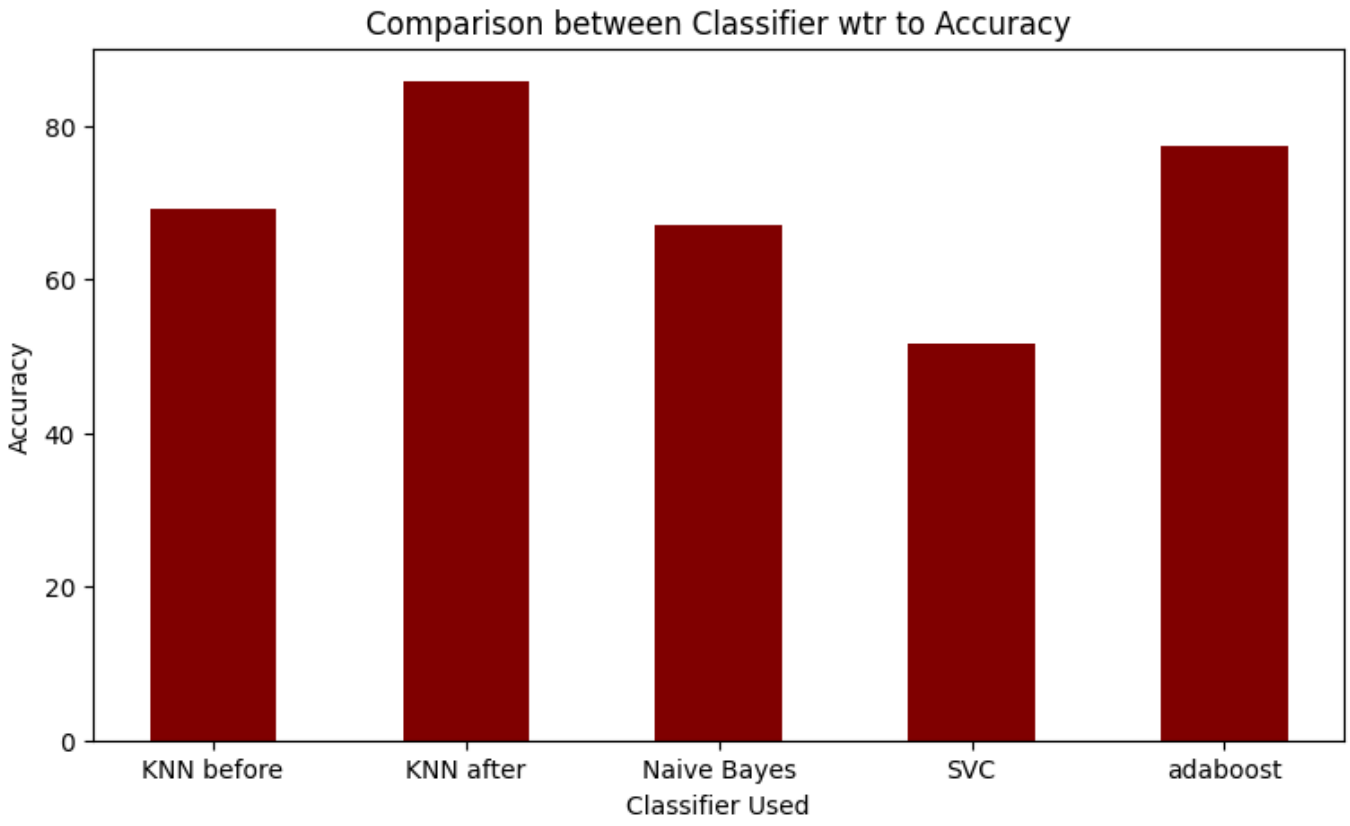

Figure 1: RESULT

5. Project Visualization/Website:

Figure 2: Welcome Page

Wonderful! You have neither insomnia nor sleep apnea.

Try to keep up your daily rountine to maintain your healithy lifestyle.

Back to home page

We are sorry to have to inform you that you have **sleep apnea.**

Sleep apnea is a condition that causes you to stop breathing while you're sleeping. The resulting lack of oxygen activates a survival reflex that wakes you up just enough to resume breathing. Sleep apnea is uncommon but widespread.

There are many approaches to treating sleep apnea, depending on the specific type of sleep apnea and how severe it is. While none of these is a cure, they can help prevent apnea events or reduce how often they happen or how severe they are. Possible treatments include: Conservative (nonmedical) treatments, Positive airway pressure and adaptive ventilation devices, Oral appliances (mouthpieces), Nerve stimulators, Surgery.

To learn more about this disorder visit here.

Back to home page

We are sorry to have to inform you that you have **insomnia.**

Insomnia is when you aren't sleeping as you should. That can mean you aren't sleeping enough, you aren't sleeping well or you're having trouble falling or staying asleep. When insomnia is severe or lasts a long time, it causes sleep deprivation. A major concern with sleep deprivation is daytime sleepiness, which can be dangerous if you're driving or doing other tasks that require you to be alert and attentive.

The main approaches to treating insomnia are: Developing and practicing good sleep habits, Medications that help you fall or stay asleep and Mental healthcare.

To learn more about this disorder visit here.

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6. Related Work

We reviewed existing research on sleep disorder detection using machine learning, highlighting:

- **Use of machine learning to identify risk factors for insomnia** (Huang et al., 2023) employed XGBoost, Random Forest, AdaBoost, and ANN. Their dataset lacked demographic diversity.
- **Classification of Sleep Disorders** (Alshammari, 2024) utilized kNN, SVM, decision trees, random forests, and ANN. They acknowledged limitations in dataset size.
- **RAPIDEST: A Framework for Obstructive Sleep Apnea Detection** (Yildirim et al., 2023) focused on identifying rare patterns in sleep stages using CNNs. It could not determine specific disorder types.
- **Central Sleep Apnea Detection by Means of Finger Photoplethysmography** (AlQuran et al., 2023) presented a machine learning approach with decision trees. Their study was limited by a small sample size, particularly for severe CSA cases.
- **Simultaneous Sleep Stage and Sleep Disorder Detection from Multimodal Sensors Using Deep Learning** (Faust et al., 2023) employed an ensemble of CNN classifiers. Their closed-set testing limited the generalizability of their findings.

7. Future Work

The project we developed focused on predicting two sleep disorders: Insomnia and Sleep Apnea. Moving forward, our project can be enhanced to classify additional sleep disorders with greater precision. A logical next step would be to delve deeper into the categories of Sleep Apnea, which include Obstructive Sleep Apnea (OSA) and Central Sleep Apnea (CSA). A key area for future research involves the implementation of unsupervised machine learning models. Techniques like clustering algorithms (e.g., k-means, hierarchical clustering) can be employed to identify distinct subgroups within the dataset based on sleep patterns and lifestyle factors. This unsupervised approach can reveal hidden structures and patterns that may not be apparent with supervised methods. Furthermore, by integrating these unsupervised findings with the existing supervised model, we can potentially achieve more informative sleep disorder classifications.

8. Conclusion

In summary, this project effectively showcases the potential of machine learning in improving the accessibility and efficiency of sleep analysis. The user-friendly website empowers individuals to proactively manage their sleep health by providing valuable insights and increasing awareness of potential sleep disorders. We anticipate further advancements by integrating additional data sources and expanding the website's capabilities to provide personalized recommendations for enhancing sleep quality.

Bilbiography

- AlQuran, M., et al. (2023). Central Sleep Apnea Detection by Means of Finger Photoplethysmography. *IEEE Journal of Translational Engineering in Health and Medicine*, 11, 1-11.
- Alshammari, T. S. (2024). Applying Machine Learning Algorithms for the Classification of Sleep Disorders. *IEEE Access*, 12, 1-11.
- Faust, O., et al. (2023). Simultaneous Sleep Stage and Sleep Disorder Detection from Multimodal Sensors Using Deep Learning. *Sensors*, 23(11), 5221.
- Huang, A. A., & Huang, S. Y. (2023). Use of machine learning to identify risk factors for insomnia. *PLOS ONE*, 18(1), e0280410.
- Yildirim, O., et al. (2023). RAPIDEST: A Framework for Obstructive Sleep Apnea Detection. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 31(11), 2267-2278.