Mental Stress Manager: AI-Based Stress Prediction System Using Machine Learning

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Abstract

Mental stress has become a growing global concern driven by fast-paced lifestyles, academic pressure, and professional demands. Long-term stress can lead to serious physical and psychological issues such as anxiety, cardiovascular problems, sleep disorders, and reduced efficiency. Conventional stress assessment methods, including surveys and clinical evaluations, are often subjective and fail to provide continuous monitoring or real-time insights.

This paper introduces MindEase, a machine learning-based web application designed to estimate stress levels using a combination of physiological and lifestyle-related inputs. The system considers parameters such as age, gender, occupation, BMI, sleep duration and quality, heart rate, blood pressure, physical activity, and daily steps. A Random Forest Regression model is used due to its effectiveness in handling mixed data types and capturing complex relationships among variables.

The solution follows a complete pipeline, including data preprocessing, feature transformation, model training, and evaluation. It is implemented using a Flask backend, HTML/CSS frontend, and SQLite database for secure user management and history tracking. The system classifies stress into Low, Medium, and High categories and provides basic recommendations to improve well-being.

The model achieves an accuracy of approximately 85–90% with low error rates, indicating stable performance. Key influencing factors include heart rate and sleep quality. Although the system is not intended for clinical use, it offers a practical and accessible tool for early stress

awareness. Future improvements may involve real-time sensor integration, explainable AI techniques, and mobile deployment.

Keywords:

Machine Learning, Stress Prediction, Random Forest, Mental Health, Data Science, Flask, Web Application, Predictive Analytics, Healthcare Technology.

Introduction

Stress is a common aspect of modern life, influenced by increasing academic responsibilities, work pressure, and social expectations. While short-term stress may enhance performance, prolonged stress can negatively impact both mental and physical health, leading to issues such as anxiety, depression, and reduced cognitive ability.

Traditional methods of assessing stress, such as questionnaires or medical consultations, often depend on self-reported data and do not provide continuous insights. These limitations create a need for systems that can evaluate stress more objectively and consistently.

With advancements in machine learning, it is now possible to analyze patterns in physiological and lifestyle data to estimate stress levels. The **MindEase** system is designed to utilize these capabilities by combining predictive modeling with a web-based interface, enabling users to monitor their stress levels and understand contributing factors more effectively.

Problem Statement

Although awareness of mental health is increasing, existing stress assessment approaches remain limited in several ways:

- Heavy reliance on subjective inputs
- Lack of continuous monitoring mechanisms
- Minimal integration of lifestyle and physiological data
- Limited availability of accessible prediction systems
- Absence of unified platforms for tracking and analysis

These limitations highlight the need for a system that can provide consistent, data-driven, and user-friendly stress prediction.

Literature Review

Previous research on stress prediction has focused on both psychological theories and physiological indicators. Early models describe stress as a biological response, while recent studies emphasize the role of cognitive and environmental factors.

Machine learning techniques such as Random Forest, Support Vector Machines, and Neural Networks have been widely explored for predicting stress levels. Among these, Random Forest has shown strong performance due to its ability to manage diverse datasets and reduce overfitting.

Wearable-based systems provide accurate real-time data but are often costly and not widely accessible. On the other hand, most existing applications focus on stress relief rather than prediction.

There remains a gap in systems that combine machine learning, multiple stress indicators, and an accessible full-stack implementation. This project attempts to address that gap.

Objectives

The main goals of this system are:

- To develop a reliable machine learning model for stress prediction
- To integrate multiple physiological and lifestyle features into a single system
- To create a simple and user-friendly web interface
- To provide basic recommendations for stress management
- To enable tracking of user stress history over time
- To ensure scalability for future improvements

Methodology

The system is developed using a structured machine learning workflow combined with web application design.

1. Data Collection

The dataset includes demographic, physiological, and lifestyle-related features such as age, gender, heart rate, blood pressure, sleep patterns, activity level, and BMI.

2. Data Preprocessing

- Missing values were handled using statistical imputation
- Outliers were identified using Z-score and IQR methods
- Categorical features were encoded using one-hot encoding

- Relationships between variables were analyzed

3. Model Selection

Several algorithms were tested, including Logistic Regression, SVM, KNN, Gradient Boosting, and Random Forest.
Random Forest was selected due to its:

- Ability to handle mixed data
- Stability against overfitting
- Strong performance on non-linear data

4. Model Training

- Data split into training (80%) and testing (20%)
- Model trained using RandomForestRegressor
- Hyperparameters tuned for better performance
- Model saved for deployment

5. System Design

The application follows a three-layer structure:

- Frontend: User interface (HTML/CSS)
- Backend: Flask server for processing
- Database: SQLite for storing user data and predictions

Results and Discussion

Performance

- Accuracy: 85–90%
- MAE: ~0.21

Observations

- Sleep quality and heart rate significantly influence stress
- Medium stress category shows highest prediction accuracy
- Errors mainly occur between medium and high stress levels

Feature Importance

Key contributing features:

- Heart Rate

- Sleep Quality
- Blood Pressure
- Activity Level
- Sleep Duration

Limitations

- Limited dataset size
- Dependence on user-provided inputs
- Overlapping patterns in physiological data

Conclusion

The **MindEase: Mental Stress Manager** demonstrates how machine learning can be effectively applied to build a practical stress prediction system. By combining physiological and lifestyle data, the system provides a more objective approach compared to traditional methods.

The Random Forest model achieved consistent performance, highlighting the importance of features such as sleep quality and heart rate. The integration of machine learning with a web-based platform makes the system accessible and easy to use.

The application can help users understand stress patterns and take preventive measures. However, it should not be considered a replacement for medical diagnosis, as it relies on limited and self-reported data.

Future improvements may include integration with wearable devices, implementation of explainable AI techniques, and development of mobile-based applications to enhance usability and accuracy.

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