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(57) Abstract :
Sleep Disorder Classification is critical for advancing healthcare and enhancing patient well-being. This study presents a novel machine learning framework designed to accurately detect sleep disorders using enriched health and lifestyle data. The proposed method integrates advanced feature engineering to derive meaningful indicators such as Sleep Efficiency, Blood Pressure Ratio, Activity-Stress Ratio, and Cardio Index, significantly improving the quality of input representations. A robust class-balancing strategy using the Synthetic Minority Over-Sampling Technique (SMOTE) is applied to address imbalanced class distributions. Each machine learning model, including K-Nearest Neighbours (KNN), Support Vector Machine (SVM), Decision Tree (DT), Random Forest (RF), XGBoost (XGB), LightGBM (LGBM), and Artificial Neural Network (ANN), is systematically optimized through automated hyperparameter tuning using GridSearchCV within a pipeline framework. Furthermore, a Super Stacking Ensemble is developed by combining the top-performing models to leverage their complementary strengths and maximize predictive performance. Experimental evaluation on the Sleep Health and Lifestyle Dataset demonstrates that the proposed framework achieves outstanding results, with ANN achieving the highest accuracy of 98.66%, followed by SVM and RF at 97.33%, and other models consistently surpassing 96% accuracy. The Super Stacking Ensemble also achieves a strong accuracy of 96.00%, demonstrating high precision (96.20%), recall (96.00%), and F1-score (96.00%). The combination of strategic feature construction, advanced data balancing, comprehensive model optimization, and ensemble learning establishes the proposed approach as a highly effective solution for sleep disorder detection and future intelligent healthcare systems.

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