

An Explainable Ensemble Learning Framework with Feature Optimization for Accurate Maternal Health Risk Prediction.

Author

Mohammad Mamun

Mohammed Ibrahim Hussain

Md. Shafiul Alam Chowdhury

Abstract

Maternal health, a critical indicator of societal well-being, encompasses women's health during pregnancy, childbirth, and postpartum. Early identification of Maternal Health Risks (MHR) is essential for preventing complications and ensuring safe outcomes for mothers and infants. With the rapid advancement of computational technologies, Machine Learning (ML) has emerged as a powerful tool in predictive healthcare, enabling accurate risk assessment and timely interventions. In this research, we propose a robust and intelligent MHR prediction framework leveraging multiple supervised ML algorithms, including Extreme Gradient Boosting (XGB), Random Forest (RF), Decision Tree (DT), Light Gradient Boosting (LGBM), and Adaptive Boosting (AD). We incorporate two feature optimization (FO) techniques: Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) to enhance model performance and reduce feature dimensionality. Beyond individual model assessments, we explore ensemble learning strategies through majority voting and stacking techniques, integrating the predictive capabilities of all base learners. Our experimental results, validated through 10-fold cross-validation, demonstrate that the Stacking Ensemble (SE) with LDA-optimized features achieves the highest accuracy of 95.49%, outperforming all individual models and other ensemble variants. To ensure transparency and trust in model decisions, we further apply Explainable Artificial Intelligence (XAI) techniques, SHAP and LIME, which provide intuitive visualizations and insights into the influence of key features on predictions. This study highlights the potential of ensemble ML in maternal health risk classification. It introduces a novel, interpretable, and data-driven approach that integrates optimization, evaluation, and explainability in a unified framework, offering significant implications for clinical adoption and digital healthcare innovation.

2025 IEEE International Conference on Quantum Photonics, Artificial Intelligence, and Networking, QPAIN 2025

Conference Paper2025

EID: 2-s2.0-105019051407

DOI: 10.1109/QPAIN66474.2025.11172243

ISBN:979-8-3315-9695-8