**Adaptive Ensemble Feature Selection and Genetic Algorithm-Tuned Ensemble Model for Robust Heart Disease Prediction**

**Abstract**

**Keywords**

**Introduction**

**Related Work**

Numerous studies have explored the application of feature selection and genetic algorithms to improve heart disease prediction accuracy. These works collectively underscore the importance of selecting optimal features and tuning classifiers to enhance diagnostic performance.

(Aleem et al., 2022) demonstrated the effectiveness of evolutionary algorithms—specifically Genetic Algorithm (GA) and Particle Swarm Optimization (PSO)for feature selection, showing that GA yielded the best improvement in classification accuracy when combined with classifiers such as Naïve Bayes, SVM, and Random Forest.

Baviskar et al. (2021) utilized GA and PSO in conjunction with deep learning models (RNN, LSTM) to enhance heart disease prediction. Their results confirmed that feature optimization significantly improves classification metrics, with LSTM+PSO achieving 93.5% accuracy (Baviskar et al., 2021)

Yewale and Vijayaragavan (2024) proposed a GA-driven feature optimization approach and achieved up to 96.72% accuracy using models like Logistic Regression and Gradient Boosting, reinforcing the value of metaheuristic techniques in medical prediction systems (Yewale & Vijayaragavan, 2024)

Similarly, Brahimi and Feradji (2024) introduced the Rival Genetic Algorithm (RGA), which enhanced prediction performance by introducing competitive selection and dynamic mutation strategies. Their model achieved over 94% accuracy on standard heart disease datasets (Brahimi et al., 2024).

Noroozi et al. (2023) evaluated sixteen feature selection techniques, concluding that both filter and evolutionary methods could significantly improve predictive accuracy—although performance varied depending on classifier type and dataset characteristics (Noroozi et al., 2023).

El-Shafiey et al. (2021) applied a hybrid RF-GA feature selection approach and reported a classification accuracy of 95.6%, validating the utility of GA in selecting the most informative attributes(El-Shafiey et al., 2021).

Although these studies have made valuable contributions, they typically focus on either individual feature selection methods or singular classification techniques. In contrast, our proposed methodology integrates a diverse ensemble of feature selection methods (filter, embedded, and wrapper), addresses class imbalance adaptively, and applies a Genetic Algorithm for tuning multiple ensemble classifiers. Furthermore, our approach includes cross-dataset validation, noise robustness testing, and SHAP-based explain ability offering a comprehensive framework for heart disease prediction.

**Methodology**

**Results**

**Conclusion**

**References**