

## COMPARING MACHINE LEARNING PERFORMANCE IN PREDICTING MUCOCUTANEOUS INVOLVEMENT AMONG SYSTEMIC LUPUS ERYTHEMATOSUS PATIENTS

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### Introduction

Systemic Lupus Erythematosus (SLE) is a chronic autoimmune disease involving multiple organ systems with mucocutaneous as the commonest manifestations, impacting patients' quality of life. These manifestations are the effects of SLE in patients and include rashes such as the malar (butterfly) rash, photosensitivity rash, oral ulcers, discoid lesions, and alopecia. Early prediction of mucocutaneous involvement is essential for timely intervention and optimal disease management. With the advancement of technologies, machine learning (ML) has emerged as a powerful technique in clinical research including SLE research. This study aims to compare different ML methods to predict mucocutaneous involvement in SLE patients using their autoantibody profiles as predictive biomarkers.

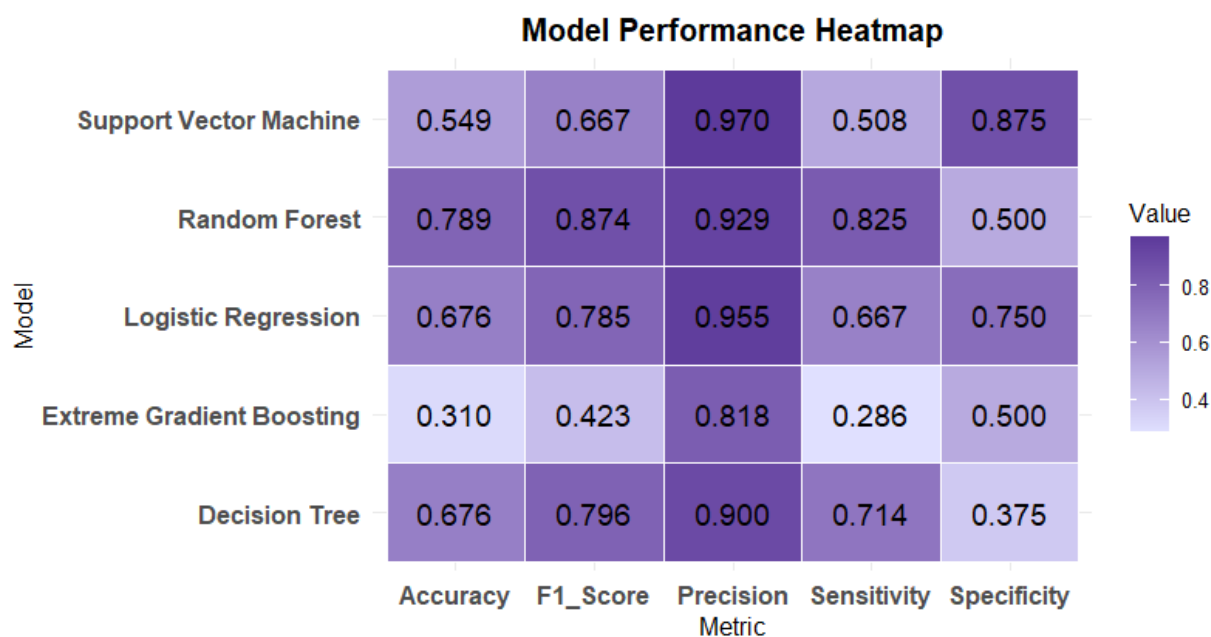
### Methods

This is a cross-sectional study involving 239 Malay patients diagnosed with SLE who fulfilled the 2019 EULAR/ACR Classification Criteria, who were recruited from two rheumatology centers (i.e. University Malaya Medical Center and Selayang Hospital). Patients' clinical data were collected using structured data collection form, while the autoantibody profiling was performed using Immunoblot and ELISA methods. All the collected clinical and laboratory data were pre-processed. The dataset was randomly split into training (70%) and testing (30%) sets. Five ML models; Extreme Gradient Boosting, Logistic Regression, Random Forest, Support Vector Machine and Decision Tree were applied using R Studio. Model performance was then evaluated based on accuracy, F1 score, sensitivity, specificity and precision metrics to identify the most effective predictive approach for clinical application.

### Results

Among the five ML models, the results showed Random Forest model achieved the best overall performance with the highest scores in precision (92.9%), F1 score (87.4%), sensitivity (82.5%) and accuracy (78.9%). Logistic Regression also performed well, particularly excelling in precision (92.9%), F1 score (78.5%) and specificity (75.0%). The Support Vector Machine model yielded the highest precision (97.0%) and strong specificity (87.5%) but lagged in sensitivity (50.8%). In contrast, Decision Tree and Extreme Gradient Boosting models underperformed relative to other models, suggesting limited suitability for this dataset.

Feature importance analysis using the Random Forest model highlighted several key predictors of SLE. Anti-nucleosomes antibody was the most influential feature in predicting the outcome, followed closely by anti-nRNP/SM and anti-Ribosomal P protein. These features contributed the greatest reduction in Gini impurity, indicating higher predictive power in the model. These findings are consistent with known clinical patterns in SLE diagnosis and may support their utility in predictive modeling.



**Figure 1.** Model Performance Heatmap

### Discussion

The Random Forest model exhibited the best predictive performance across key evaluation metrics for mucocutaneous involvement in Malay SLE patients, aligning with findings from other studies. Future research employing more robust study designs is recommended to improve clinical prediction and enhance the reliability of ML approaches.

**Keywords:** Systemic Lupus Erythematosus, machine learning, mucocutaneous manifestations, prediction, random forest