Machine learning based classification of ischemic and non- ischemic exercise stress test ECG

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Abstract

Background: Myocardial ischemia is a fatal heart condition due to insufficient blood flow in the heart muscles. Ischemia can occur with or without visible symptoms (silent ischemia) and may cause unexpected heart attacks if untreated at early stages; hence, a preliminary diagnosis must be performed. Exercise Stress Test (EST) Electrocardiogram (ECG) is a non-invasive diagnostic procedure that can help identify various disease conditions including Myocardial Ischemia (MI).

Objective: This study aims to classify the ischemic and nonischemic EST ECG using Machine Learning (ML) algorithms.

Methodology: EST ECGs for 152 patients (n=53 female) of mean age (50 ± 11.92 years) were recorded. ST segment morphology changes were measured during pre-load, load, and recovery at J + (40, 60, and 80 ms) and utilized as input to 14 ML classifiers. Random Forest (RF) was selected based on most suitable output and was used to classify between ischemic and non-ischemic by considering the clinical features such as ST segment variations, Blood Pressure (BP), Metabolic equivalent (Mets), and Rate Pressure Product (RPP).

Results: 10-fold cross-validation was performed for lead II and V5 EST ECG data and were fed to RF model. The model accuracy, sensitivity, precision, and F1 score for lead II were 93%, 89.17%, 93%, and 89.63% respectively. For V5, the performance matrices were 91%, 80%, 95%, and 86.14%, respectively.

Conclusion: Physicians may easily relate to the clinical variables utilized as input to the RF model, making this model user-friendly for clinicians. The model is also capable to minimize the error rate and time taken for classification.

Keywords: Exercise stress test, Myocardial ischemia, Random forest, ST segment
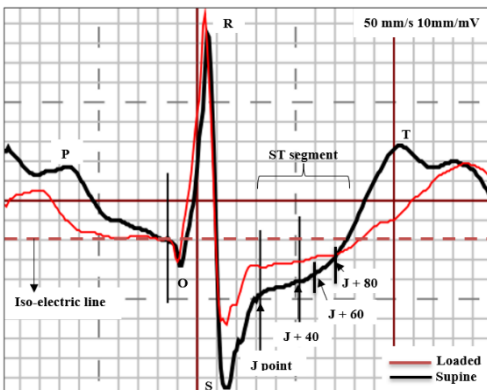
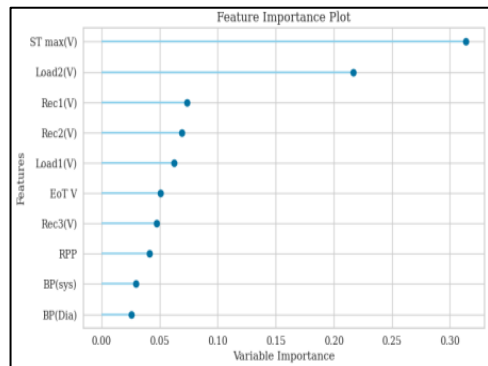**Fig 1**: ST segment depression with J + 40, 60, 80 ms.

Fig 2: Deviation at max load (ST max) is ranked as most important clinical feature.
(Load= loaded condition, Rec= Recovery, EoT= End of Test)