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ECG Signal Assessment

Explainable AI Model using a Hybrid Approach

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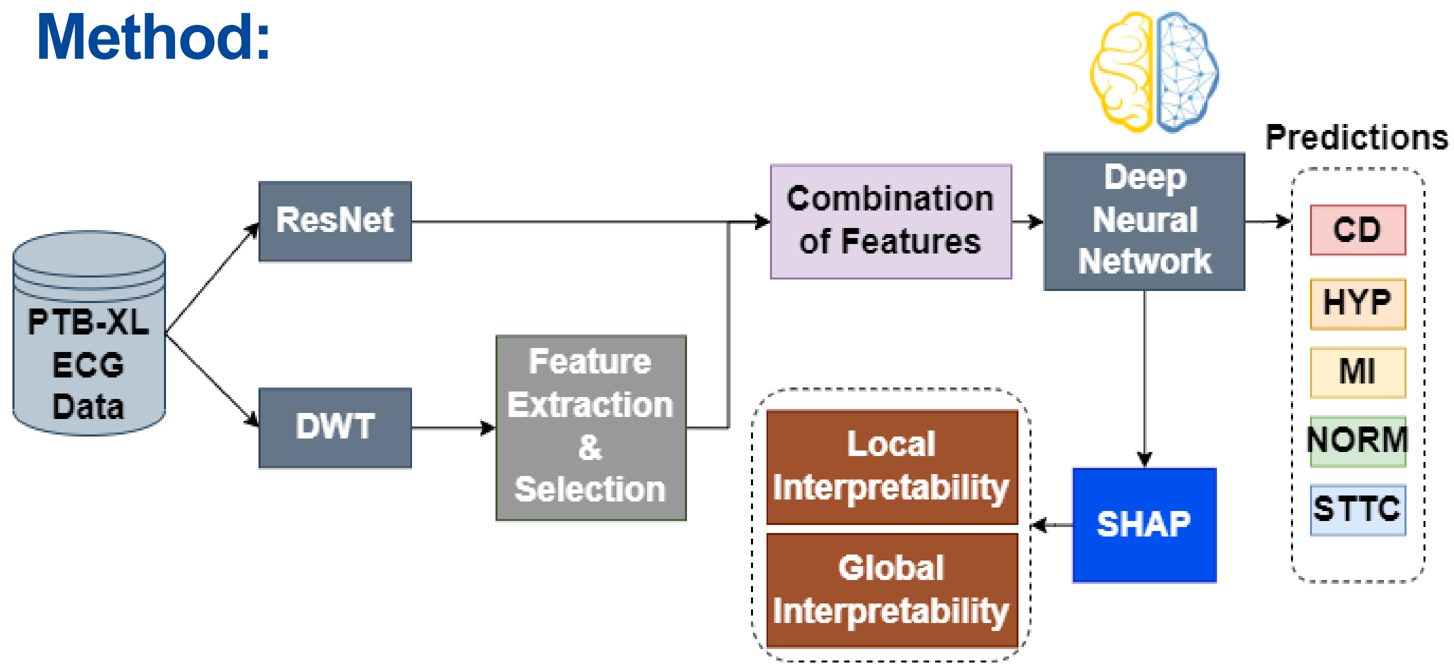
Project Objectives:

The use of artificial intelligence (AI) systems can automate the onerous task of manually interpreting electrocardiogram (ECG) parameters to detect cardiac diseases. However, it is crucial to ensure performance, transparency and interpretability in these systems to instill confidence. This project seeks to develop a robust AI model for assessing 12-lead ECG signals, while providing interpretable explanations for its predictions using explainable AI technique.

Method:



We propose a hybrid approach that combines Residual Network (ResNet) and Discrete Wavelet Transformation (DWT). The approach begins by extracting feature maps from the ResNet model and statistical features using DWT. Next, the two sets of features are fed into a deep neural network to predict cardiac diseases. Finally, we employ Shapley Additive explanations (SHAP) to explain the model's predictions. The approach is evaluated on the PTB-XL dataset, which is the largest publicly accessible dataset. It consists of five class labels: Conduction Disturbance (CD), Hypertrophy (HYP), Myocardial Infarction (MI), Normal ECG (NORM), and ST/T Change (STTC).

Findings:

The hybrid approach outperformed an end-to-end ResNet model in predicting positive instances of patients with diseases. It has achieved higher recall on the disease classes (i.e., CD, STTC, MI and HYP). This has significant clinical implications in terms of early detection and treatment of these conditions.

Recall/ Class	CD	NORM	STTC	MI	HYP
Hybrid Model	**0.72**	0.88	**0.76**	**0.68**	**0.44**
End-to-end ResNet model	0.65	**0.90**	0.69	**0.68**	0.40

Our SHAP analysis further highlighted how the learned features from ResNet and features extracted using DWT work synergistically to capture complex patterns and characteristics, enabling more accurate identification of cardiac diseases.