Automated Classification of Electrocardiogram Data Using Machine Learning

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Introduction

Background:

Utilizing PeacLab's supervised machine learning (ML) framework[1] that:

- Uses multivariate time series data from large-scale computing systems to diagnose performance anomalies
- Extracts statistical features and then selects important features to reduce data dimensionality
- Trains tree-based ML models

Problem:

- Investigating medical data manually can be time-consuming and lead to delays in diagnosis
- ML models can automate the investigation process while maintaining high accuracy
- Drawbacks of deep learning (DL) models:
  - Require large quantities of labeled data
  - Costly to train and maintain in a resource limited environment

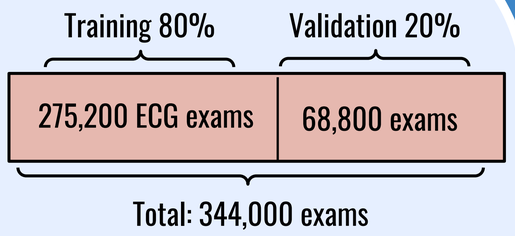
Goal:

- Determine the applicability of Peaclab's supervised ML framework to a public medical dataset of electrocardiogram (ECG) exams
- Determine if any of 6 ECG anomalies (1dAVb, RBBB, LBBB, SB, AF, ST) are present based on a patient's ECG exam data

Methods

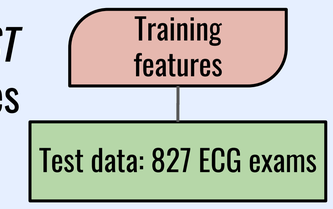
1. Preprocess Training Data:

- tsfresh feature extraction from time-series data
- Chi-square feature selection



2. Train Model: One vs. Rest Classifier with LGBM

- Fits a model for each class separately
  - Classes: *1dAVb, RBBB, LBBB, SB, AF, ST*
  - Each exam can have multiple anomalies

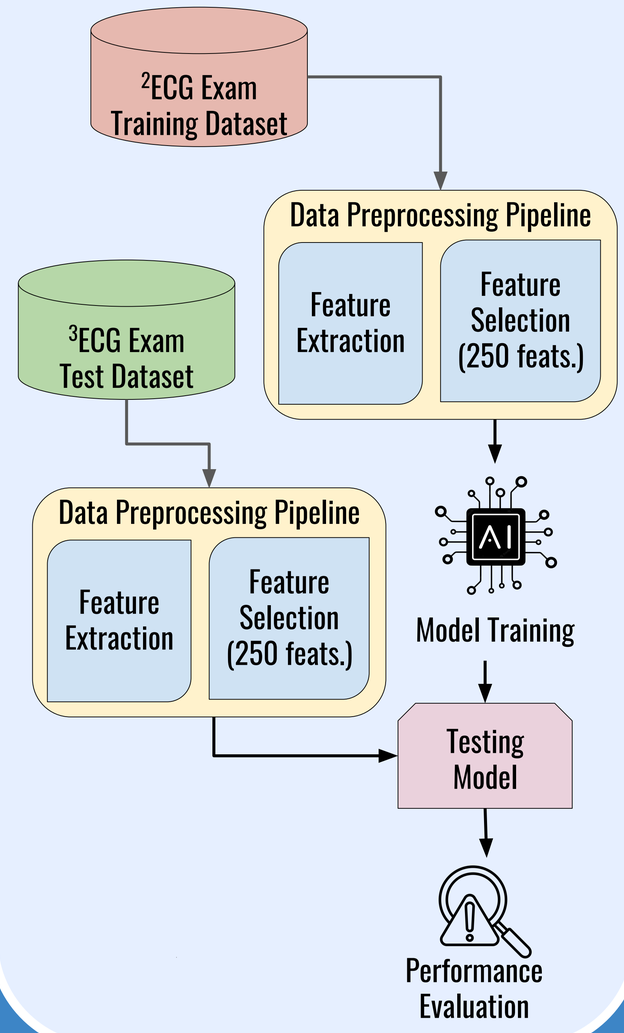


3. Evaluate Model:

- Perform the same feature extraction, scaling, and selection used to process training dataset
- Compare the predicted labels and true labels for each anomaly type separately
- Report precision, recall, and F1-score for each anomaly

	1dAVb	RBBB	LBBB	SB	AF	ST
Pred	0	1	1	0	1	0
Truth	0	0	1	0	0	1

Pipeline



Results

ECG Anomaly	Precision		Recall		F1-Score	
	LGBM	Baseline	LGBM	Baseline	LGBM	Baseline
1dAVb	0.48	0.87	0.50	0.93	0.49	0.90
RBBB	0.87	0.90	0.78	1.00	0.82	0.94
LBBB	1.00	1.00	0.88	1.00	0.93	1.00
SB	0.99	0.83	0.72	0.94	0.80	0.88
AF	0.49	1.00	0.49	0.77	0.49	0.87
ST	0.48	0.95	0.50	0.97	0.49	0.96

Overall: Our model exhibited poorer performance compared to the DL-baseline model[4]

Potential Explanation: Only 15% of the ECG data used to train the DL-baseline model was public

- Better Performance by LGBM
- Similar Performance (about <10% difference)
- Better Performance by DL-Baseline[4]

Discussion & Future Work

Discussion:

- Existing model would not be able to be implemented in real-world situations as the model only correctly identifies 49% to 88% of anomalies
- Potentially fatal misdiagnosis
- Proof of concept → if improved, similar models could be utilized in the future
  - Tree-based classifiers can be faster and less resource intensive compared to DL-models

Future Work:

- Train the model with more data
- Experiment with other feature selection techniques + ML models
- Experiment with hyperparameter tuning

References

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