Automated Classification of Electrocardiogram Data Using Machine Learning

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Introduction

Background:

Utilizing PeacLab's supervised machine learning (ML) framework[3] that:

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

Problem:

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

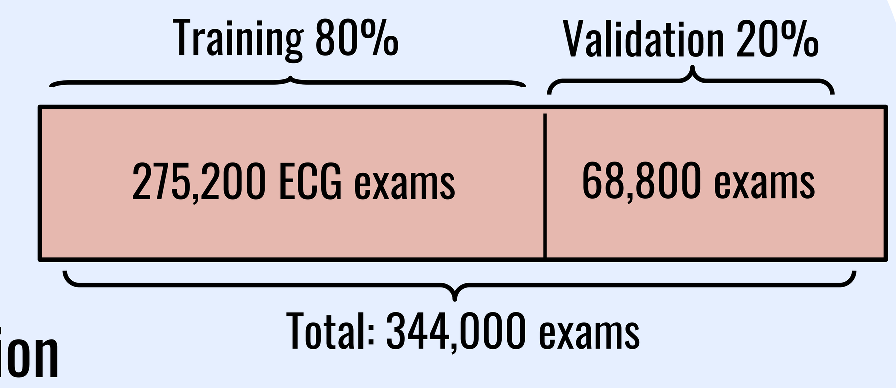
Goal:

- Determine the applicability of the previously developed supervised ML framework to a public medical dataset of electrocardiogram (ECG) exams.
- Determine if any of 6 different 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-squared feature selection

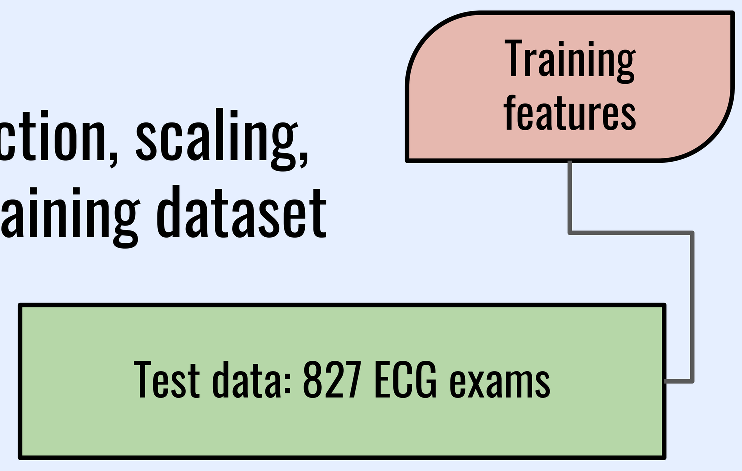


2. Train Model: One vs. Rest Classifier with LGBM

- 6 anomaly classes: 1dAVb, RBBB, LBBB, SB, AF, ST
- Fits a model for each class separately
- Differs from previous framework due to ability to predict multiple anomalies per exam

3. Preprocess Test Data:

- Perform the same feature extraction, scaling, and selection used to process training dataset



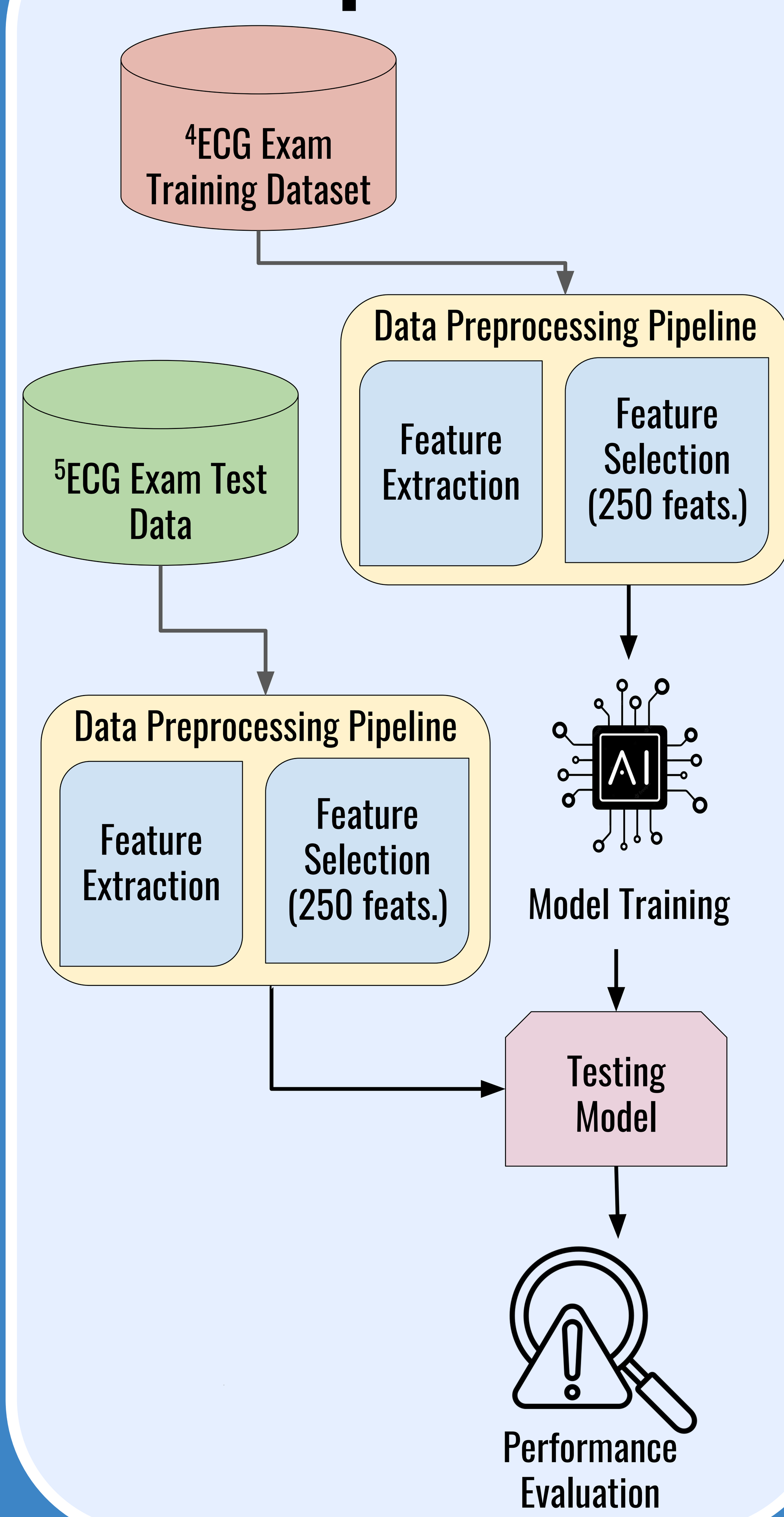
4. Test Model:

- Run model on test data.

5. Evaluate Model

- Evaluate predictions by iterating each predicted anomaly column as a NumPy array and doing a side-by-side comparison with arrays of the true labels
- Each anomaly prediction is evaluated independent of the others as one exam can contain multiple ECG anomaly types

Pipeline



Results

ONE-VS-REST LGBM			
ECG Anomaly	**Precision**	**Recall**	**F1-Score**
1dAVb	0.48	0.50	0.49
RBBB	0.87	0.78	0.82
LBBB	1.00	0.88	0.93
SB	0.99	0.72	0.80
AF	0.49	0.49	0.49
ST	0.48	0.50	0.49

DEEP-LEARNING (DL) BASELINE[6]			
ECG Anomaly	**Precision**	**Recall**	**F1-Score**
1dAVb	0.867	0.929	0.897
RBBB	0.895	1.000	0.944
LBBB	1.000	1.000	1.000
SB	0.833	0.938	0.882
AF	1.000	0.769	0.870
ST	0.947	0.973	0.960

Conclusions

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

Potential Explanation: Only 15% of the ECG data used for training the DL-baseline model was publicly available

Thoughts:

- 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 Steps:

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

References

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