# Paradigm Shift from Feature-Based Machine Learning to End-to-End Deep Residual Neural Networks for Pediatric Age Classification from 12-Lead ECG

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Pediatric electrocardiogram (ECG) screening is critical for the accurate diagnosis of cardiac abnormalities. In this study, a deep learning model based on residual network (ResNet) was developed and validated to detect pediatric and classify 12-lead ECGs into different pediatric groups, outperforming feature-based machine learning models.

The models used three different inputs from a dataset of 151,725 recordings of 12-lead ECGs taken at a 500 Hz sampling rate. The input to the feature-based machine learning model was ECG features, including heart rate, T-wave amplitude relative to QRS amplitude, QRS peak-to-peak amplitude, biphasic QRS complexes, QRS duration, and negative T-waves on leads V2 and V3. These features fed them into the multilayer perceptron (MLP) network. For the end-to-end ResNet model, the first input was a 10-second ECG (RawECG) signal, and the second input was the corresponding 1.2-second average representative beat (RepBeat) signal. The model was trained with data augmentation techniques such as sigmoid compression, baseline wander addition, dropout, and scaling using the modified RandAugment technique.

The performance of the models was evaluated using 10-fold nested cross-validation for pediatric detection and 5-fold nested cross-validation for pediatric groups and adult classification. The feature-based MLP model achieved an F1 score of 0.70 for pediatric detection and an average F1 score of 0.62 for classifying pediatric groups and adults. The end-to-end ResNet model achieved an F1 score of 0.88 for pediatric detection from RawECG input and an F1 score of 0.83 from RepBeat input. The model also achieved an average F1 score of 0.77 for classifying pediatric groups and adults from RawECG input, and an F1 score of 0.73 from RepBeat input.

The proposed end-to-end ResNet model with RawECG input outperforms the RepBeat input and the feature-based MLP model. It can help clinicians diagnose cardiac abnormalities quickly and accurately in both pediatrics and adults.