ECG Classification Midterm Report

Course: Introduction to Artificial Intelligence (EARIN)

Semester: Summer 2025

University: Warsaw University of Technology

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Project:

Classification of 12-lead ECG Signals using Random Forest, CNN and LSTM

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1. Introduction

Electrocardiograms (ECGs) are recordings of the heart's electrical activity across 12 leads. These signals are essential for diagnosing heart conditions, but manual analysis is time-consuming.

This project classifies ECGs into four diagnostic categories (Normal, AFib, MI, Other) using Random Forest (RF), CNN and LSTM. We use the CPSC-2018 dataset and simulate labels for now. This document is meant to be understandable even by non-experts in AI or medicine.

2. Dataset and Preprocessing

- **Dataset:** CPSC-2018 ECG Dataset
- **Files:** `.mat` format with 12-lead signals
- **Steps:**
  - Standardize to (5000, 12) shape
  - Labels simulated (to be replaced with real)

3. Feature Extraction

- **RF:** mean, std, max, min, power (5×12 leads $= 60$ features)
- **CNN:** Spectrograms (128×128) of the average signal
- **LSTM:** Raw signal input (5000×12)

4. Models

a) Random Forest

Scikit-learn `RandomForestClassifier` using feature vectors.

b) CNN

Architecture: Conv2D $\rightarrow$ MaxPool $\rightarrow$ Conv2D $\rightarrow$ MaxPool $\rightarrow$ Flatten $\rightarrow$ Dense $\rightarrow$ Output

c) LSTM

Architecture: Masking $\rightarrow$ LSTM $\rightarrow$ Dense $\rightarrow$ Output

5. Training Setup

- Split: 80% training / 20% testing
- Epochs: 5
- Batch size: 8
- Optimizer: Adam

6. Results

Random Forest

Accuracy: 27%

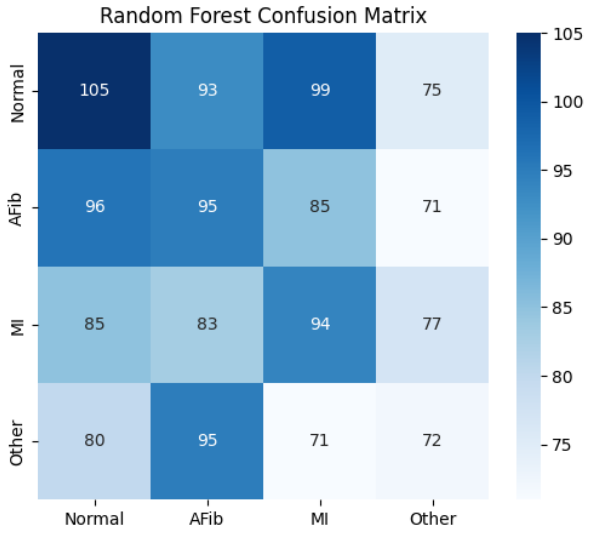

Figure 1: Random Forest Confusion Matrix

CNN

Accuracy: 26%

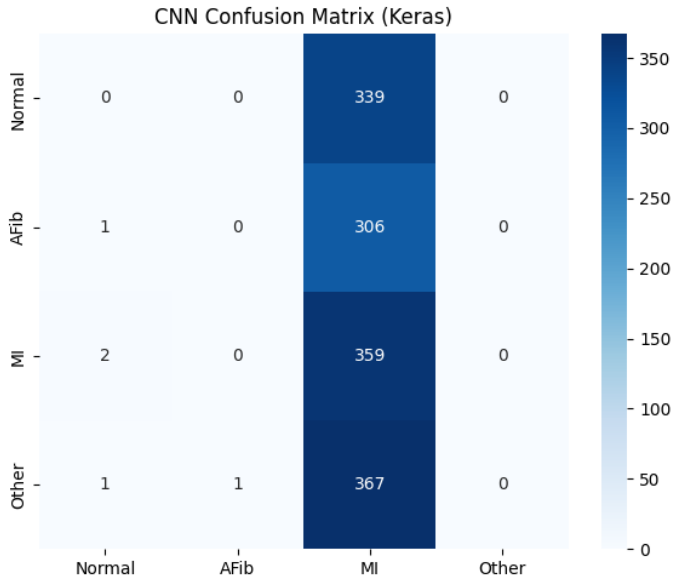

Figure 2: CNN Confusion Matrix

LSTM

Accuracy: 27%

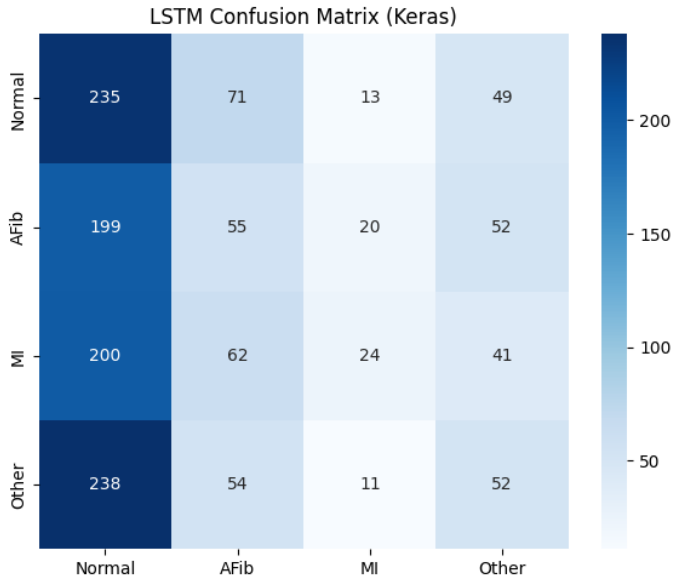

Figure 3: LSTM Confusion Matrix

7. Discussion and Future Work

Observations:

- RF performs evenly but lacks precision
- CNN is biased toward one class

- LSTM has best recall on "Normal"

Pending Questions:

- Can CNN + LSTM hybrid improve performance?
- Which features best capture arrhythmias?
- What input size is ideal for LSTM?

Next Steps:

- Replace simulated labels with real annotations
- Add signal augmentation (noise, shifting)
- Try BiLSTM, deeper CNN