Master Thesis:
Transformer- and ensemble-based multi-label arrhythmia ECG classification

Kilian Kramer

Prof. Dr. Pietro Bonizzi
Prof. Dr. Joël Karel
Prof. Dr. Stef Zeemering

Maastricht University

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Problem Introduction

- Cardiovascular diseases, such as Atrial Fibrillation, are among the most common causes of death in the older population, yielding to an increased demand for professional assessment

- Meanwhile many research and accurate models are available for simpler (binary) ECG arrhythmia classification problems, e.g. Atrial Fibrilliation or common grouped arrhythmia types

- Problem: Often more individual and fine-graned assessment needed

Problem Introduction

- AI can help to develop classification models for individual cardiovascular diseases and improve processes in medical supervision

- However, few public research is available for fine-graned arrhythmia classification tasks including rare diseases, such as Atrial Flutter, Premature Ventricular Contractions, Prolonged QT interval etc.

- In recent years, Transformer models have gained significant popularity and many research papers show promising results on applying these models on ECG arrhythmia classification

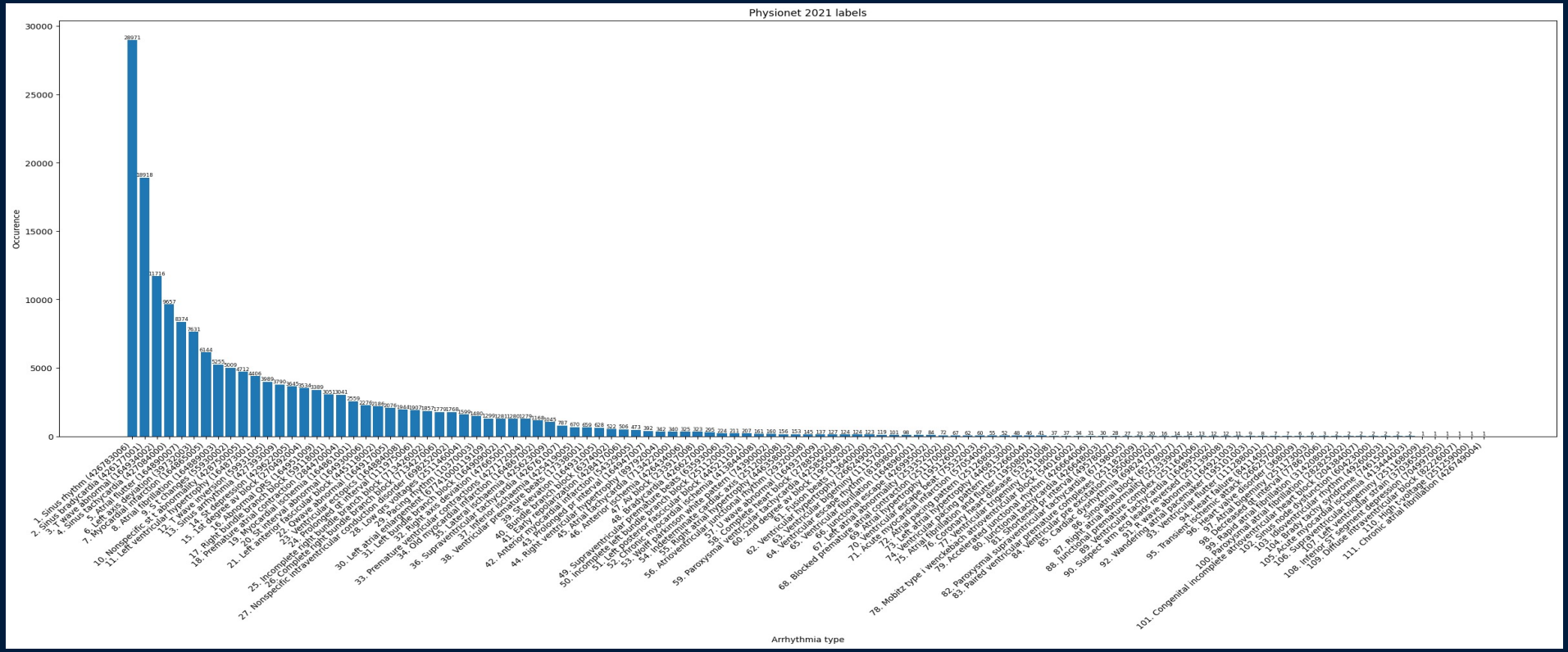
Related Work

Data: Physionet 2021 Challenge database

Dataset source	Average ECG length (seconds)	Data samples
Ningbo database	10s	34,905
PTB-XL database	10s	21,837
Chapman-Shaoxing database	10s	10,247
Georgia 12-lead challenge data	9s	10,344
CPSC database	15s	6. 877
CPSC-extra database	15s	3,453
PTB database	110s	516
INCART database	1800s	74

about 89.000 12-lead ECGS

Physionet 2021 data distribution



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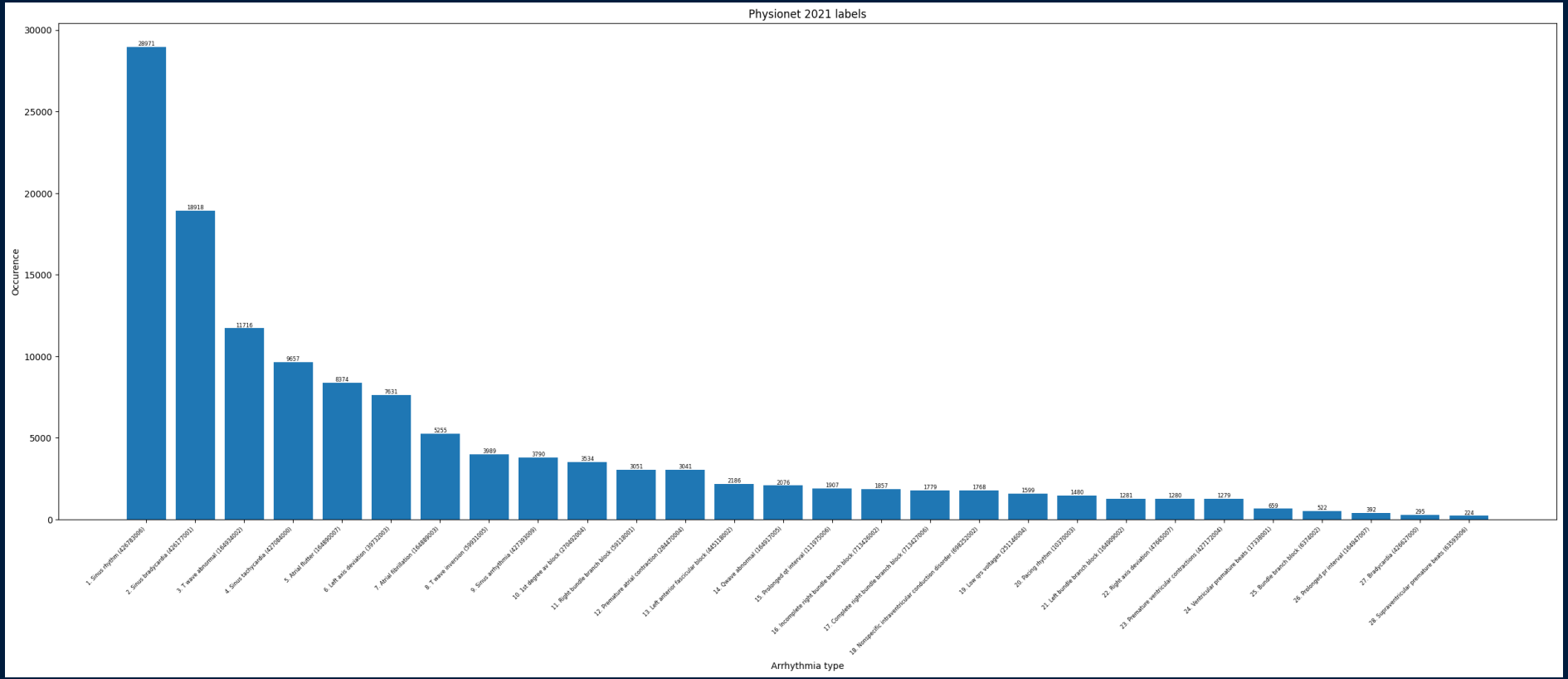
Physionet 2021 scored challenge data distribution (subset)



Research Questions

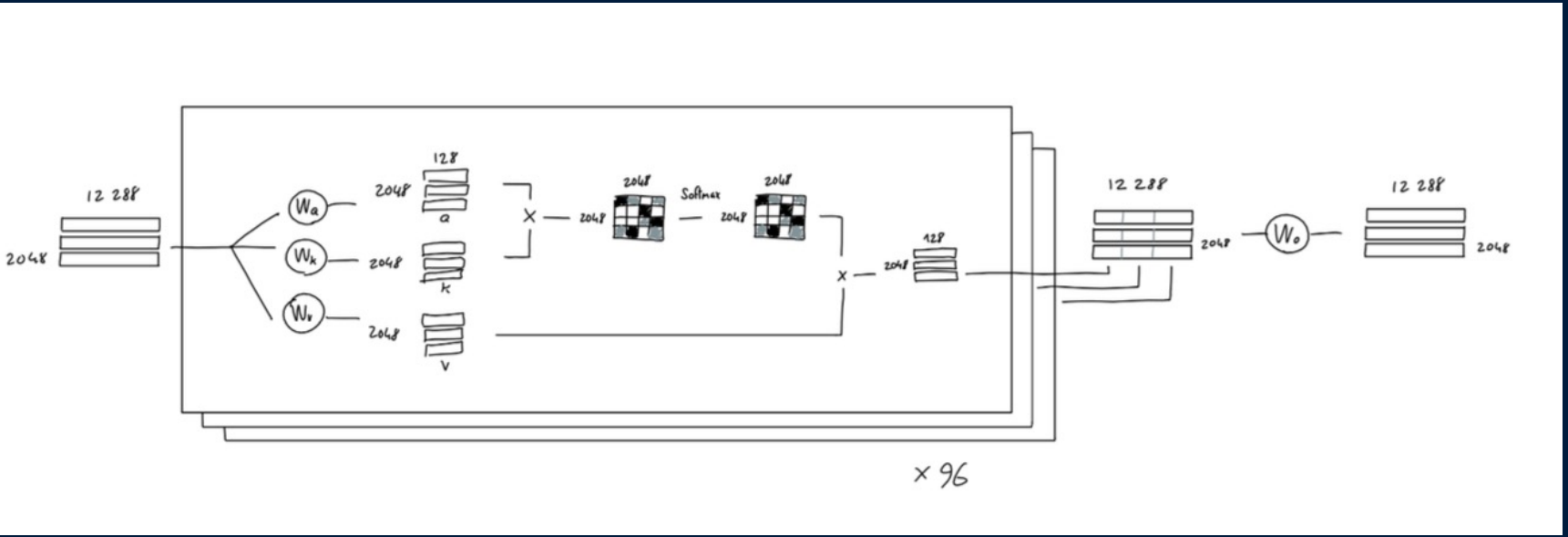
1. How well does a Transformer-based model perform on the Physionet 2021 challenge data compared to a feature-based model or a Convolutional Network?

2. Can an ensemble Transformer model and Convolutional Network effectively capture spatio- temporal information and improve accuracy?

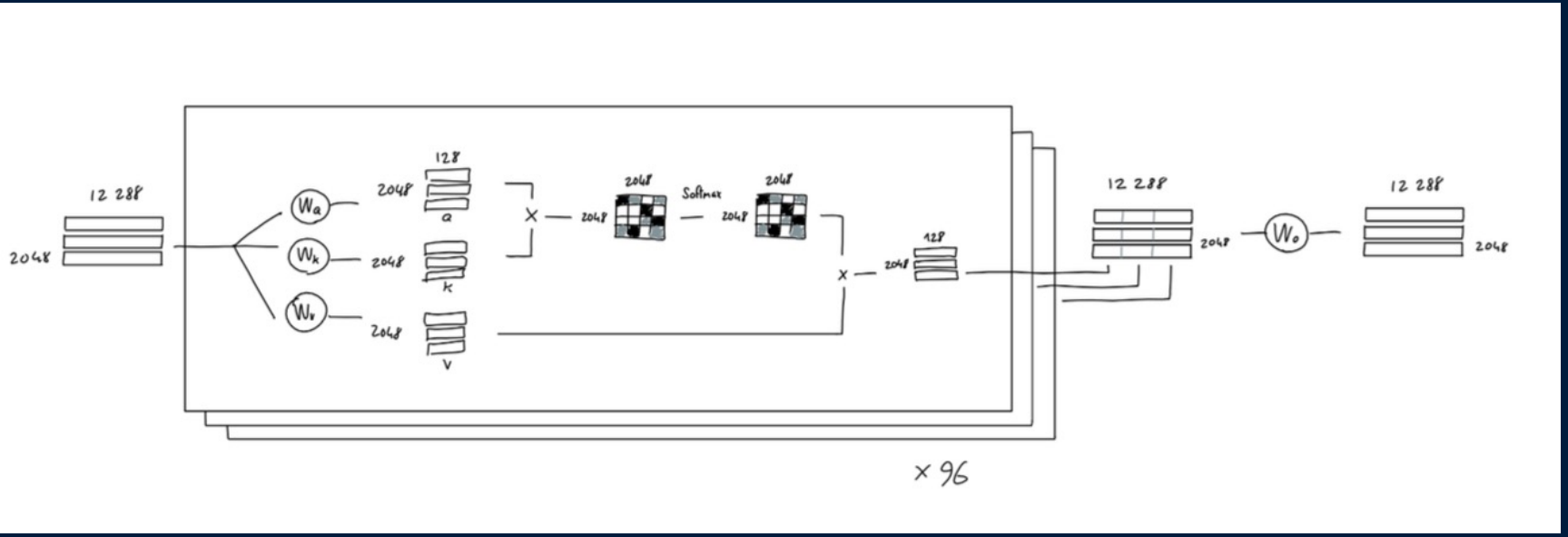
3. Which model performs best at discriminating SR, AF, AFL, PAC and PVC on both datasets?

4. What are the challenges in transferring the pre-trained models from the Physionet 2021 challenge data to the MyDiagnostick database? Do the models generalise well, even though different ECG devices were used?

Methodology 1: Transformer with equal-sized segments as input

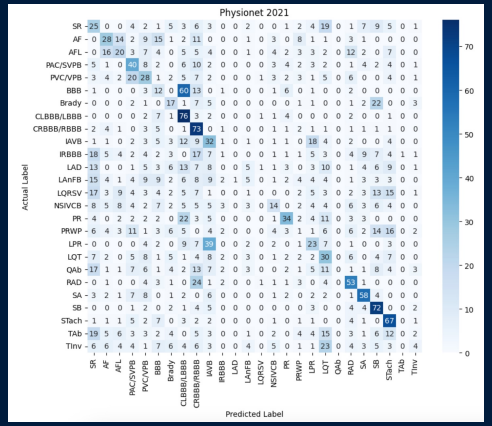


Methodology 1: Transformer with trainable embedding matrix



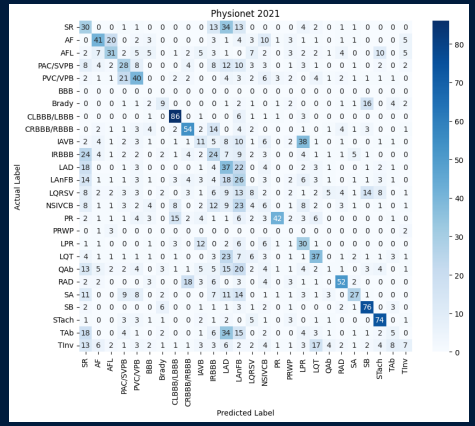
Methodology 2: Ensemble Model

Model 1



+

Model 2



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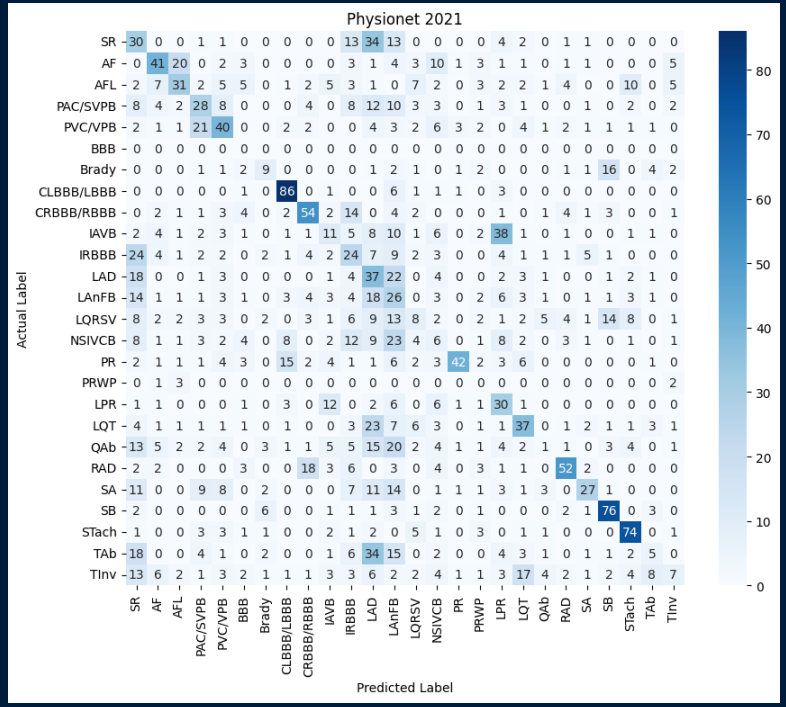
Methodlogy


Physionet 2021
Actual Label
Predicted Label
SR AF AFL PAC/SVPB PVC/VPB BBB Brady CLBBB/LBBB CRBBB/RBBB IAVB IRBBB LAD LAnFB LQRSV NSIVCB PR PRWP LPR LQT QAb RAD SA SB STach TAb TInv
0 10 20 30 40 50 60 70 80

Conclusion