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

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Problem Introduction

- Cardiovascular diseases, such as Atrial Fibrillation, are among the leading causes of death in the population, resulting in an increased demand for cardiac assessment
- Deep learning can improve medical monitoring and can be used to develop multi-classification models for arrhythmia detection
- Today, much research and accurate models are available for simpler arrhythmia classification tasks, e.g. AFIB classification (binary) or common arrhythmia groups classification (AAMI standard)

Problem Introduction

- Problem: Professional treatment requires individual and detailed ECG assessment
- In recent years, Transformer models have gained considerable popularity due to a mechanism called self-attention and research papers show promising results for applying Transformer models on less comprehensive ECG arrhythmia detection
- However, there are few public research and accurate models available for for comprehensive fined-graned arrhythmia classification, including Transformer models and rare types, such as Atrial Flutter, Premature Ventricular Contractions, Prolonged QT interval etc.

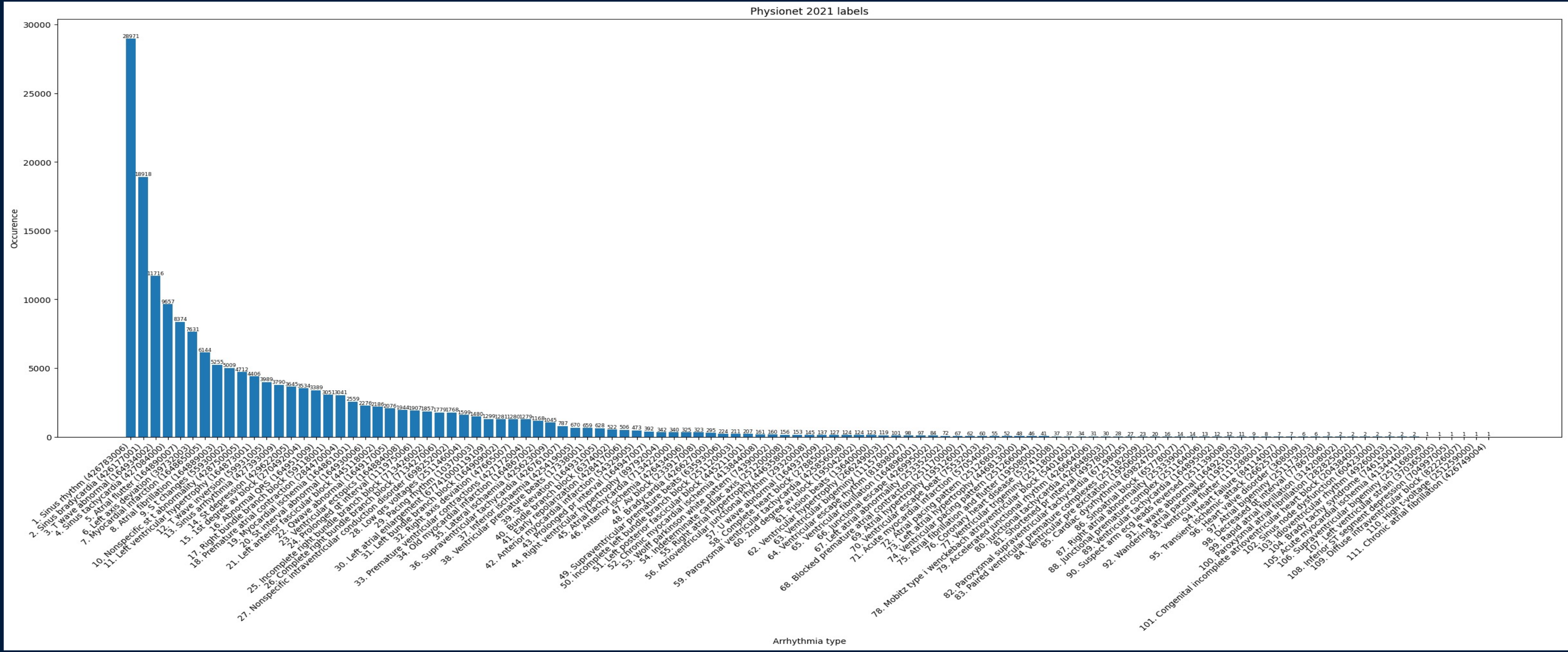
Related Work

Data: Physionet 2021 Challenge database

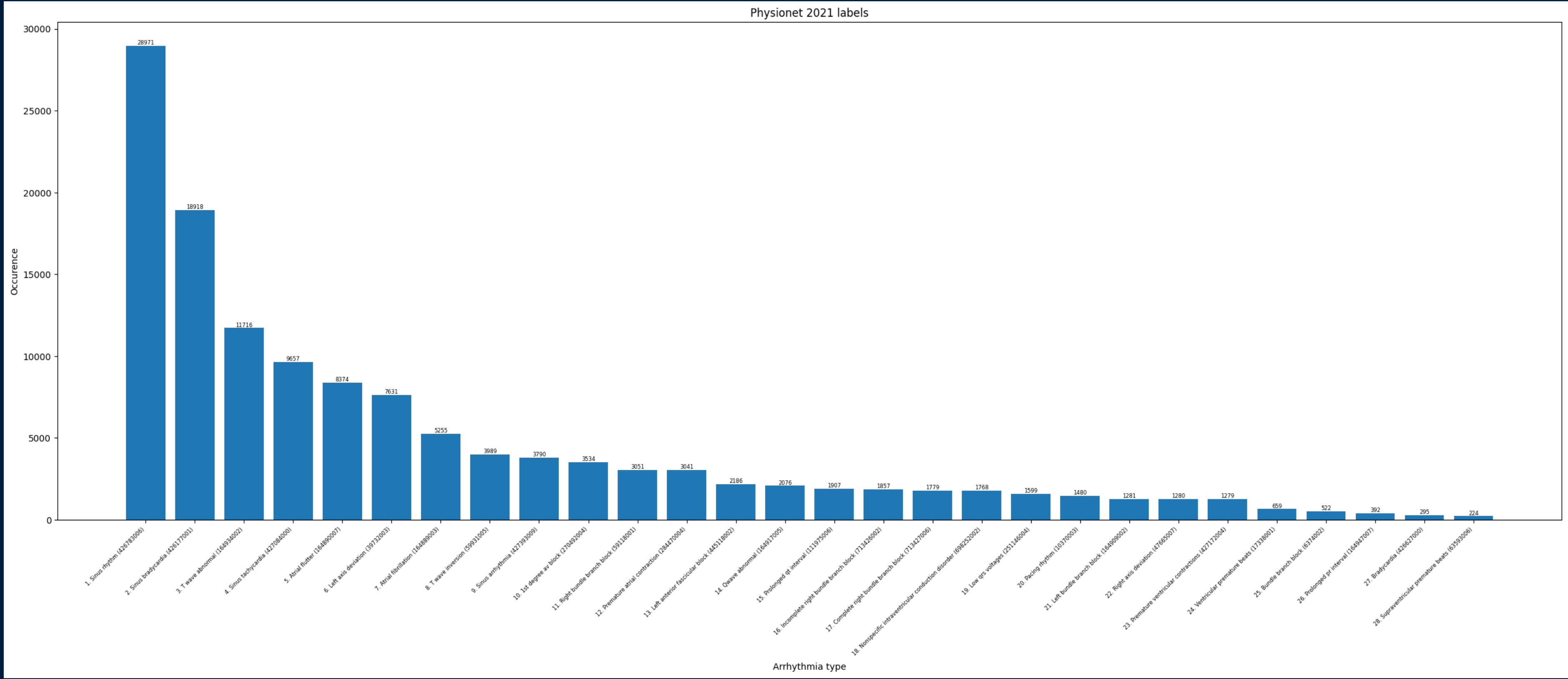
Dataset source	Average ECG length (seconds)	Data samples
Ningbo database	10s	34,905
PTB-XL database	10s	21,837
Chapman-Shaoxing database	10s	10,247
Georgia 12-lead challenge data	9s	10,344
CPSC database	15s	6. 877
CPSC-extra database	15s	3,453
PTB database	110s	516
INCART database	1800s	74

about 89.000 12-lead ECGS

Physionet 2021 data distribution



Physionet 2021 scored challenge data distribution (subset)



Research Questions

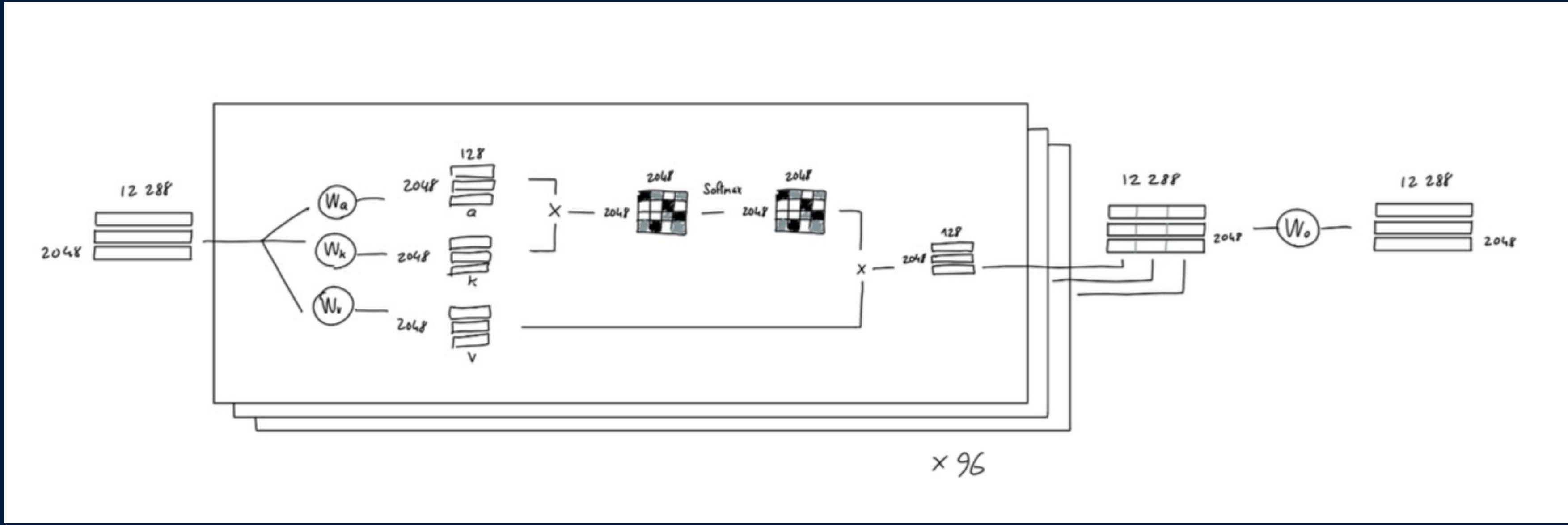
1. How well does a Transformer-based model perform on the Physionet 2021 challenge data compared to a feature-based model or a Convolutional Network?

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

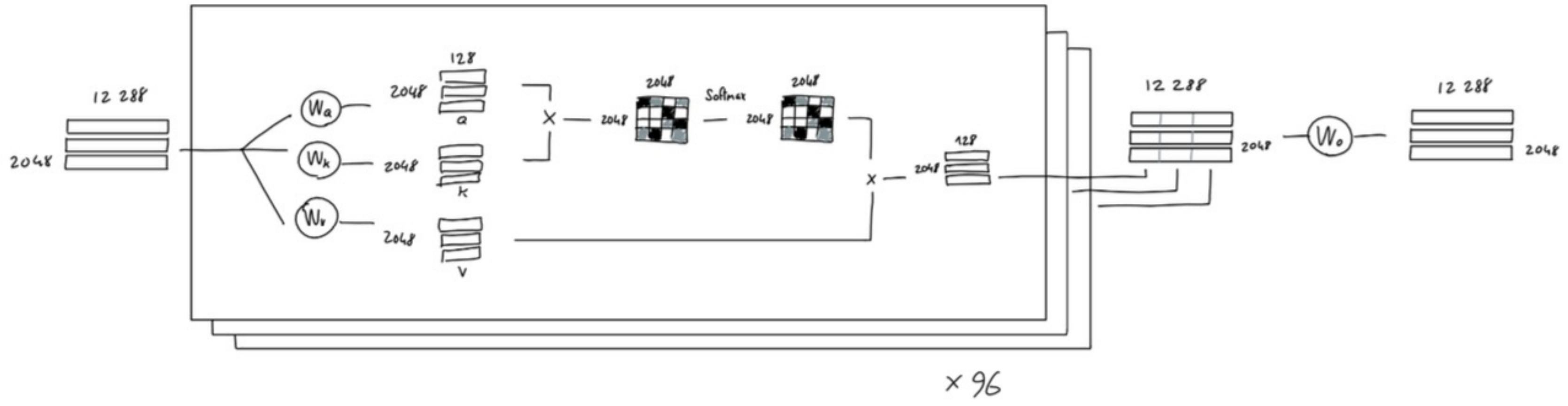
3. Which model performs best at discriminating SR, AF, AFL, PAC and PVC on both datasets?

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

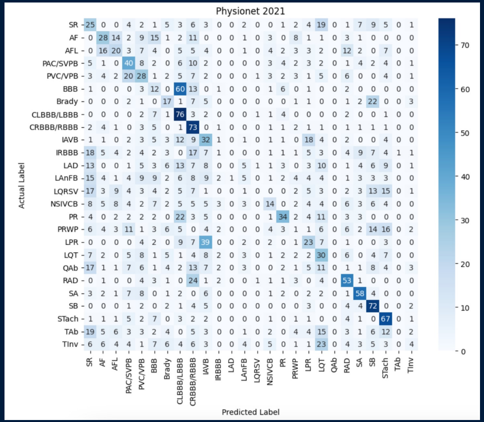


Methodology 1: Transformer with trainable embedding matrix



Methodology 2: Ensemble Model

Model 1



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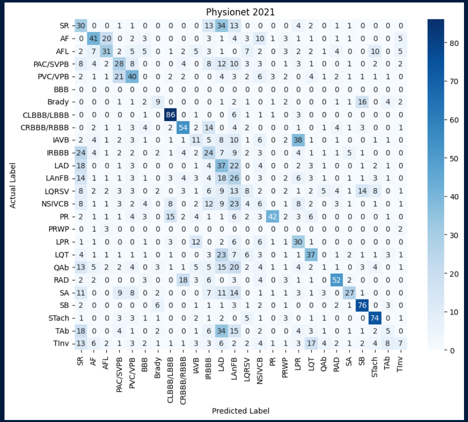
Model 2



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Experiments and Evaluation

Evaluation: Physionet 2021

Evaluation: Physionet 2021 metrics

Master's Thesis evaluation: Application of Transformer models on the Physionet 2021 challenge database

KK

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Mo, 24.06.2024 11:42

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Dear organisers of the CinC Physionet 2021 Challenge,

first of all, a big thank you for the provided Physionet 2021 Challenge database, which is an important part of my Master's thesis. Regarding my current Master's thesis on the application of Transformer and other models (i.e. ensemble of CNN, Transformer and feature-based model) to multi-label arrhythmia classification, I need your help to evaluate my models. I have used the Physionet 2021 Challenge database to train my models and would like to compare my results with the official Challenge metrics and participant team scores (https://moody-challenge.physionet.org/2021/results/), but the official test data is private. Could you please run my best validated model on the test data so that I can successfully draw a proven conclusion from my evaluation?

Yours sincerely,

Kilian Kramer from Maastricht University, Netherlands

Evaluation: Physionet 2021 metrics

Conclusion