

# Deep learning in emergency care

Axel Nyström, 2021-12-09

# About me

- MSc in computer science and engineering
- 2 years as data scientist in Malmö

# About me

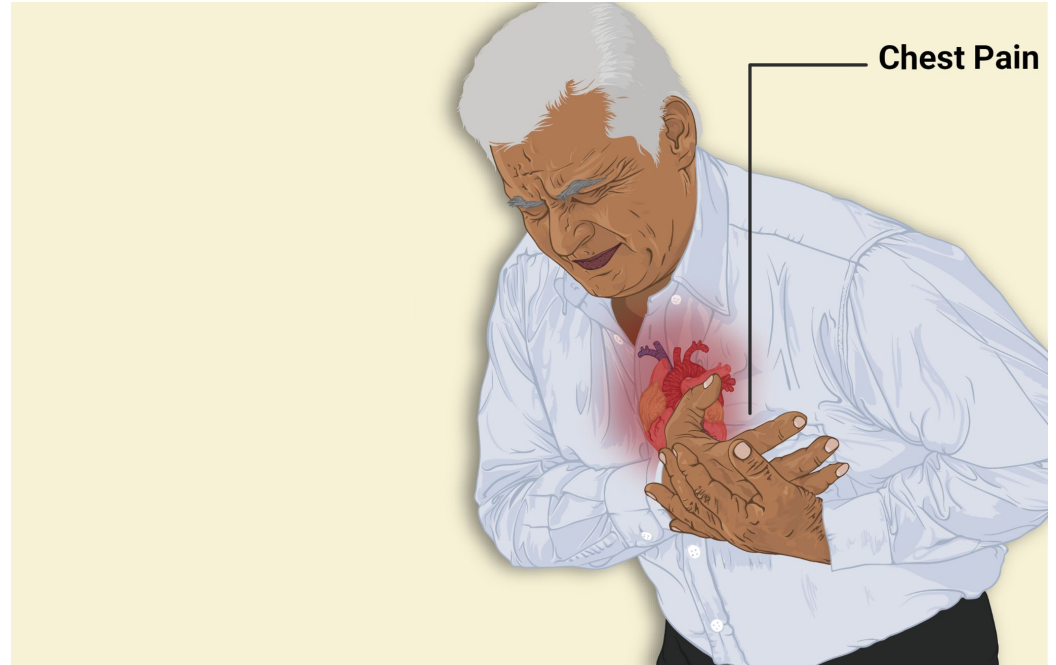
- Machine learning at the emergency department
- Focus on patients with chest pain

# About me

- Jonas Björk
- Ulf Ekelund
- Jakob Lundager Forberg
- Mattias Ohlsson

Machine learning for predicting  
major adverse cardiac events  
using serial electrocardiograms

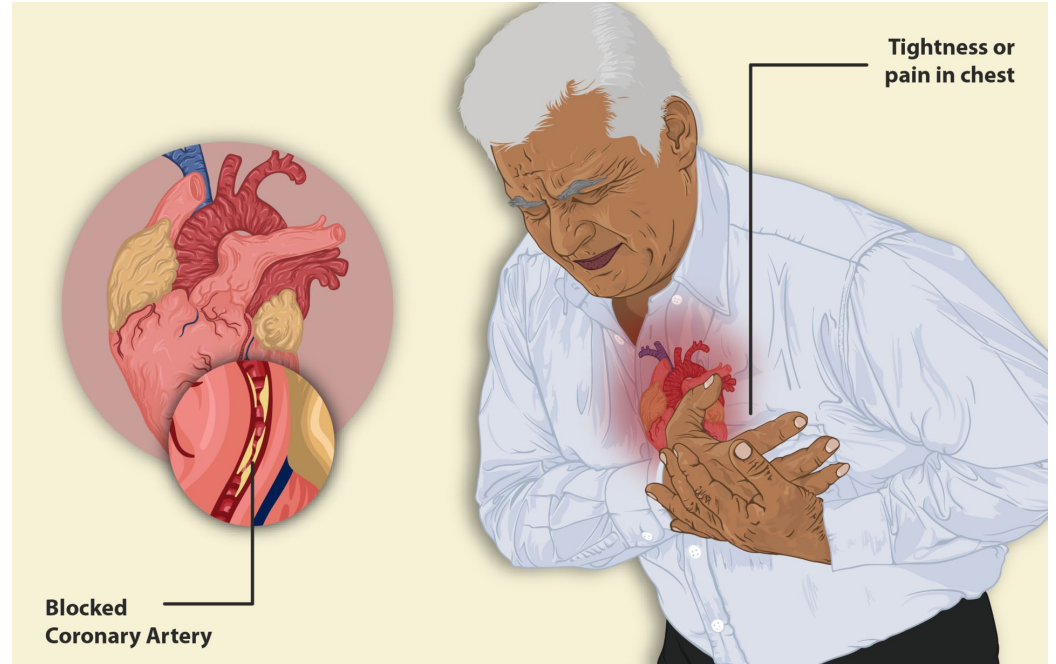
# Chest pain



# Angina pectoris

Angere = “to strangle”

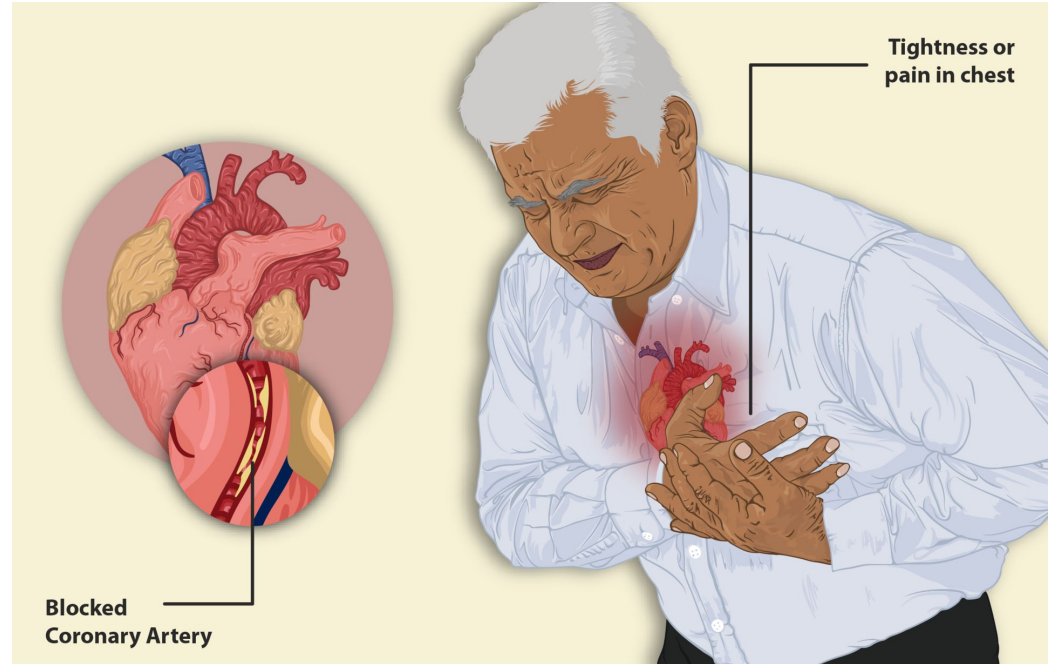
Pectus = “chest”



# Angina pectoris

Insufficient oxygen (ischemia)

Can lead to heart attack





# What the doctor wants to know

- Send home?
- Send to the cardiac care unit?

# What the doctor wants to know

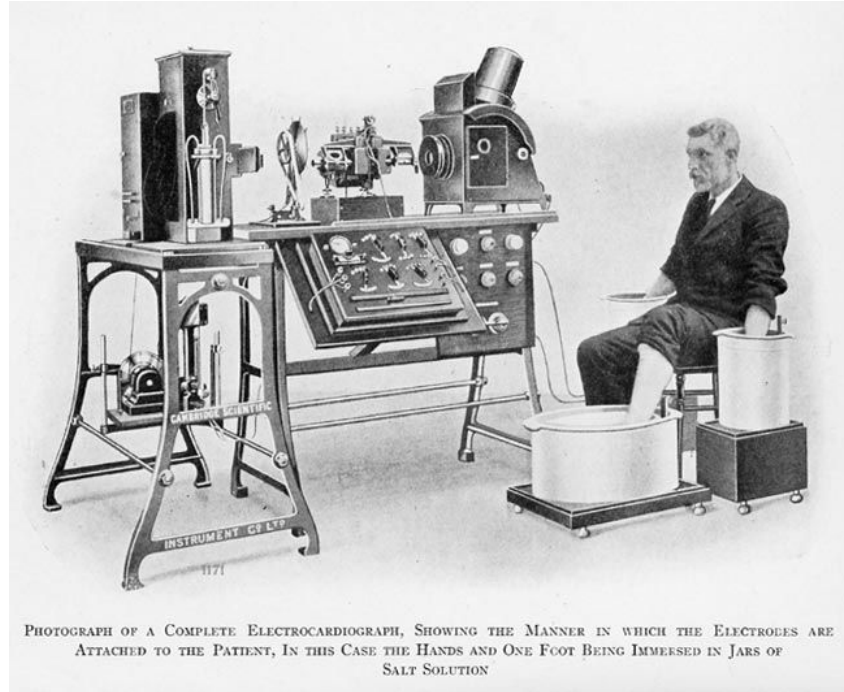
## Major Adverse Cardiovascular Event?

- Chest pain
- Heart attack
- Death

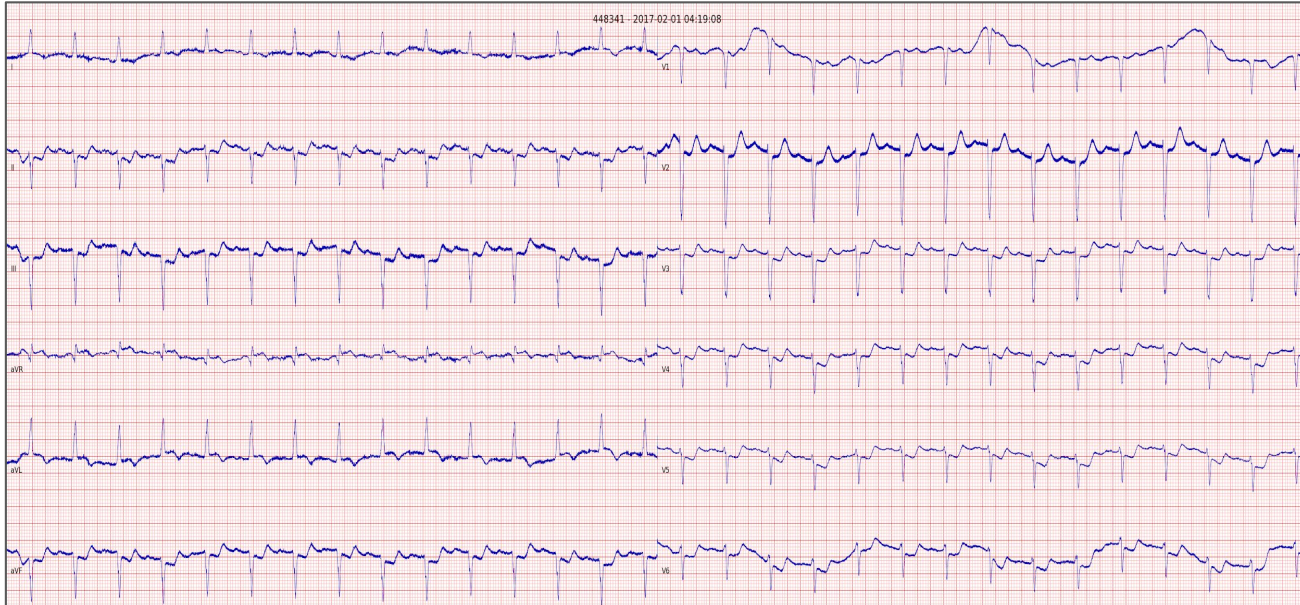
# What the doctor does

- Looks at the ECG
- Compares with previous ECGs
- Takes blood sample

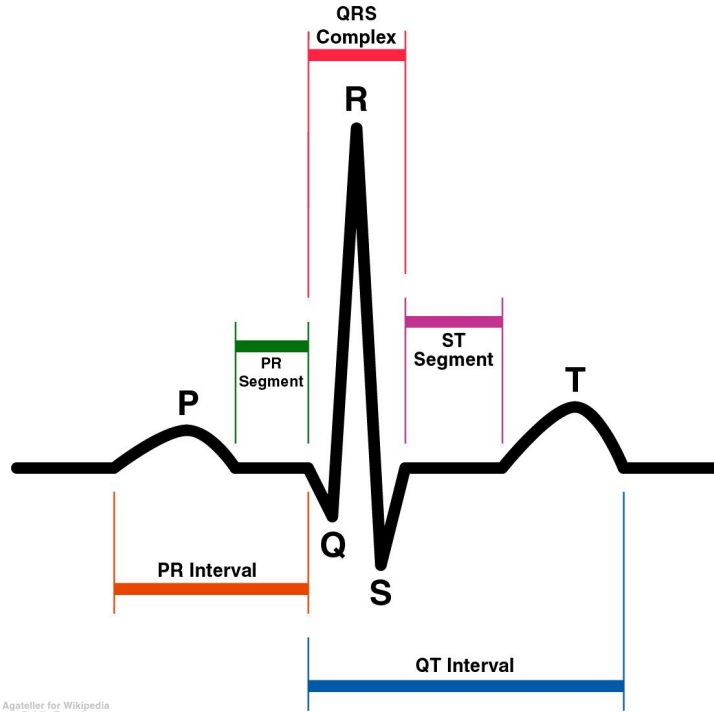
# What is an ECG?



# What is an ECG?

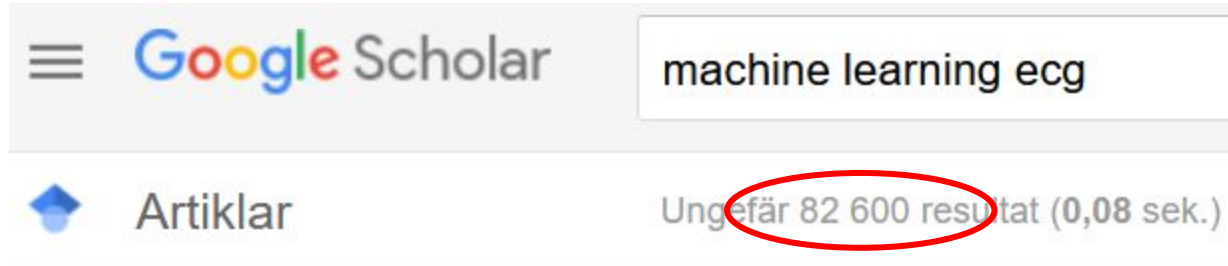


# What is an ECG?



Agateller for Wikipedia  
Public Domain

# Problem formulation



The image shows a screenshot of the Google Scholar search interface. At the top left, there is a hamburger menu icon followed by the text "Google Scholar". To the right of this is a search input field containing the text "machine learning ecg". Below the search bar, there is a section for "Artiklar" (Articles), indicated by a blue graduation cap icon. To the right of "Artiklar", the text "Ungefär 82 600 resultat (0,08 sek.)" is displayed. The number "82 600" is circled in red.

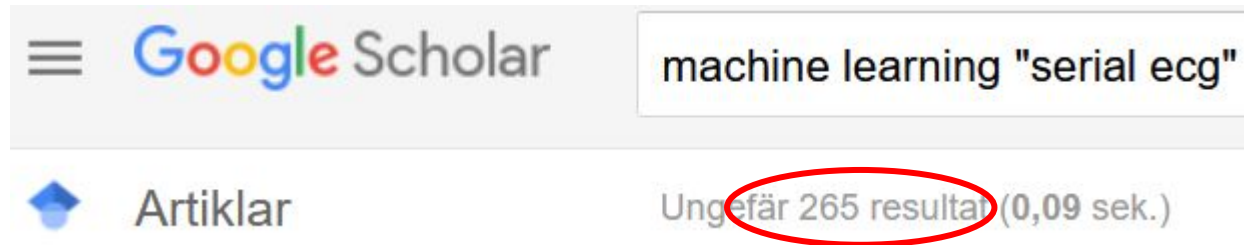
Google Scholar

machine learning ecg

Artiklar

Ungefär 82 600 resultat (0,08 sek.)

# Problem formulation





# Problem formulation

Is there any added value of previous ECGs for predicting MACE?

# ESC-Trop

- Patients with chest pain at ED
- Consecutive between 2017-2018
- 26547 unique patients



# ESC-Trop

- Patients with chest pain at ED
- Consecutive between 2017-2018
- 26547 unique patients
- 26267 non-STEMI
- 26044 with TnT measurements
- 24048 with ECG records at index
- **19500** with >1 ECG record



# Strategy

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- Pick a model

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- Tune it for 1 ECG

# Strategy

- Pick a model
- Tune it for 1 ECG
- Tune it for 2 ECGs

# Strategy

- Pick a model
- Tune it for 1 ECG
- Tune it for 2 ECGs
- Compare to see which was better



# Problems

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- What features to include?

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# What features to include?

Only ECGs

- Simpler
- Easier (maybe)

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## Only ECGs

- Simpler
- Easier (maybe)

## ECGs + age, sex, troponin

- More clinically relevant



# Problems

- What features to include?
- What model to use?
- How to tune the model?
- How to quantify the improvement?

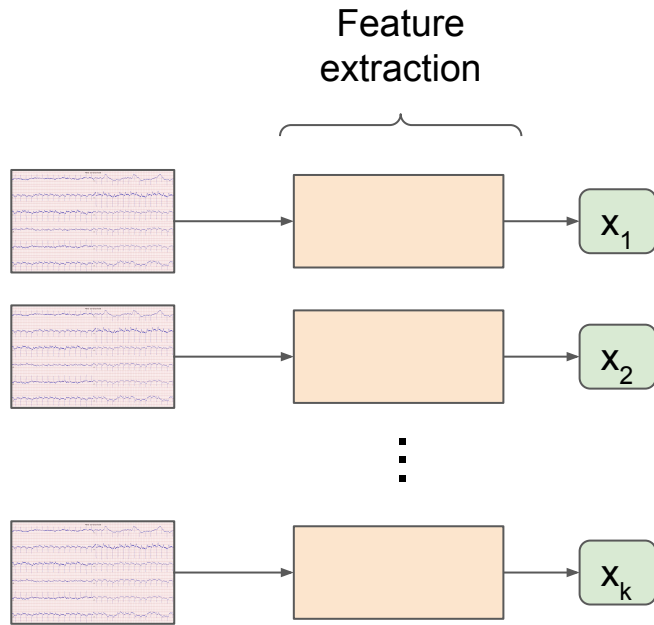
# Serial ECGs



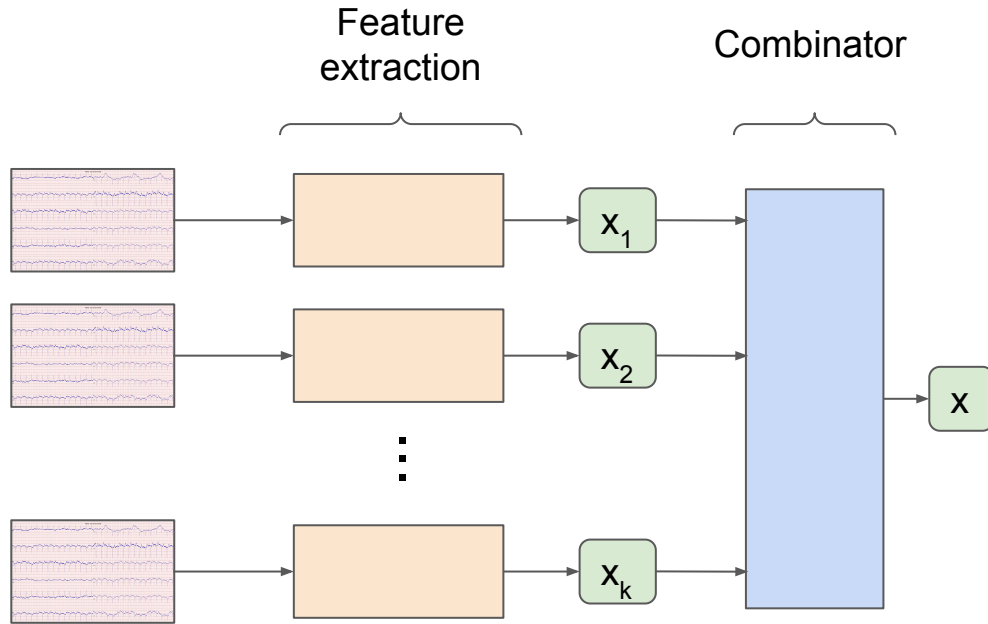
⋮



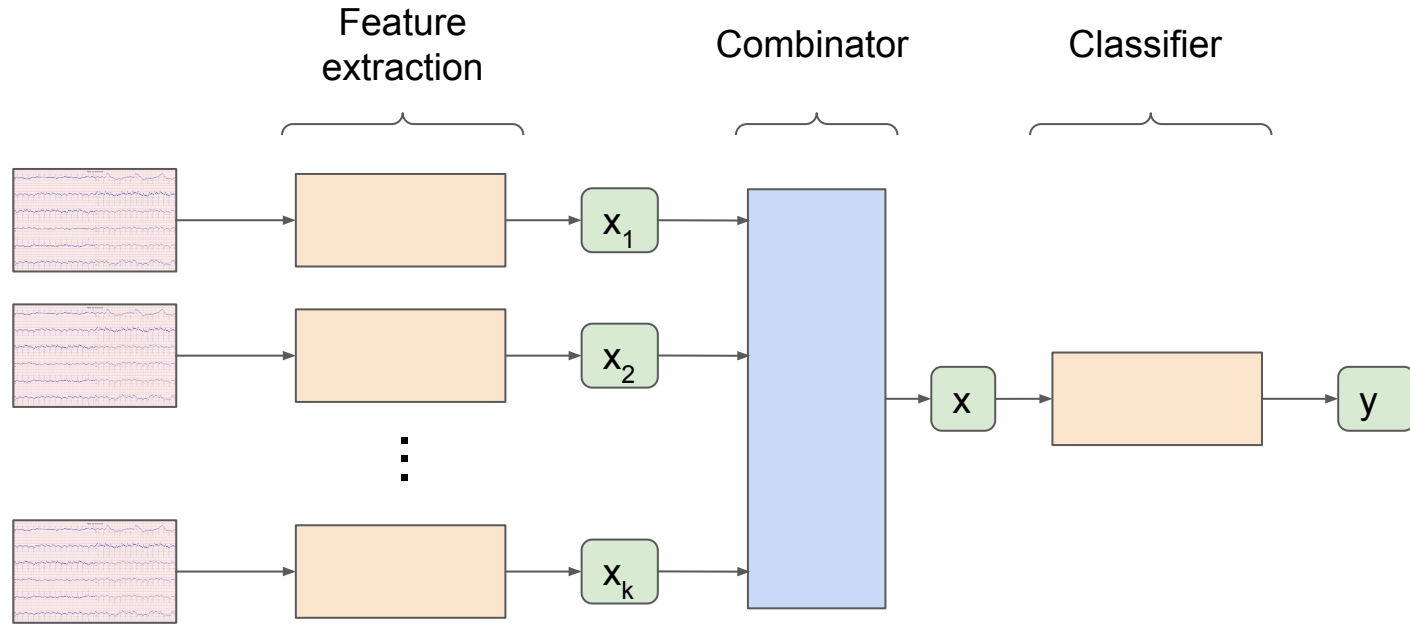
# Serial ECGs



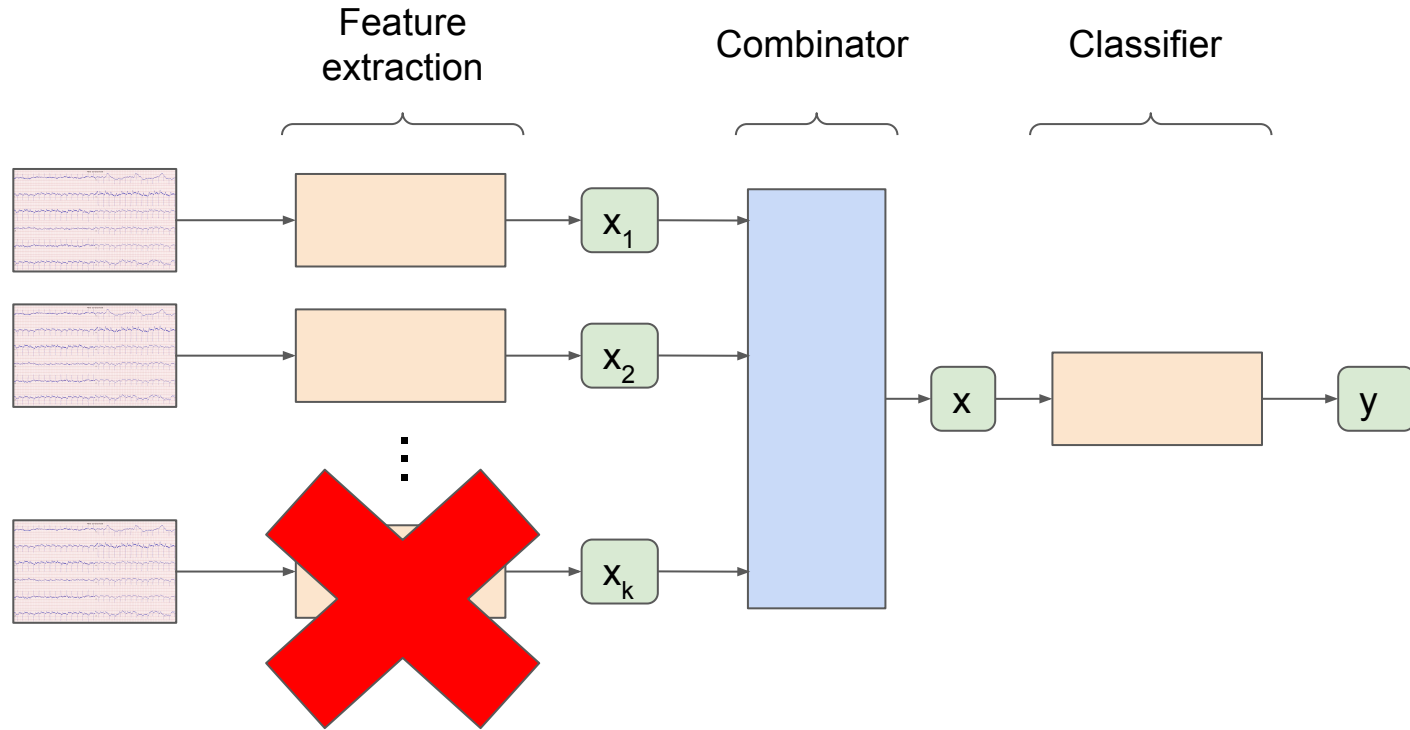
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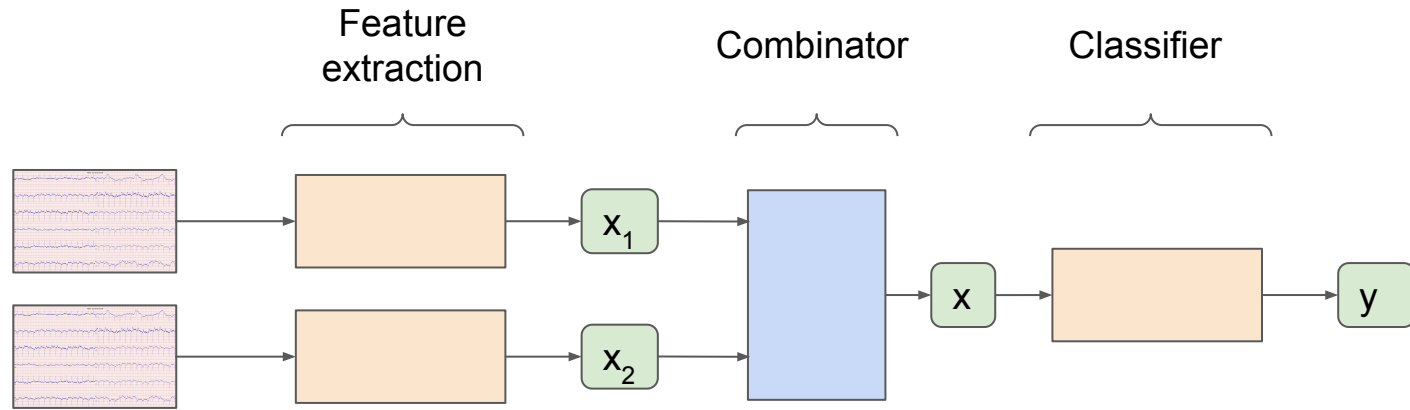
# Serial ECGs



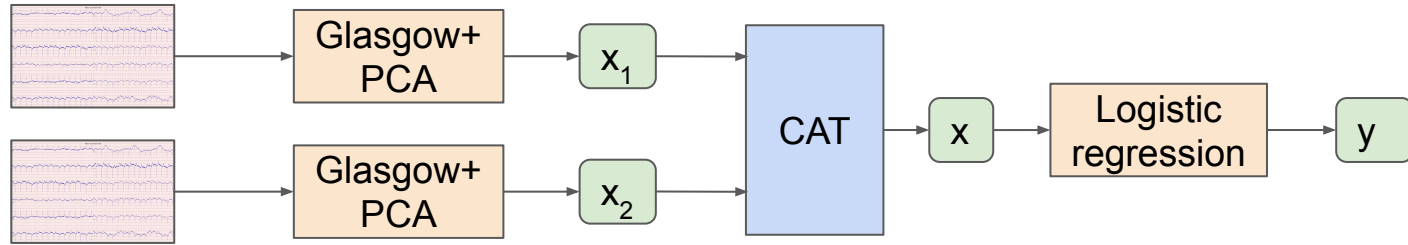
# Serial ECGs



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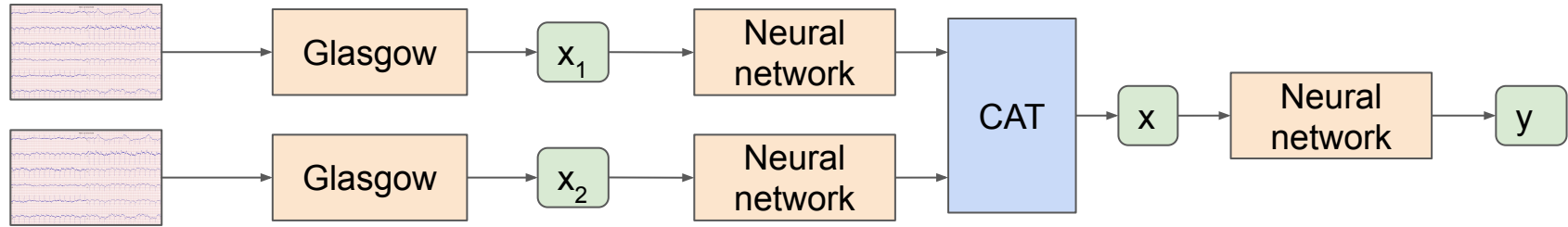


# Serial ECGs - Logistic regression

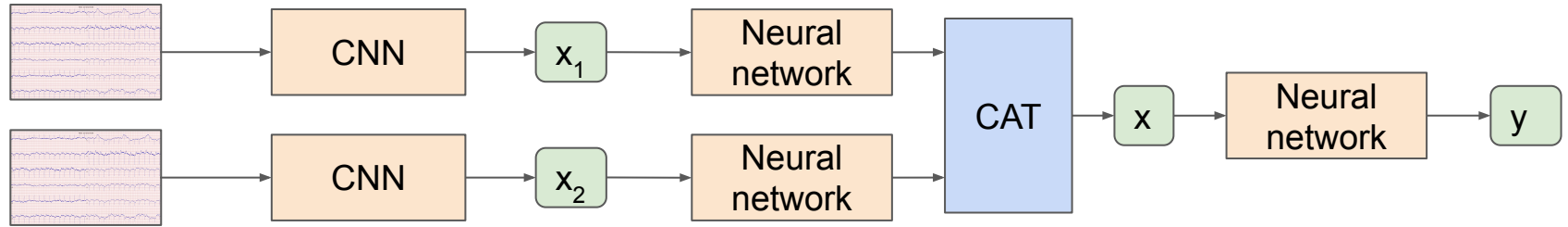




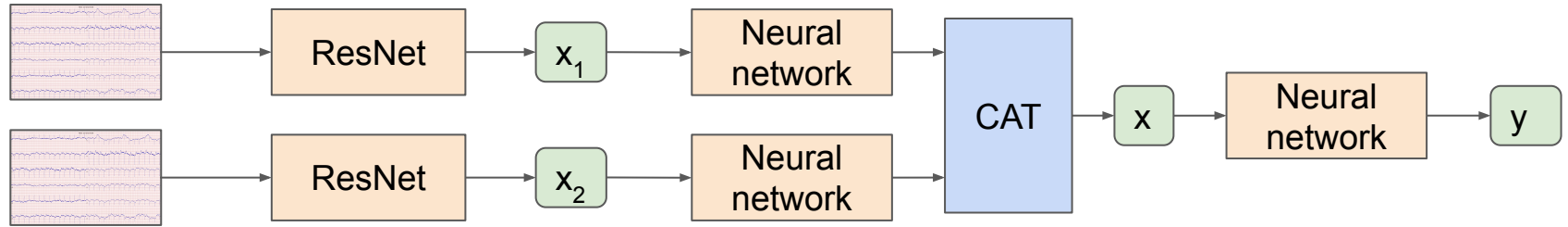
# Serial ECGs - Neural Network



# Serial ECGs - Convolutional Neural Network



# Serial ECGs - Pre-trained ResNet



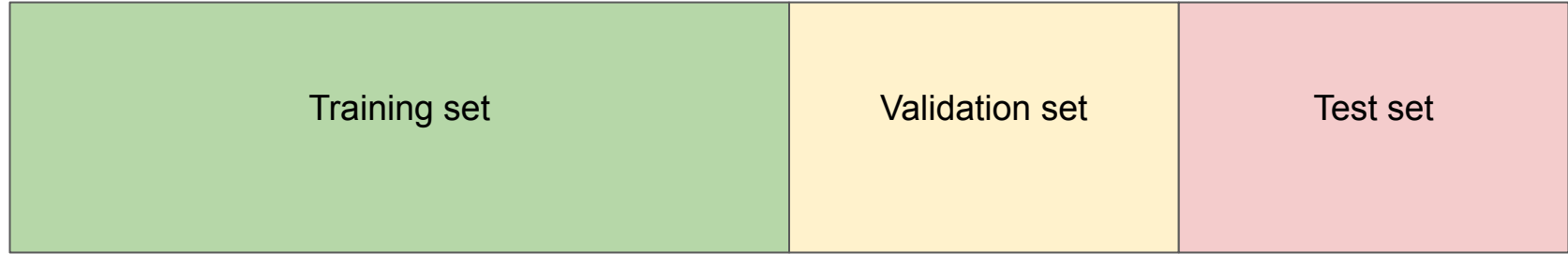
# What model to use?

- Logistic regression (LR)
- Neural network (NN)
- Convolutional neural network (CNN)
- Pre-trained ResNet (RN)

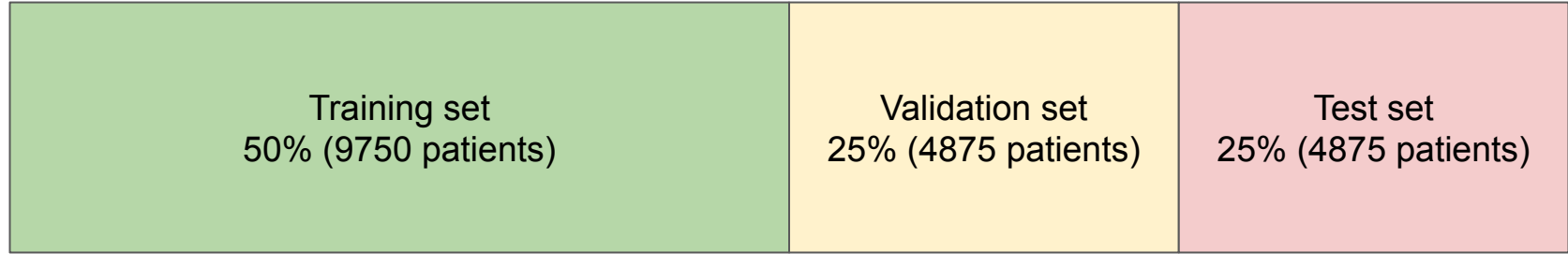
# Problems

- What features to include?
- What model to use?
- How to tune the model?
- How to quantify the improvement?

# How to tune the model?



# How to tune the model?



# How to tune the model?

- Train/validation/test set split
- Random search
- Ensemble of best models



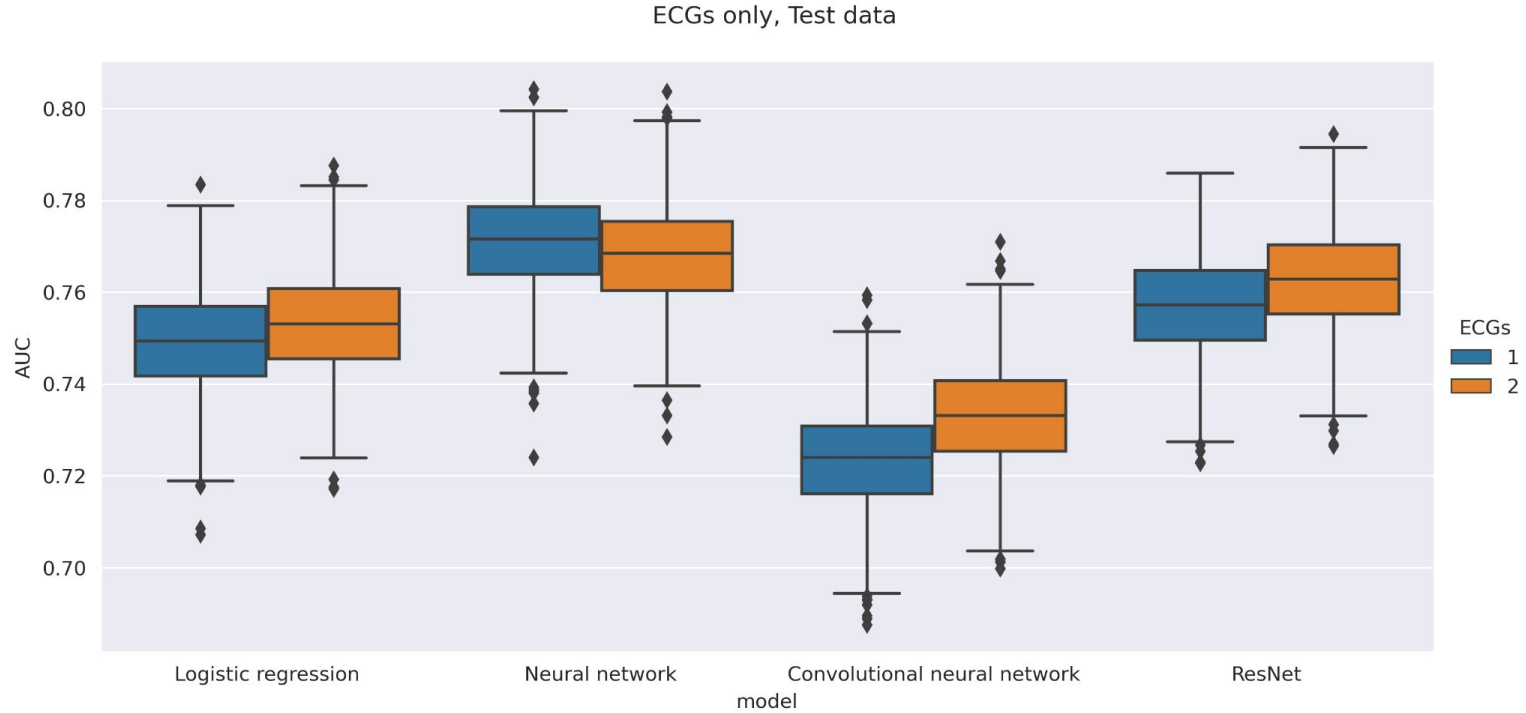
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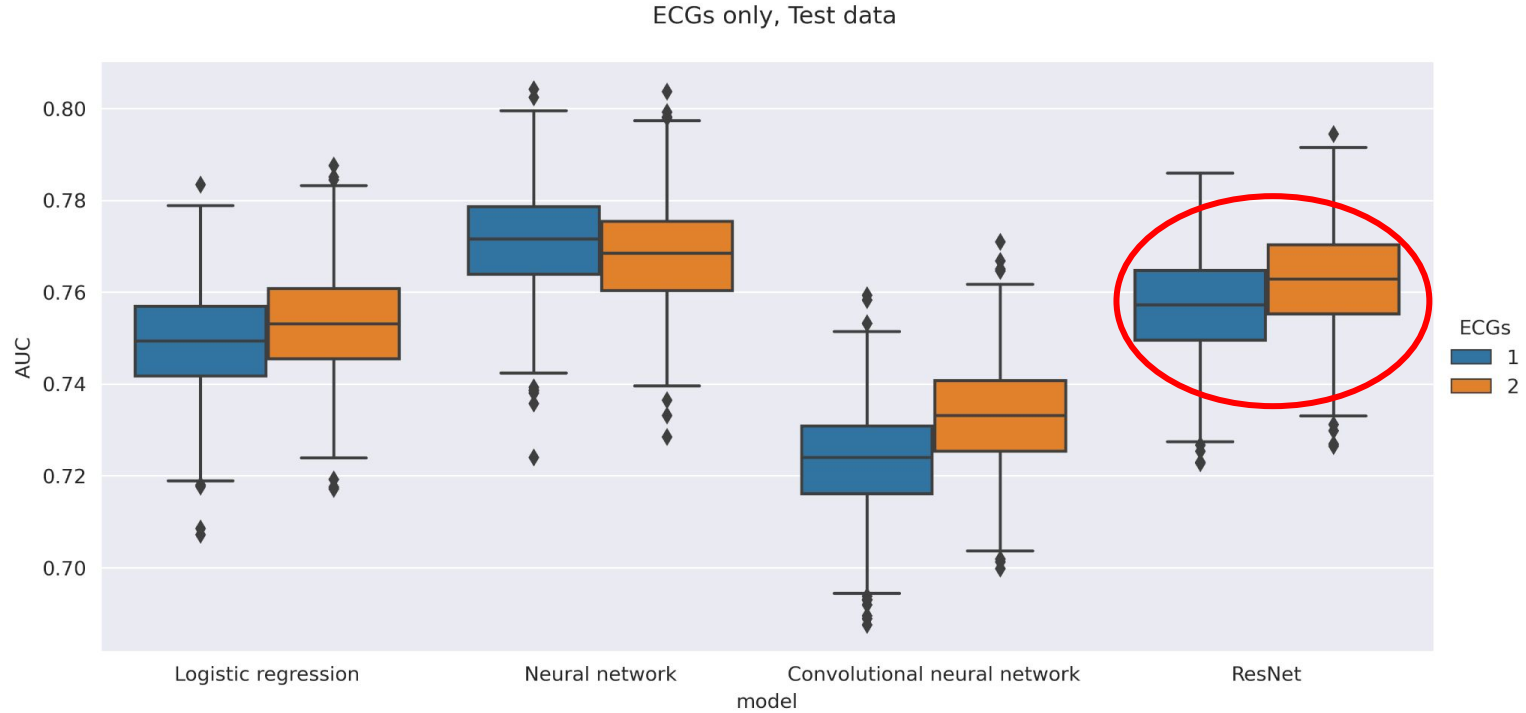
# How to quantify the improvement?

- Metric: ROC AUC
- Bootstrapping

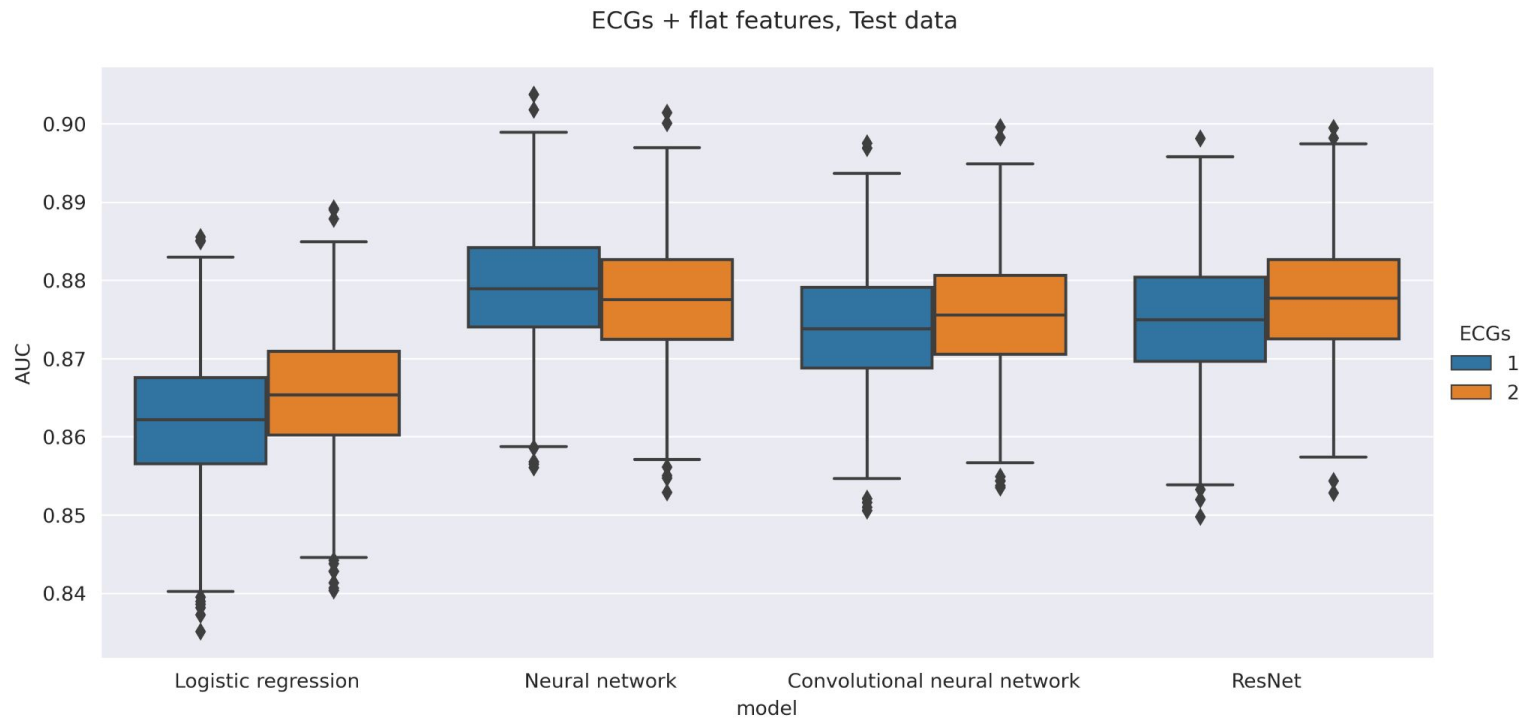
# Results



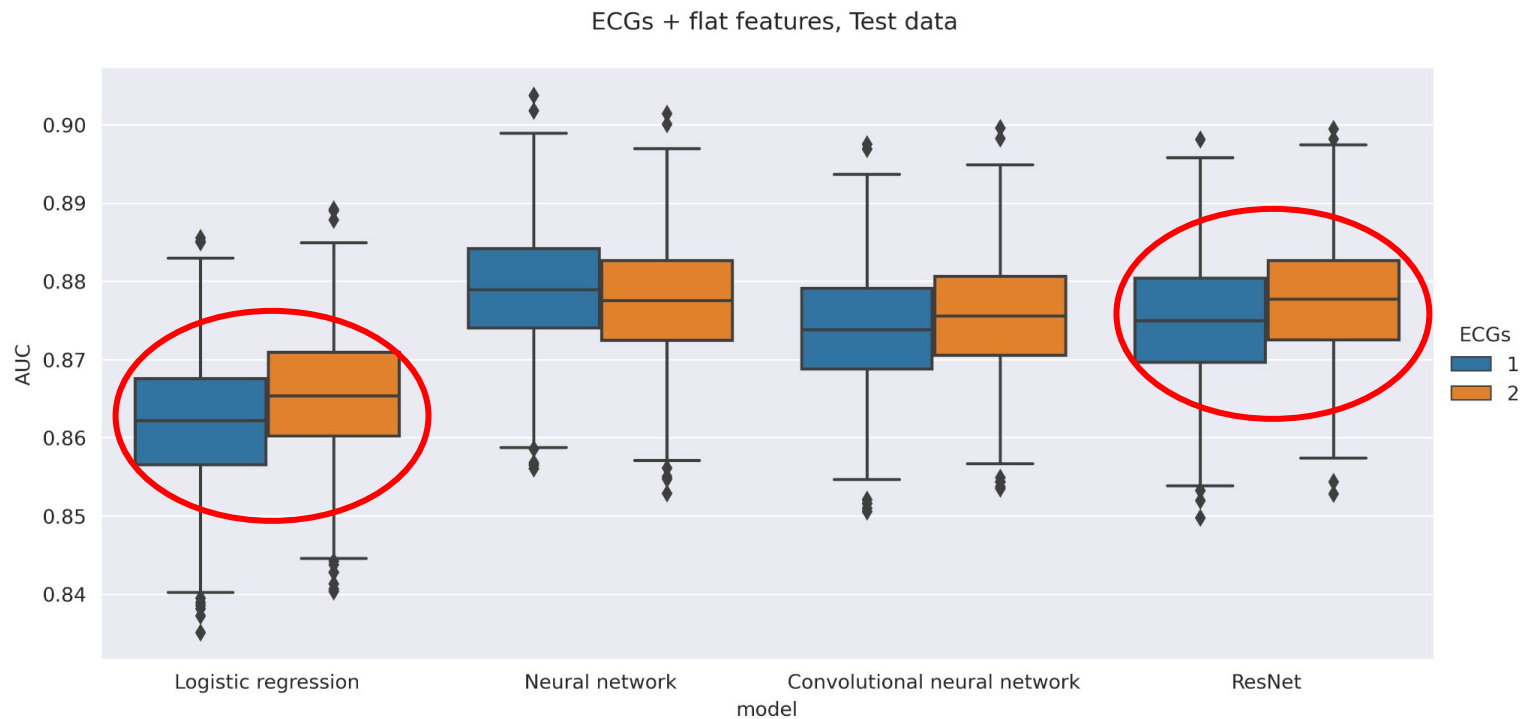
# Results



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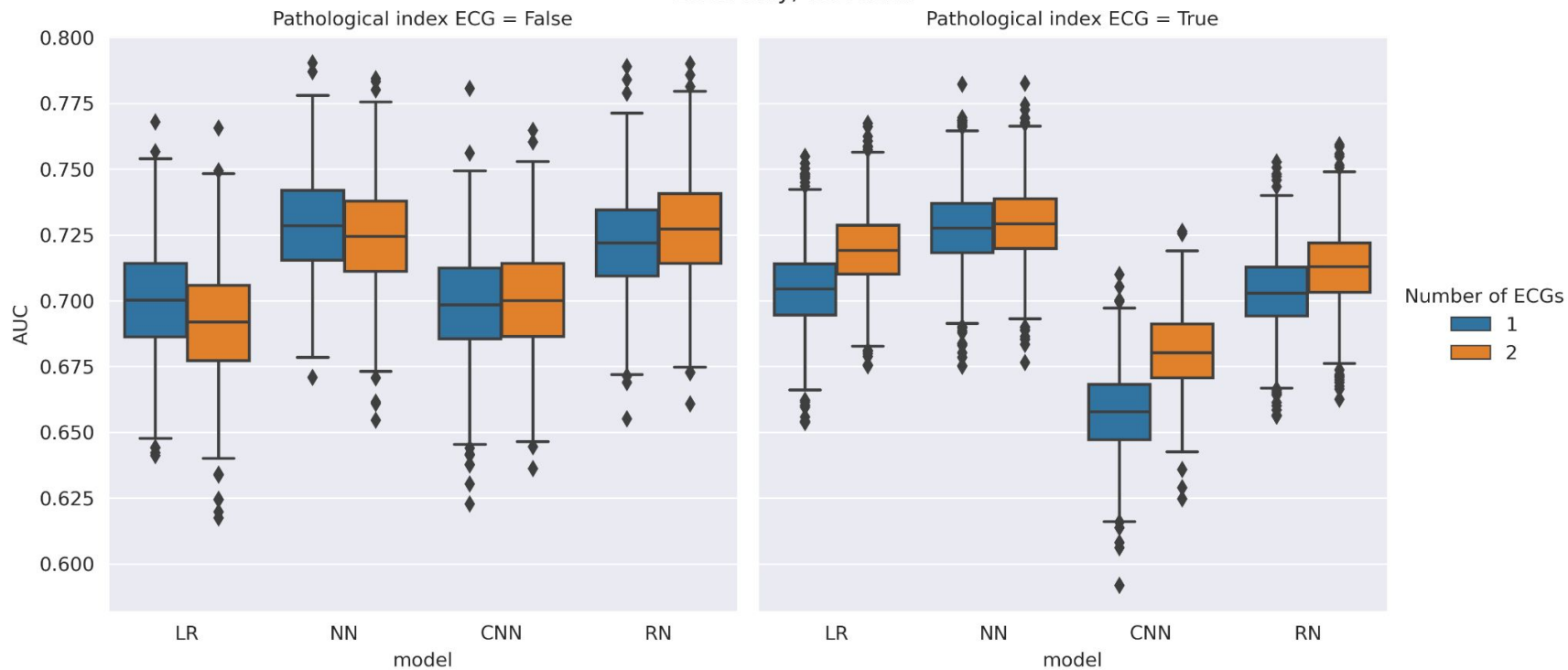


# Results



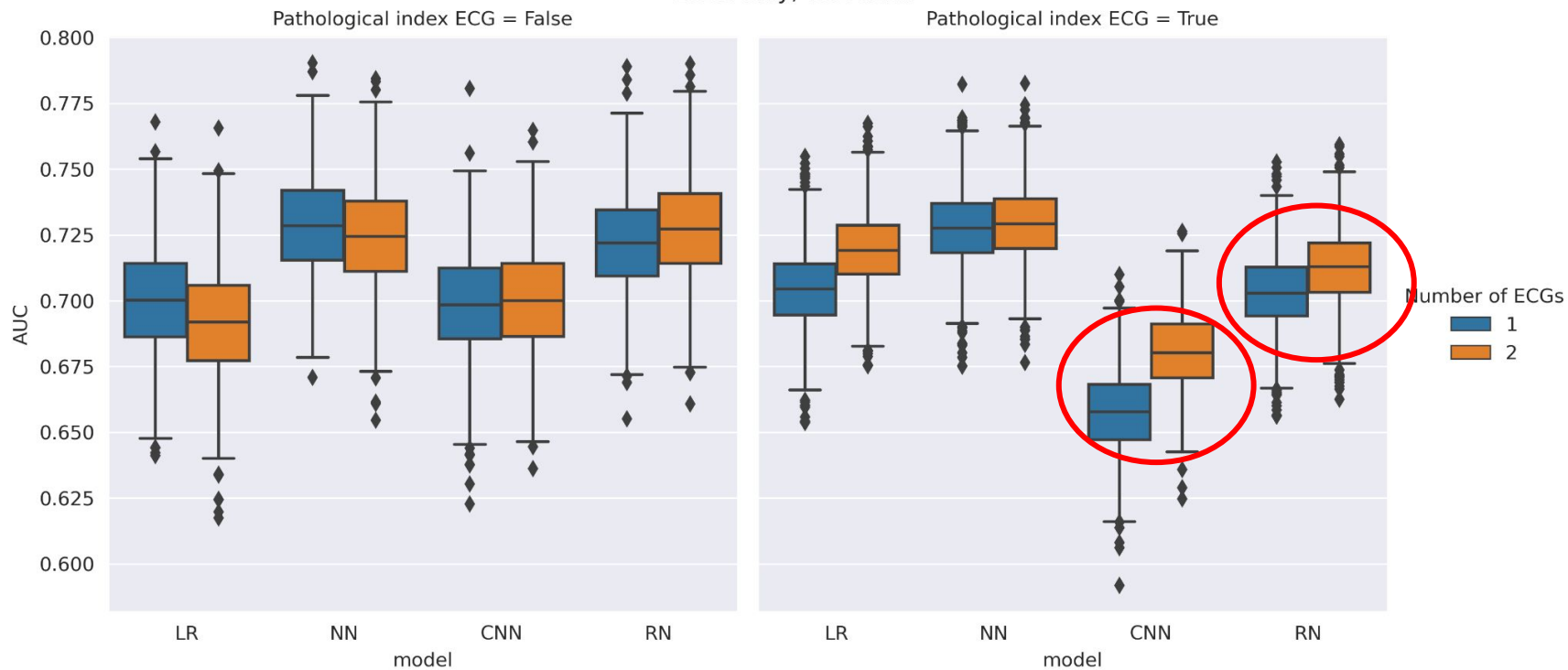
# Results, stratified on index ECG

ECGs only, Test data



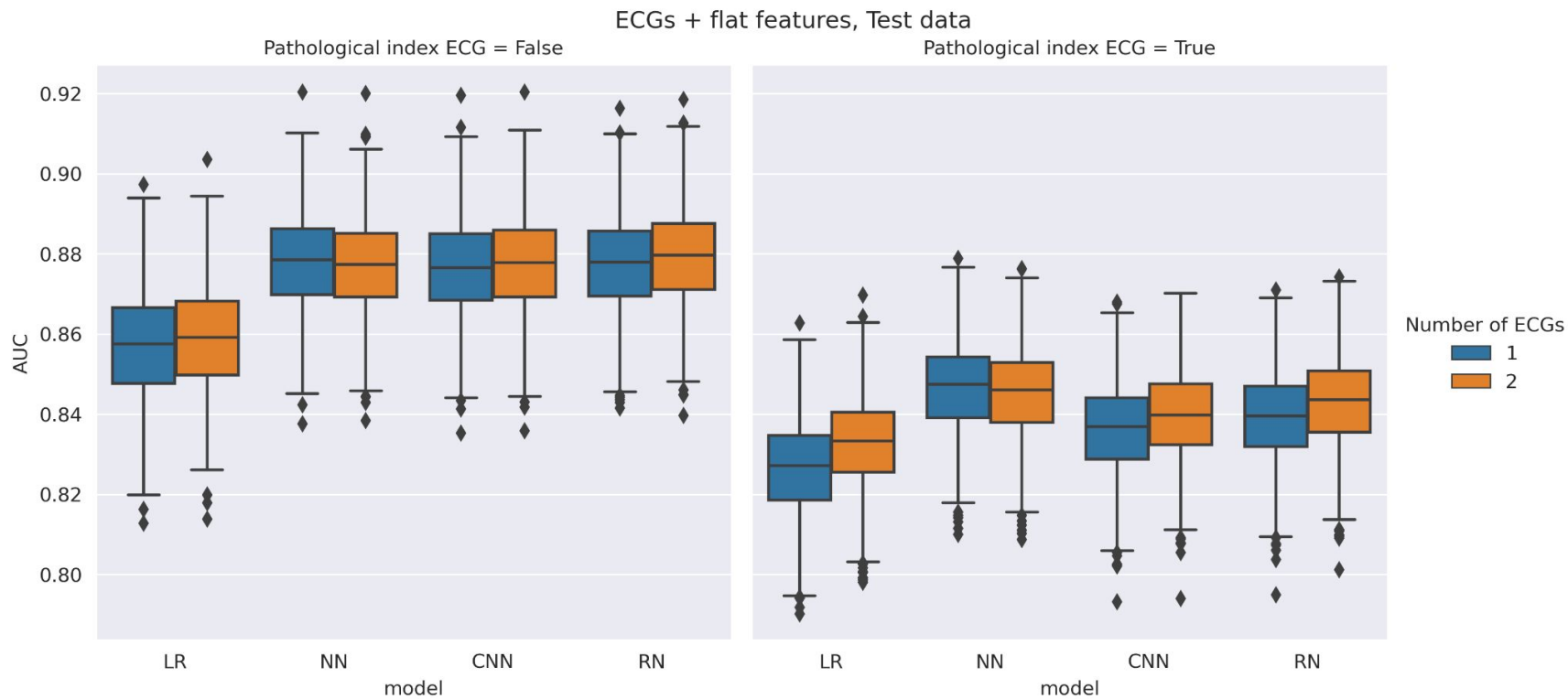
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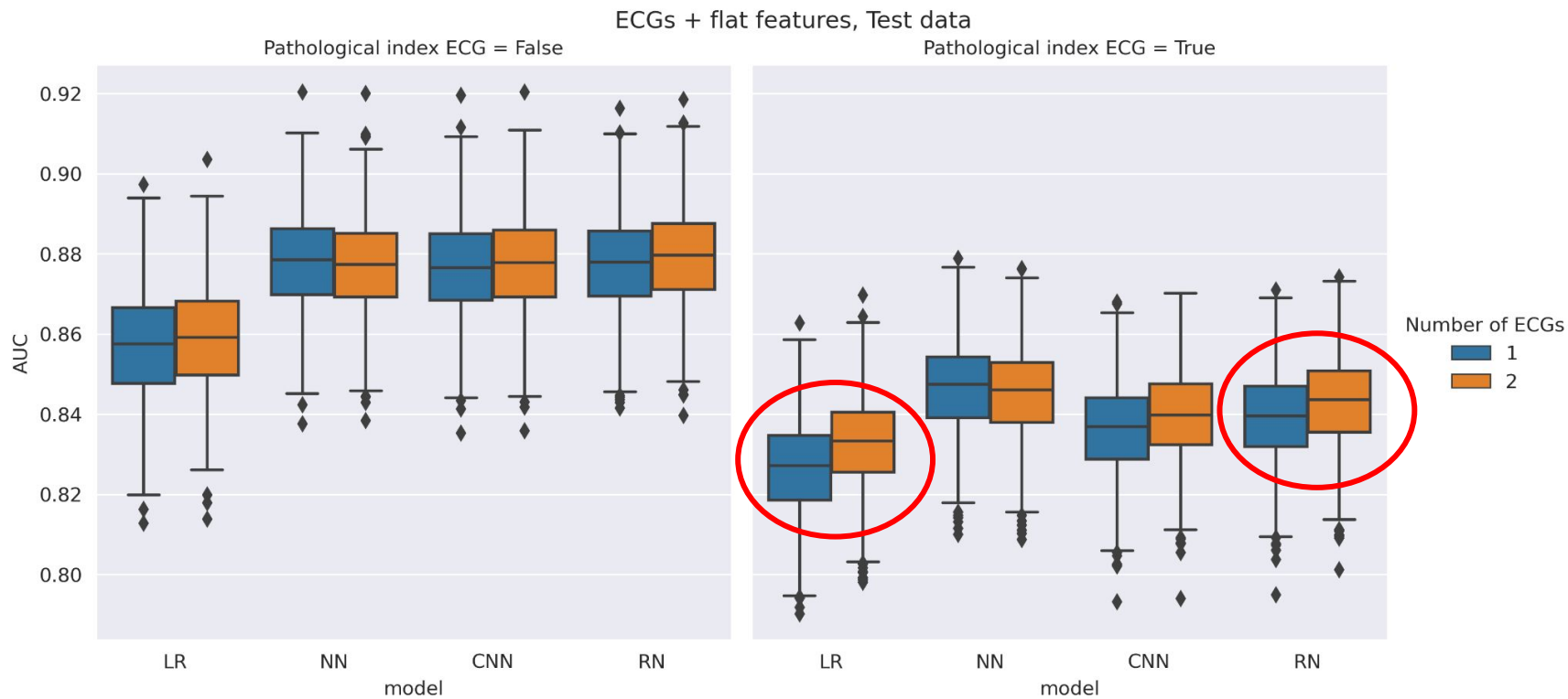




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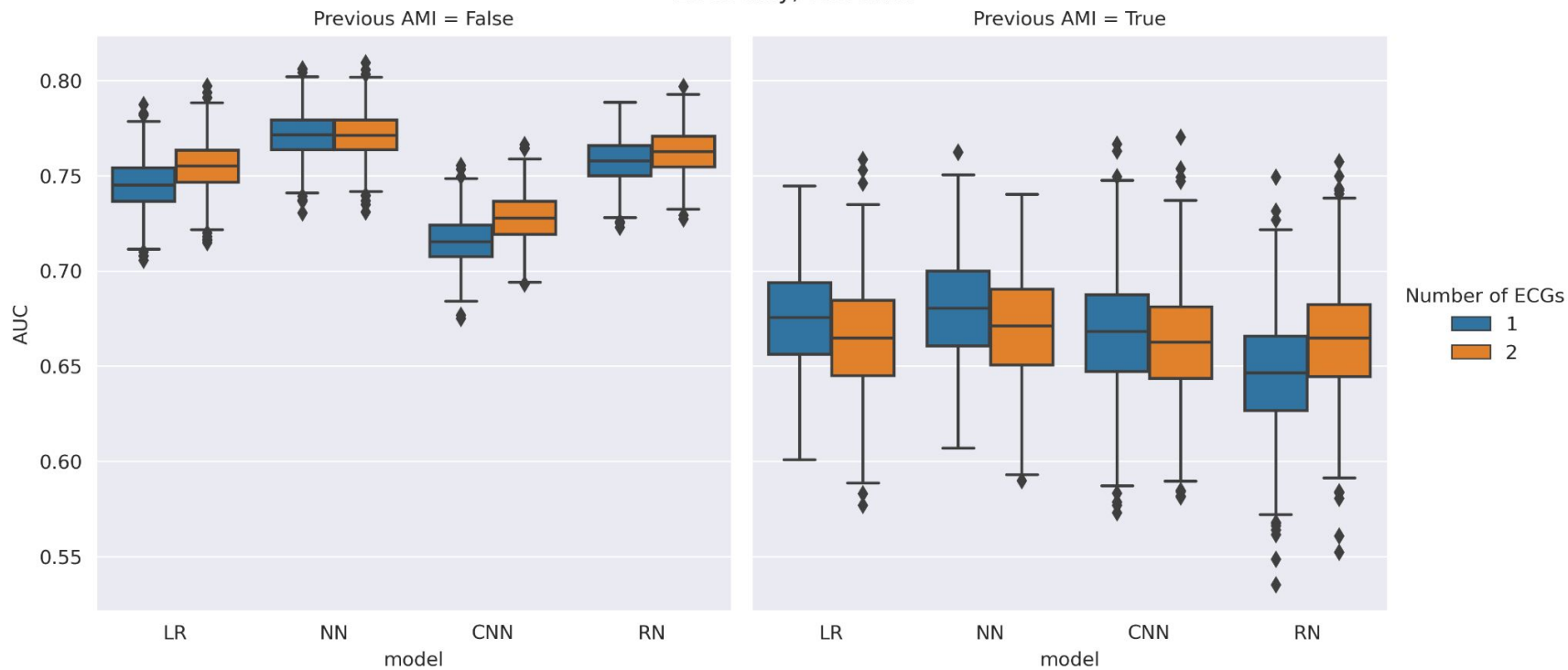


# Results, stratified on index ECG



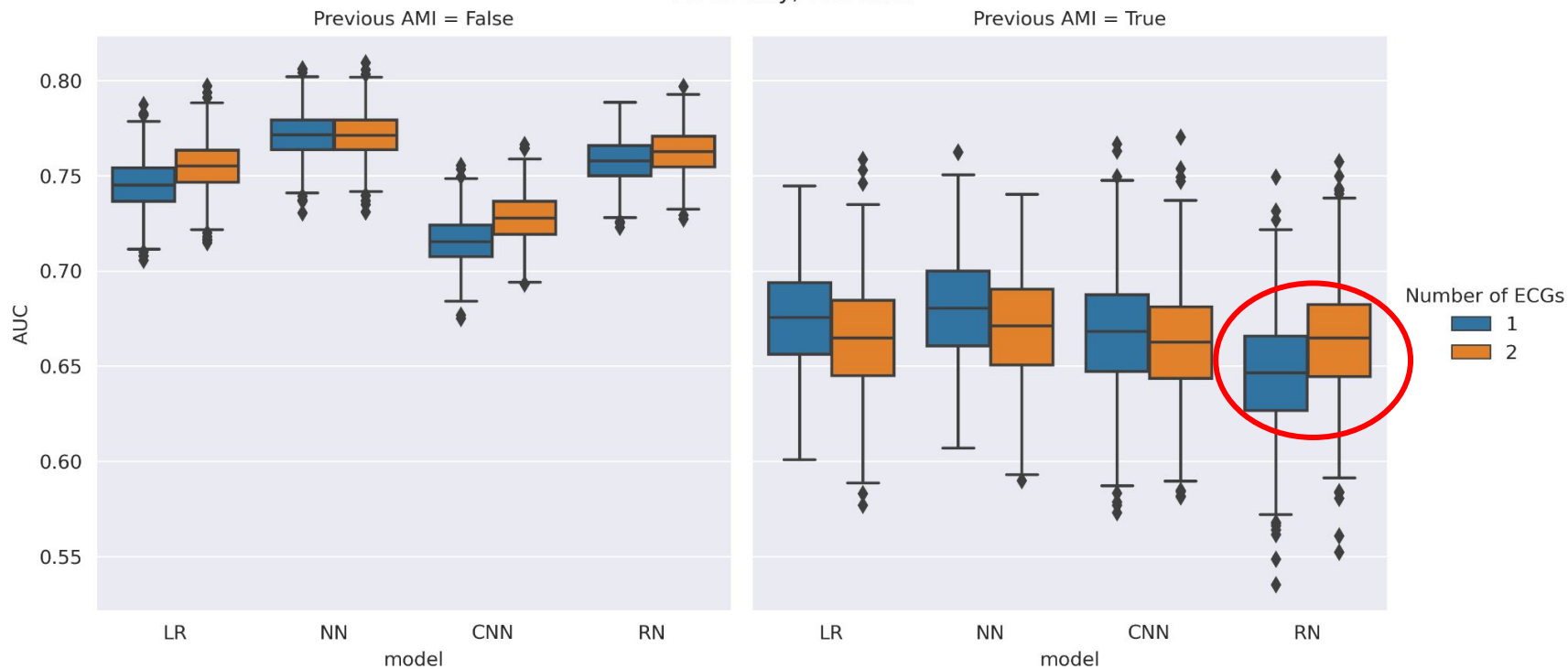
# Results, stratified on previous AMI

ECGs only, Test data

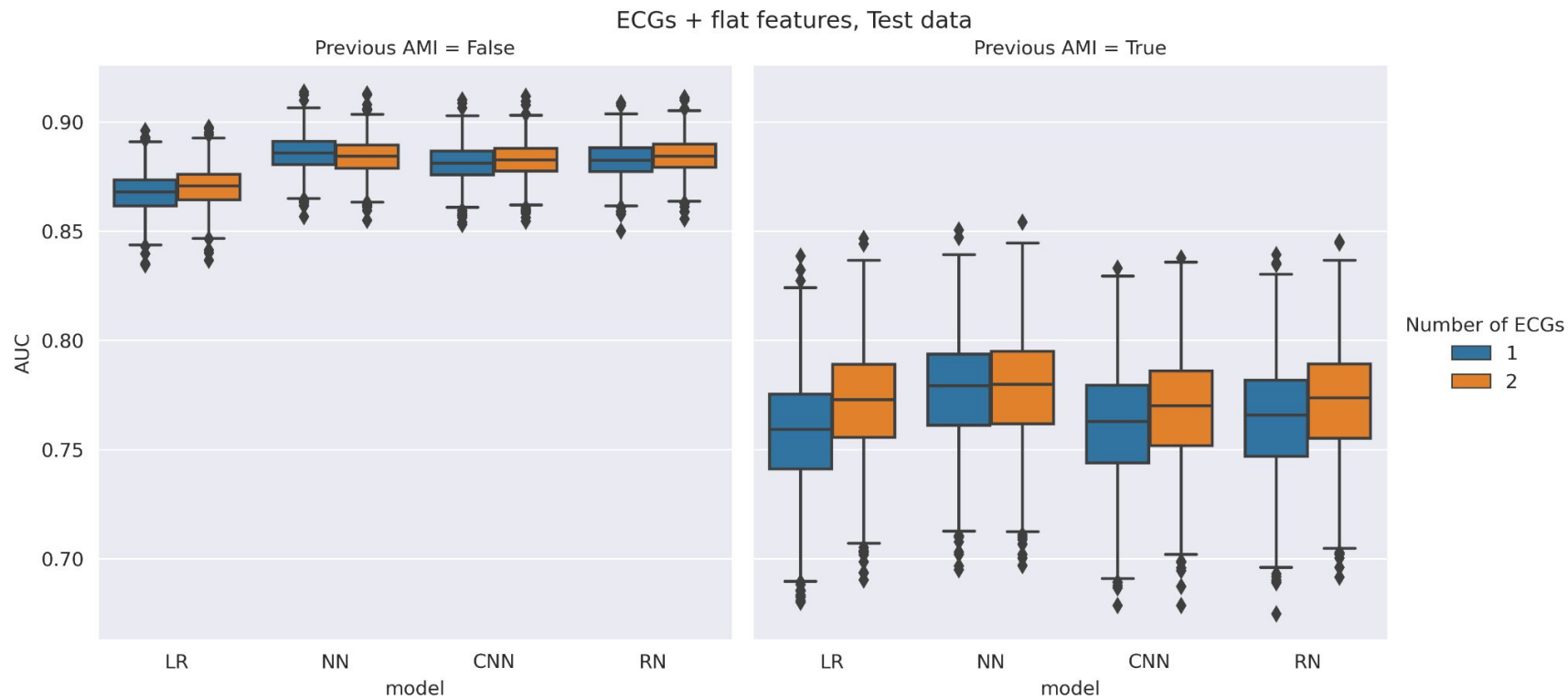


# Results, stratified on previous AMI

ECGs only, Test data



# Results, stratified on previous AMI



# Results, stratified on previous AMI



# Conclusions

- There might be a signal in the previous ECGs

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- There might be a signal in the previous ECGs
- But this signal is weak enough to be practically useless



Questions?