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Automatic 12-lead ECG classification using a convolutional network ensemble

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Introduction / Challenge Description

- PhysioNet 2020 challenge: 12-lead ECG traces classification.
- Over 43,000 training examples:
  1. Containing 27 classes: covering different rhythm, morphology and diagnoses.
  2. Datasets from four countries (China, Germany, Russia, USA),
  3. Varying length of ECGs.
- Our main approach: Make use of an ensemble of end-to-end learnt deep neural networks.

Previous experiences

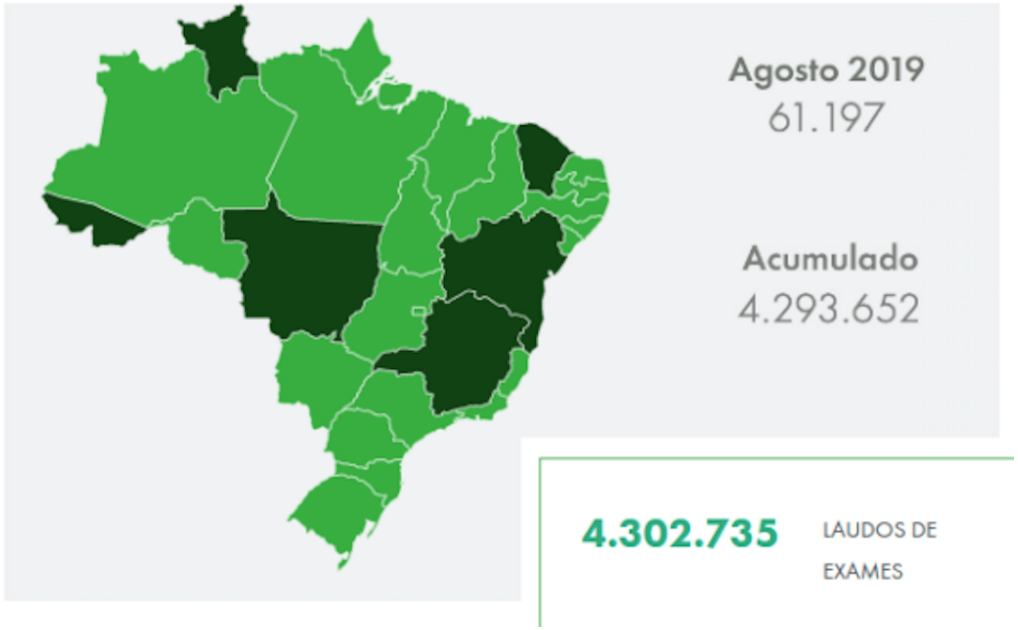

Figure: Tele-health network center

Ribeiro, A.H., Ribeiro, M.H., Paixão G.M.M. et. al. (2020)
Automatic diagnosis of the 12-lead ECG using a deep neural network
Nature Communications (11), 1760.

Previous experiences

- Training data: 2.5 million records from 1.5 million different patients.
- Test data: $\sim$1 thousand records from distinct patients annotated by three medical doctors.

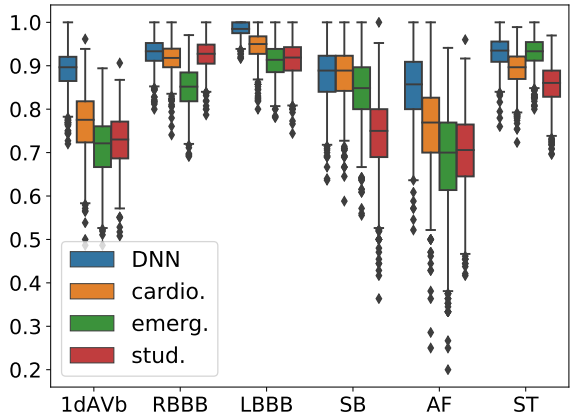

Figure: F1 score

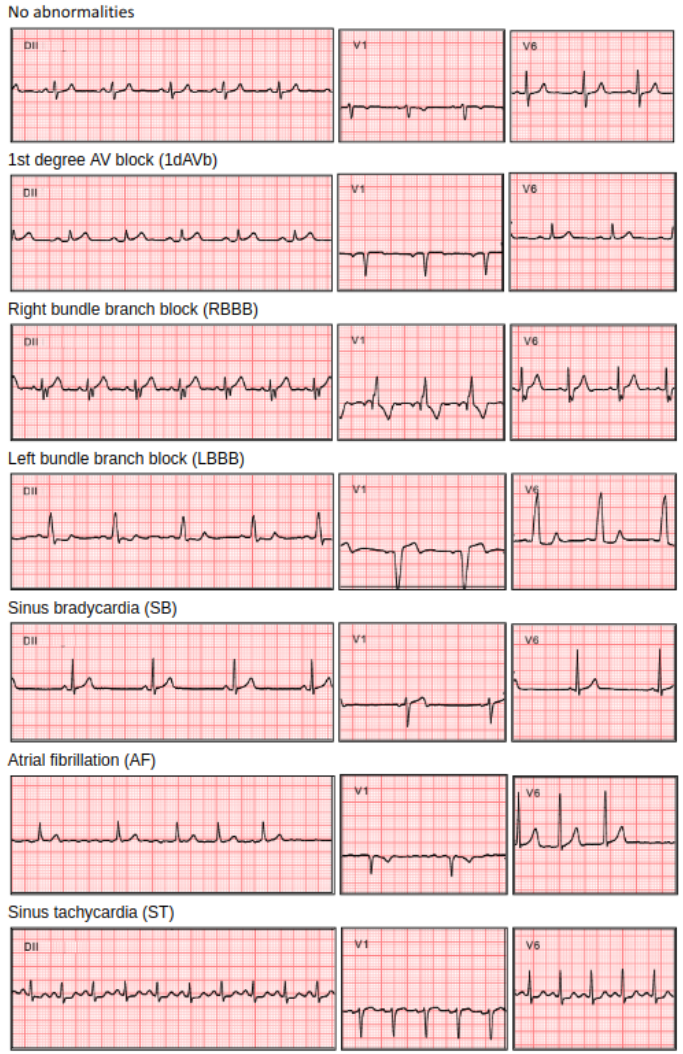

Figure: Abnormalities classified

Convolutional neural network

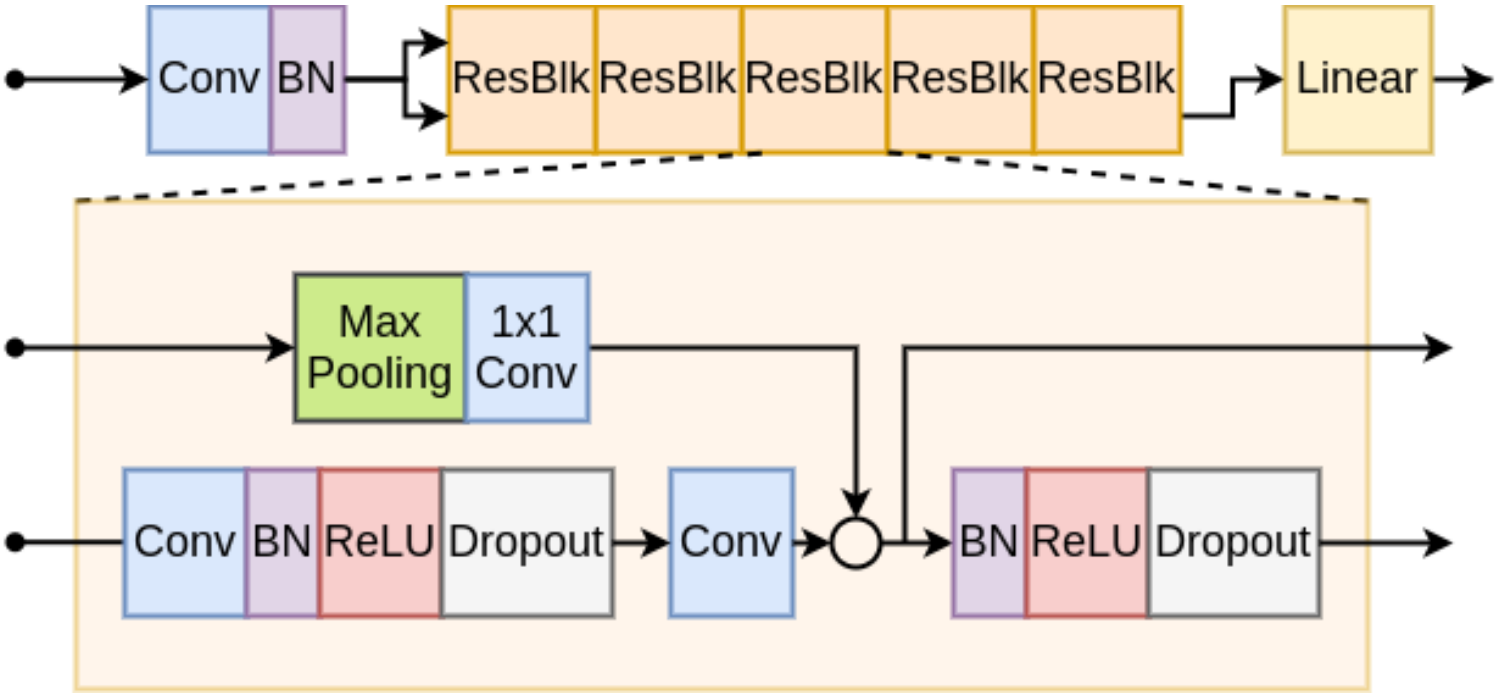

Figure: **Residual neural network.** The uni-dimensional neural network architecture used for ECG classification.

Ensemble of deep neural networks: motivation

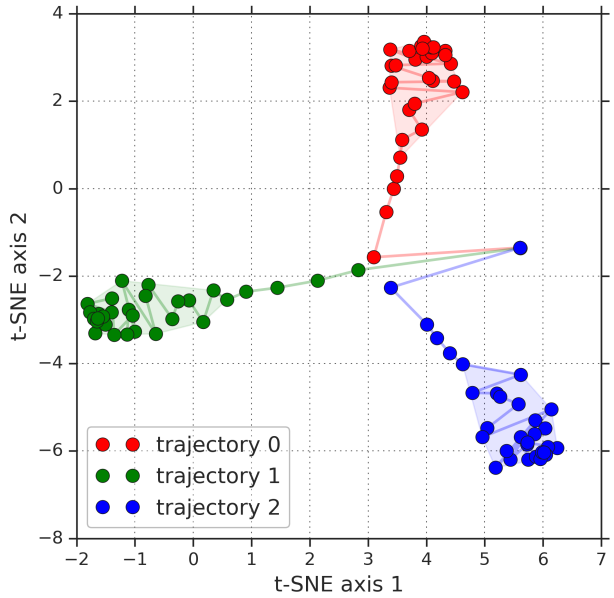

Figure: **Motivation for the ensembles.** Convergence to different local minima from random neural network initialization points.

Fort, S and Hu, H. and Lakshminarayanan, B. (2020).
Deep Ensembles: A Loss Landscape Perspective
arXiv:, 1912.02757.

Ensemble Model

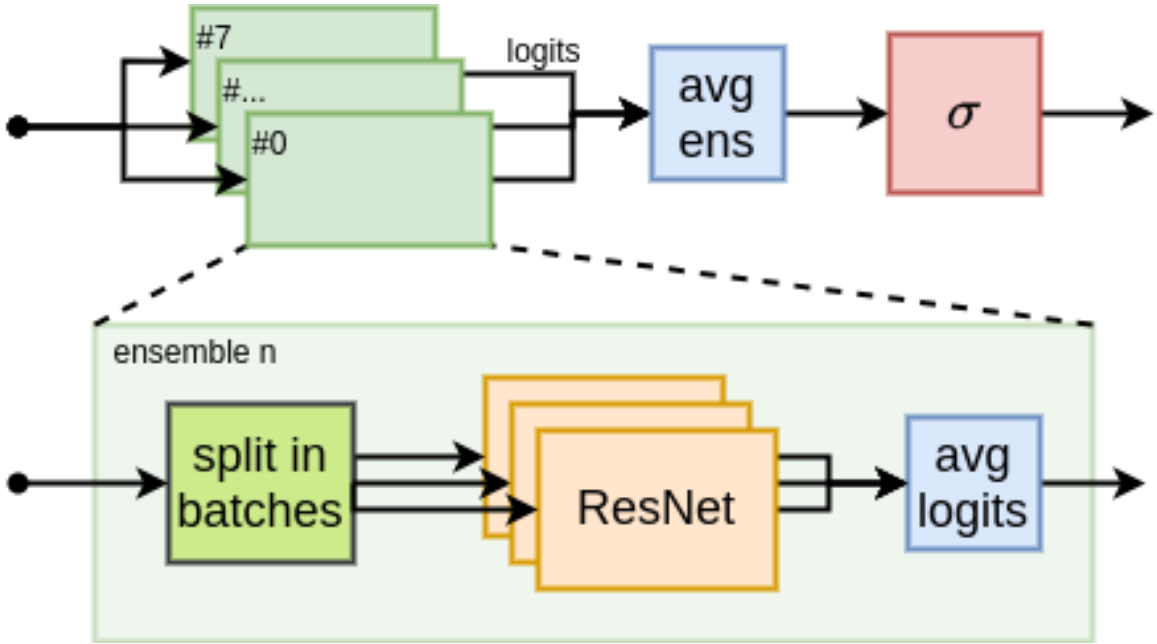

Figure: **Full Model.** Ensemble of ResNets which can handle variable length ECGs.

Results

- Team name "Code Team"
- Final score (#5) ranks us on the **7-th** position team-wise.

entry	score	short description
#1	0.622	Single DNN model
#2	0.626	Jointly predict some classes
#3	0.637	Larger weight for top-k predictions
#4, #5	0.657	Ensemble of 7 models

Table: **Challenge submissions.** Challenge metric score on the partial test dataset from the official challenge phase.

Training history

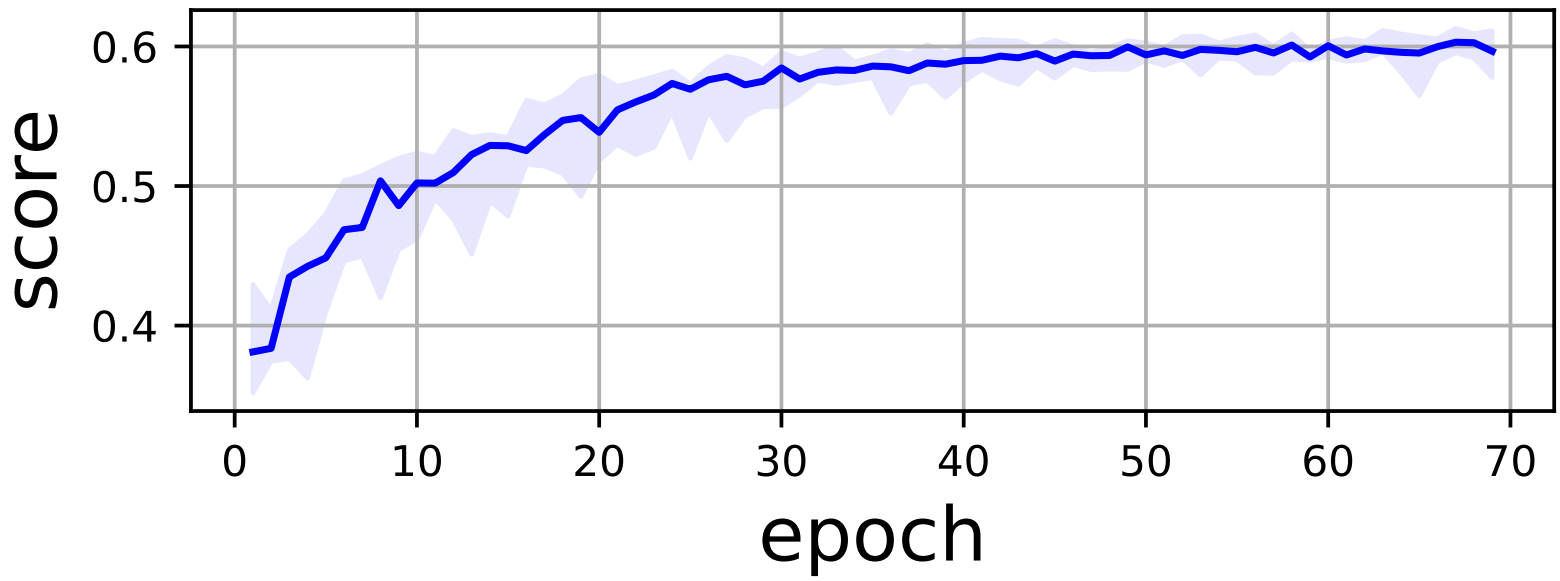

Figure: **Training history.** Challenge score metric evaluated on the 30% hold-out validation data

Model Analysis

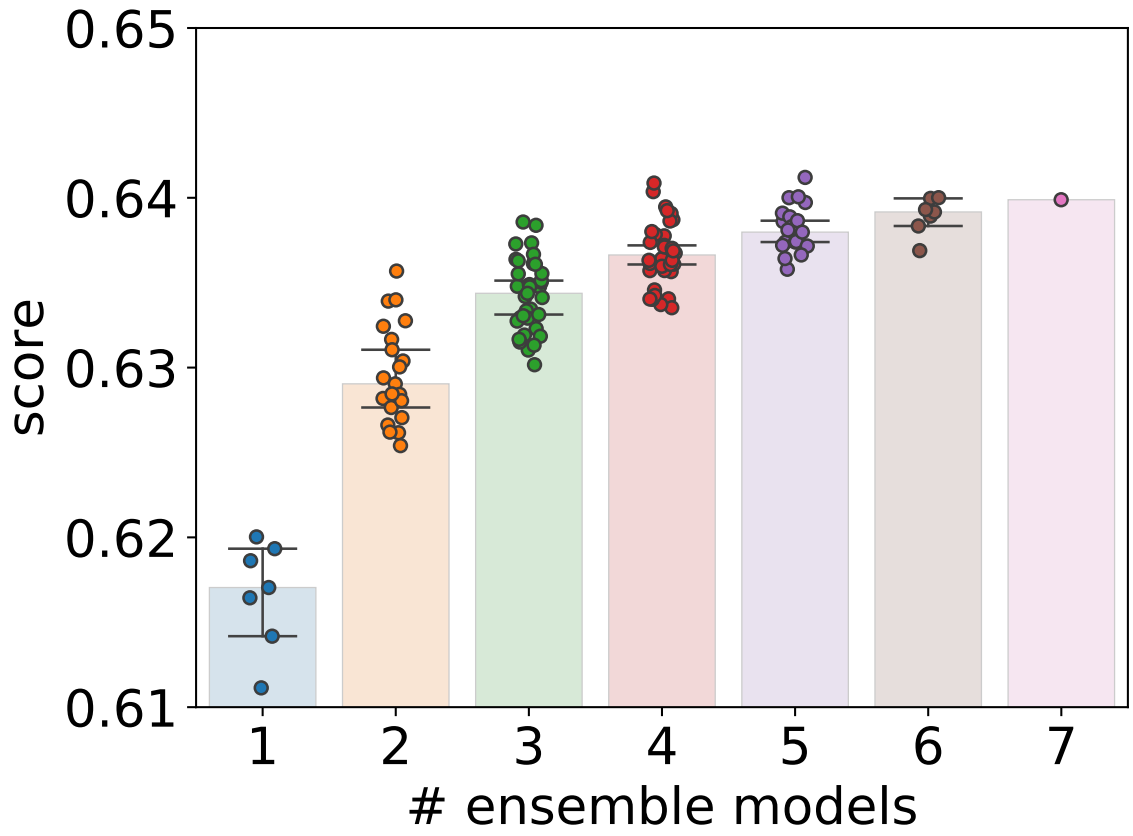

Figure: **Performance of Ensembles.** Validation set performance (30% training data) using varying ensemble sizes.

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Thank you!

Code available at:

github.com/antonior92/physionet-12ecg-classification

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