First Steps Towards Self-Supervised Pretraining of the 12-Lead ECG*

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Outline

Introduction

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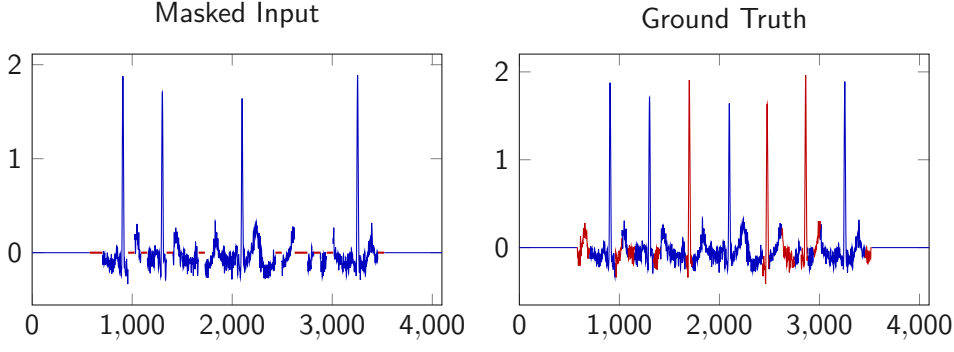
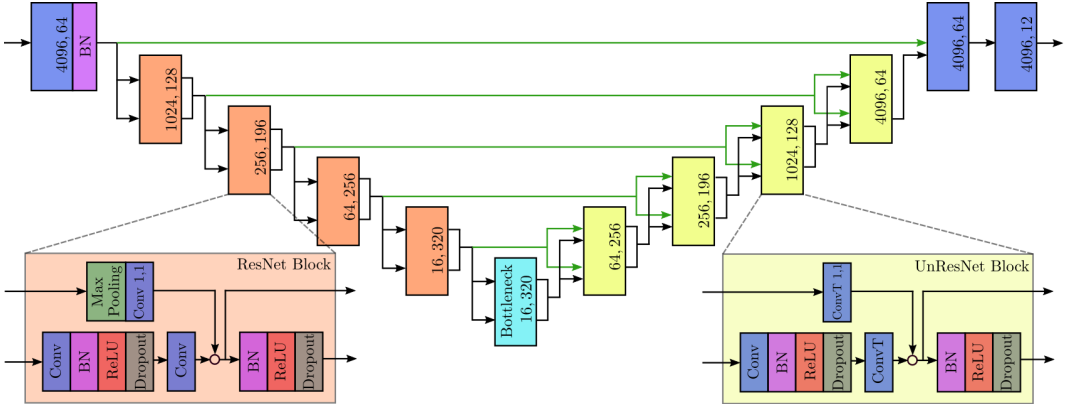
- Supervised learning:
  - state of the art results.
  - high amount of labeled training data necessary.
- Self-supervised learning (SSL):
  - Generate supervision signal from data itself.
  - Use unlabeled data $\rightarrow$ high amount of available data.
- Fine-tune on downstream task with limited amount of labeled training data.
- Hope: Improve performance on downstream task.
- Contribution: propose a simple self-supervised pre-training method for ECGs

Pre-Training Task Description

- Inspired by BERT completion task.
- Input: Mask out multiple subsequences of chosen length. Replace with zero.
- Output: Prediction masked susequences.



U-ResNet: A ResNet based encoder-decoder architecture with U-Net skip connections.



Experiments: Automated ECG Classification

Datasets:

- Pre-training:
  - Brazilian **CODE training**[1] set: 2.3 M. ECGs.
  - Brazilian **CODE test** set: 811 ECGs.
- Training:
  - **CPSC 2018**[2]: 6,877 ECGs; 8 anomalies.
  - **PTB-XL**[3]: 21,837 ECGs; 71 anomalies.

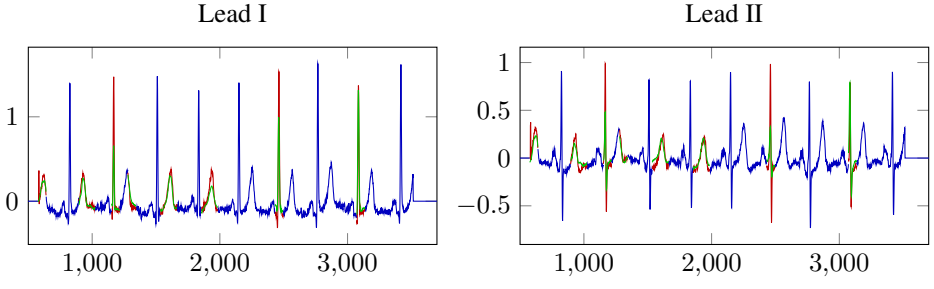
[1] Alkmim et al., "Improving patient access to specialized health care: the Telehealth Network of Minas Gerais, Brazil".

[2] Liu et al., "An Open Access Database for Evaluating the Algorithms of Electrocardiogram Rhythm and Morphology Abnormality Detection".

[3] Wagner et al., "PTB-XL, a large publicly available electrocardiography dataset".

Pre-Training: Reconstruction

Example of reconstruction from CODE test set.



Average MSE loss when evaluating the reconstruction on different datasets:

CODE train	CODE test	CPSC	PTB-XL
1,197	1,803	17,403	22,011

Improvements of model with pre-training (PT) than without pre-training.

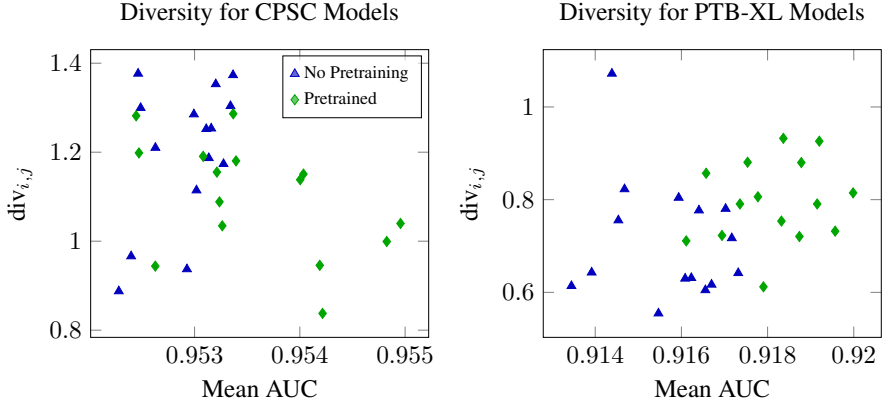
Table 1: Results on CPSC (top) and PTB-XL (bottom)

Model	F_β	G_β	AUC
Ours	$.775 \pm .004$	$.533 \pm .016$	$.953 \pm .001$
Ours + PT	$\mathbf{.780 \pm .013}$	$\mathbf{.538 \pm .019}$	$\mathbf{.954 \pm .001}$

Model	F_{max}	AUC
SOTA ResNet	$.767 \pm .008$	$.919 \pm .008$
Ours	$.667 \pm .037$	$.917 \pm .004$
Ours + PT	$.638 \pm .034$	$\mathbf{.919 \pm .003}$

Diversity of Predictions

- Often ensemble based models because of higher performance metrics.
- Higher performance is based on diversity of base models.
- Different base models usually obtained with random initialization points.
- Pre-trained model has same starting point.
- Do we still obtain diverse base models?



Conclusion and Future Work

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1. Conclusion
   - First steps towards an unsupervised pre-training method for ECGs.
   - Introduced simple completion based pre-training task with a U-ResNet.
   - Show modest performance boost on challenging downstream tasks.
2. Future Work
   - Explore new contrastive self-supervised learning methods.
   - Expand on more test data sets.

Thank you!

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- Wagner, Patrick et al. “PTB-XL, a large publicly available electrocardiography dataset”. In: *Scientific Data* (2020).