AI for wearable ECG prototype (ResNet + SE model)
Tech 07 class project
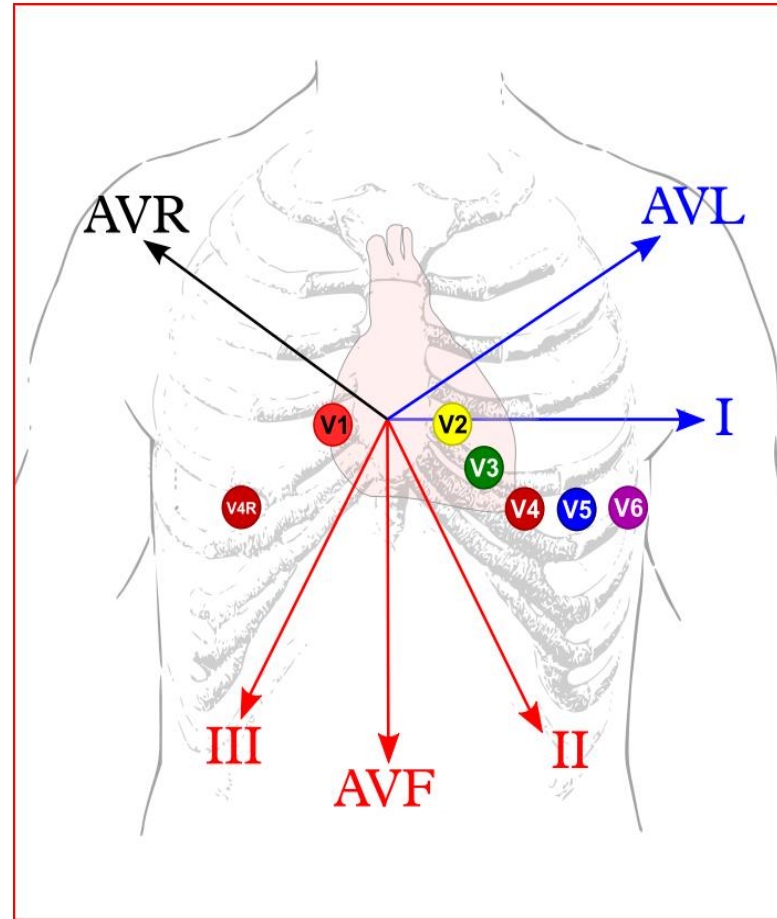
Related to a virtual poster presentation at SciPy 2025
https://www.scipy2025.scipy.org/

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github: https://github.com/JennEYoon/ECG-transform

Areteus ECG prototype (Areteus.us.com)

ECG 12-signal device, on t-shirt

Electrodes placement diagram
Source: ECGpedia.org

Sample ECG plot

New ECG 12-signal datasets for AI <mark>(to do)</mark>

ECG datasets for 50 years (<2017)
- MIT-BIH

- PTB original

New 12-signal datasets (2018-2021)
- Large patient numbers
- High Quality 12-signal (latest hospital ECG machines)
- Multiple hospitals, multiple countries
- Efforts to standardize diagnostic class labels
- Developed with recent deep learning models in mind (ResNet, SENetworks, Transformers, RNN)

Data Processing <mark>(to do)</mark>

From new, large 12-signal datasets <mark>(2018-2021 collections)</mark> PTB-XL dataset was selected with about 22,000 patients, 10 second recording length. From this, 1,000 patients were selected for a test run.

ECG signals data processing

- Peak center, split into 1.5 sec. windows, zero pad left & right.

- Baseline meander fix to zero

- Filters not applied:
  - Peak to peak distance standardizing
  - Peak amplitude standardizing
  - Removing negative values (squaring)
  - random split, overlapping split
  - much longer time windows
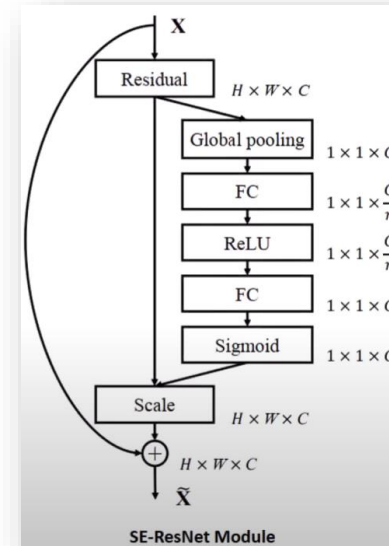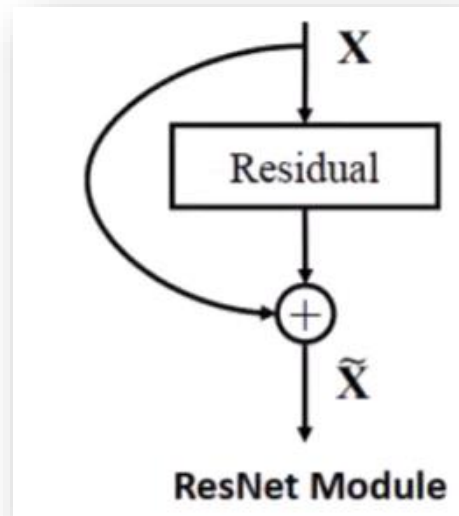 - no relationship, feed each one of 12 signals independently

Image, peak centering, zero padding
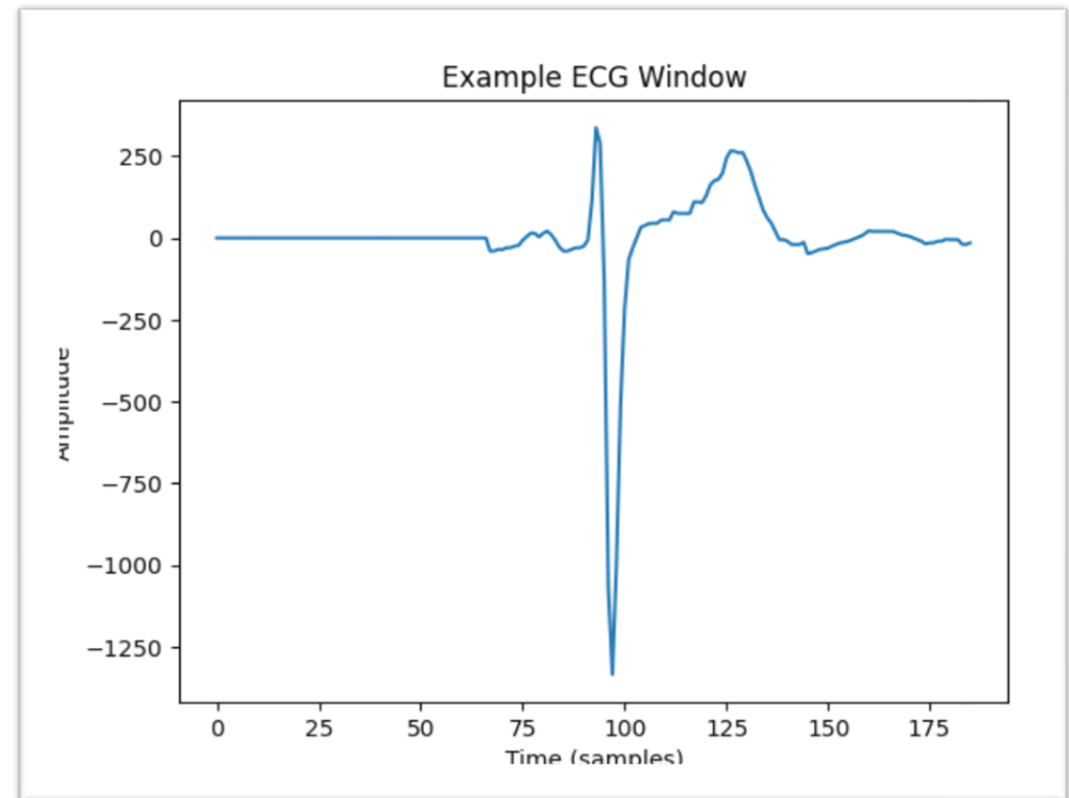
ResNet (Residual Network) + SE (Squeeze and Excite)
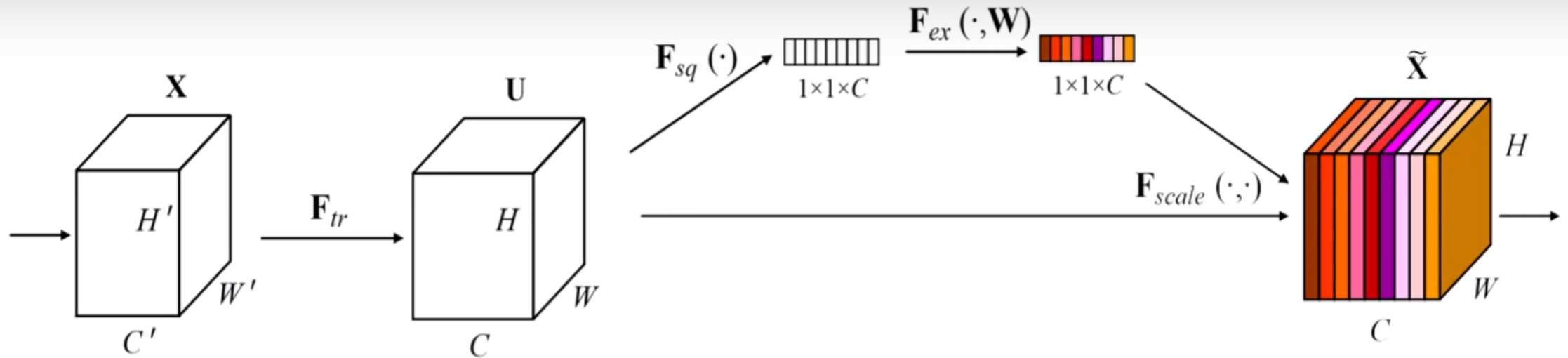
draw sheets, signals, 12-channels

Results: What I hope to show <mark>(to do)</mark>

ResNet+ SE, PTB-XL 12-signal data:

Accuracy, F1 score
Binary classification
4-6 class classification
24 class classification
Comparison of PTB-XL with SPH data

CNN, Random Forest, old MIT-BIH, PTB data:

Accuracy, F1 score: earlier models
 * MIT-BIH (2-signals, small sample)
 * PTB original (12-signals, small sample)

Areteus device inference:

- proof of concept, using one person, healthy heart data, 30 recordings taken over 2 days.
Translate binary/hex into usable numpy format

Future Steps:

Areteus device – need to gather many more patient data, and from large number of abnormal diagnostic classes.

Areteus device - testing for accuracy when user moves, when user did not attach all 12-nodes at right locations.

Areteus device – how to adapt the device to body sizes. Initially medium t-shirt size is available, but small and extra-large sizes planned. Will need to test device accuracy on users with varying body sizes.

Transformer + RNN model, also a good candidate. 2-stage training, makes full use of 12-signal dataset. Future work

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https://github.com/JennEYoon/ECG-transform/tree/main/Tech07-project

Deep Residual Networks, c. 2015: https://arxiv.org/abs/1512.03385

Yannic Kilcher: https://www.youtube.com/watch?v=GWt6Fu05voI

Squeeze-and-Excitation (SE) Networks, c. 2017: https://arxiv.org/abs/1709.01507
Soroush Mehraban: https://youtu.be/3b7kMvrPZX8?si=g0JY09P5dIPMXwRj