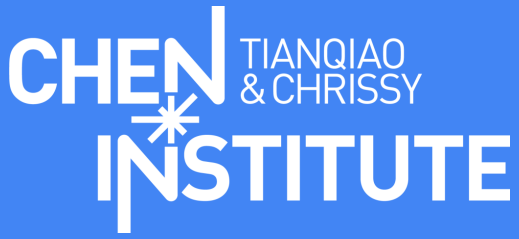
Chen Data Science & AI for Neuroscience Summer School



Caltech

Data Processing Principles

Sabera Talukder

What are your data processing principles?

- Visualize Your Data → Intuition Development

- Visualize Your Data → Intuition Development
- Signal Extraction (aka Denoising)

- Visualize Your Data → Intuition Development
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- Dataset Augmentation

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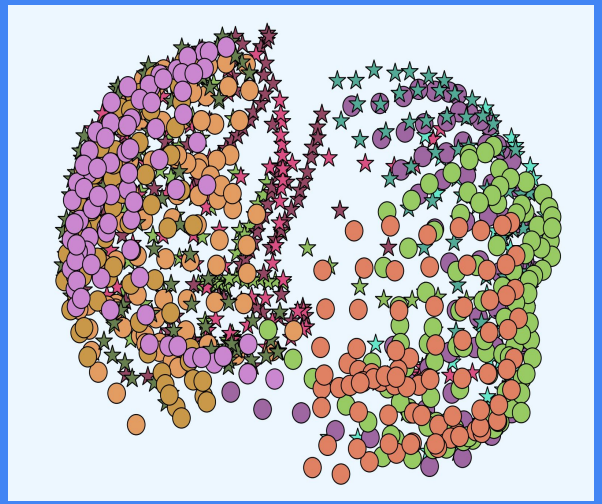
- Train / Validation / Test Splits

Visualize Your Data



Talukder et al. 2022

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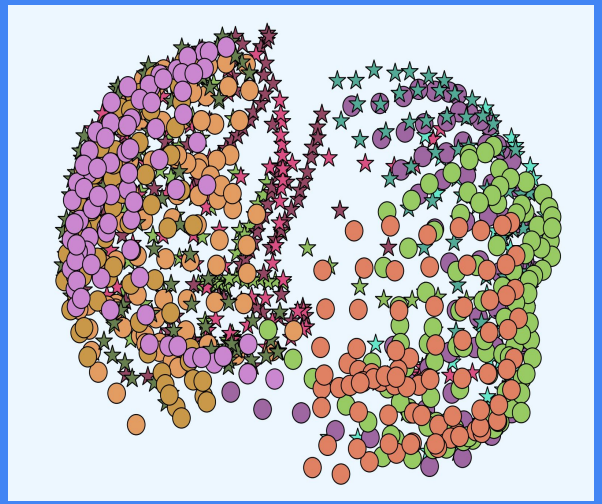

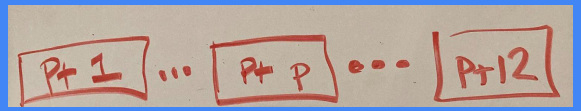

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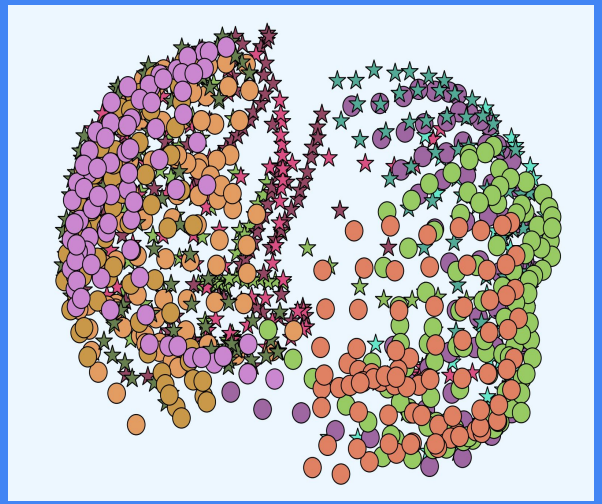

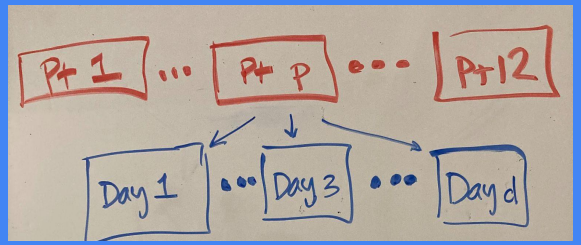

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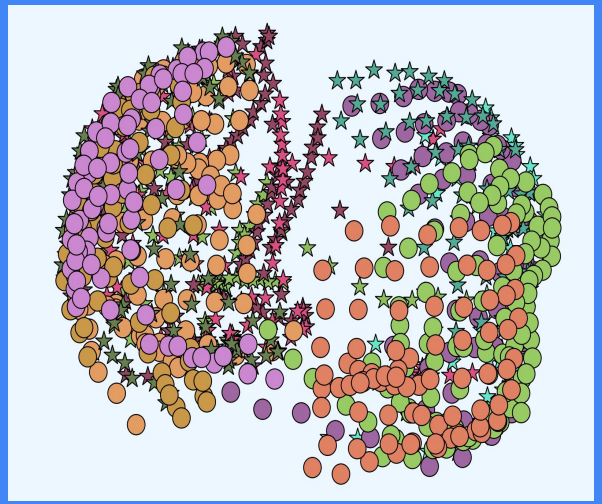

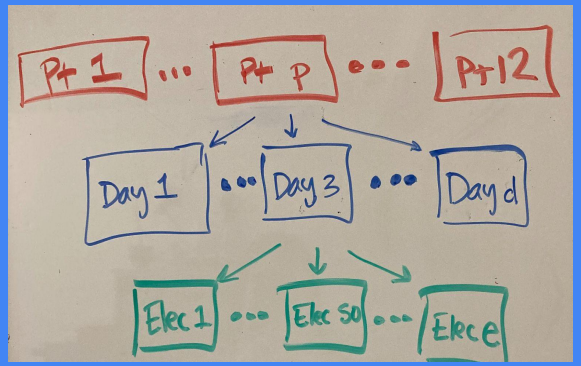

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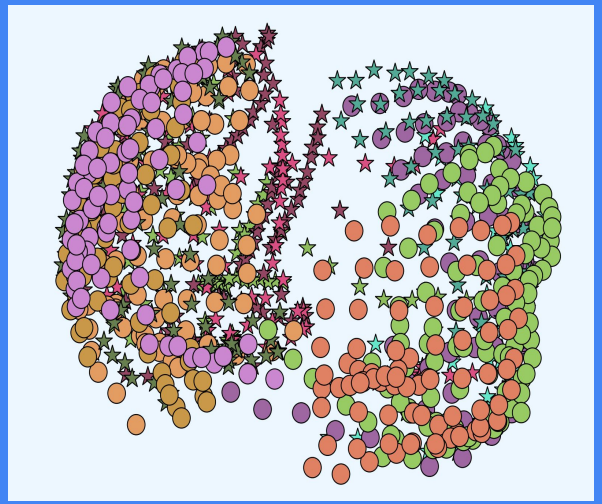

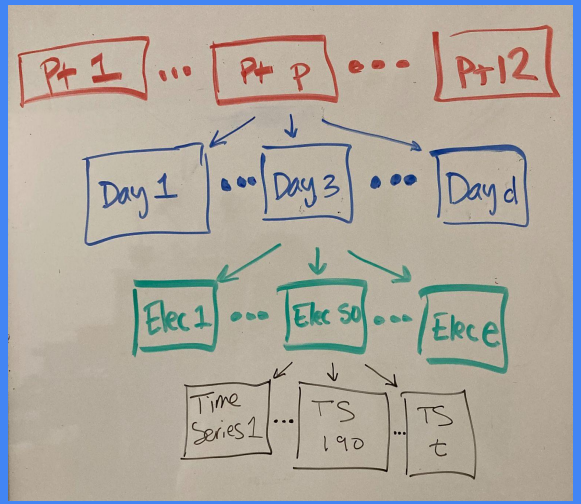

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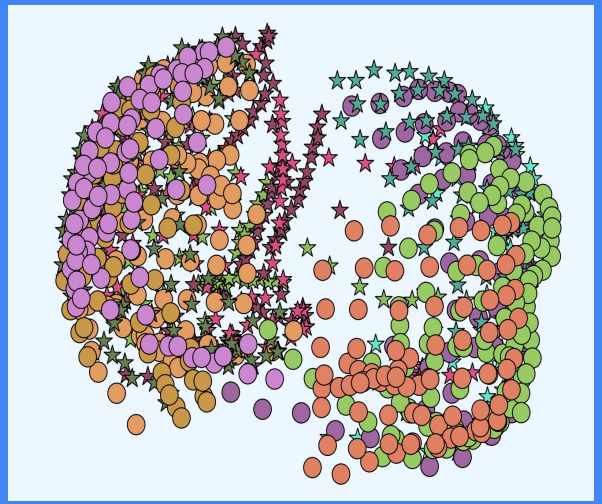

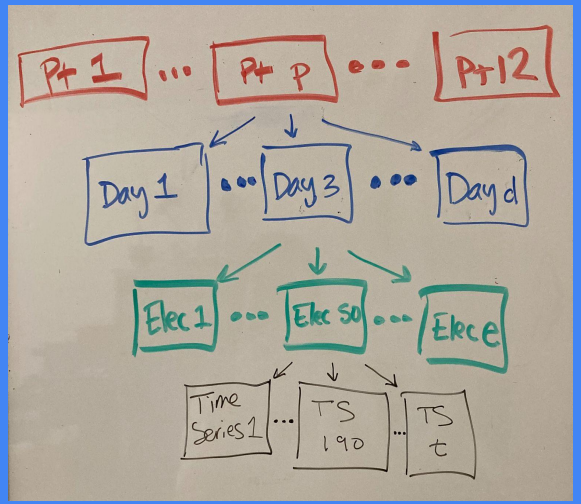

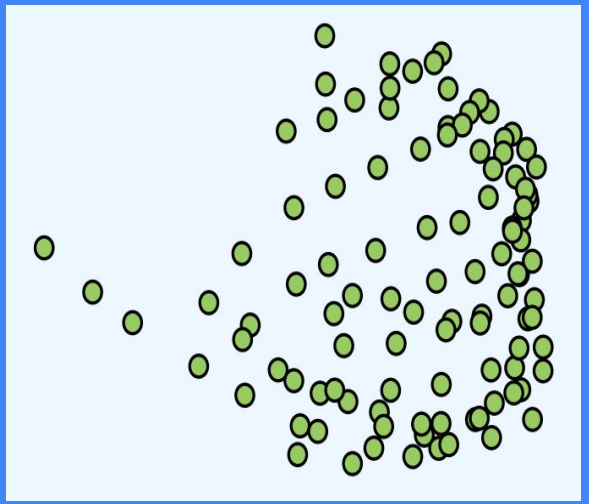

Talukder et al. 2022

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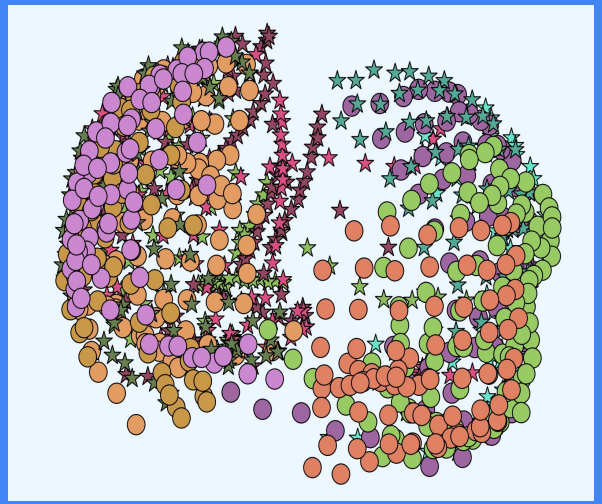

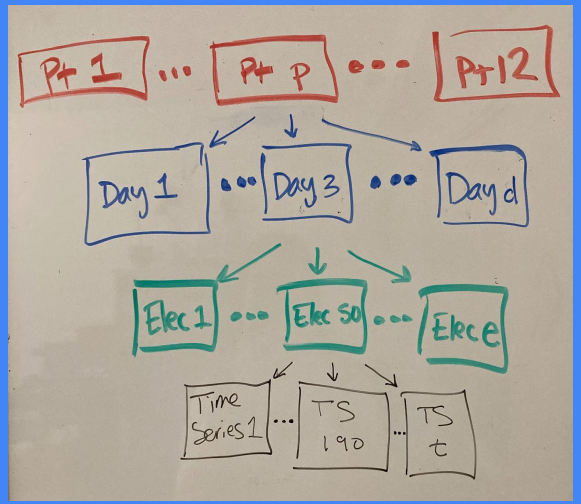

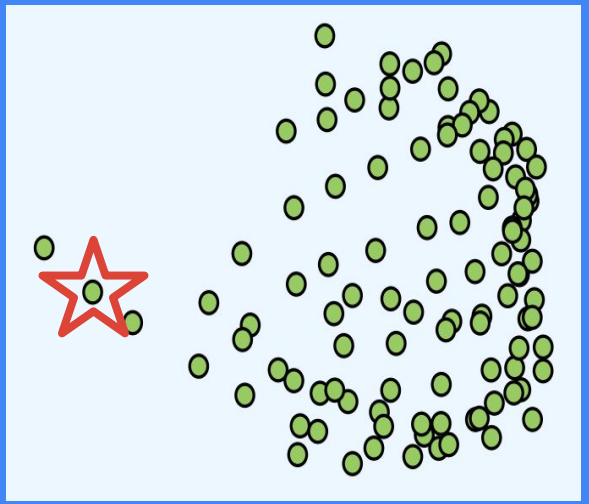

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Visualize Your Data

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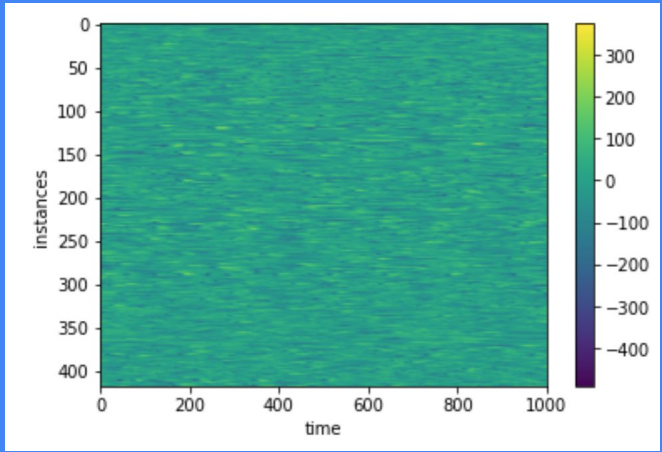

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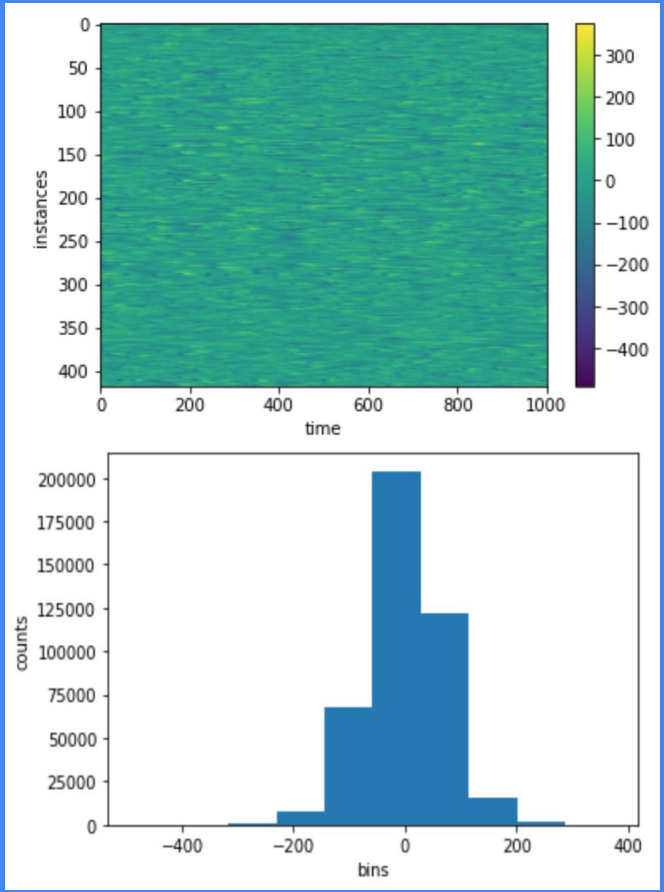

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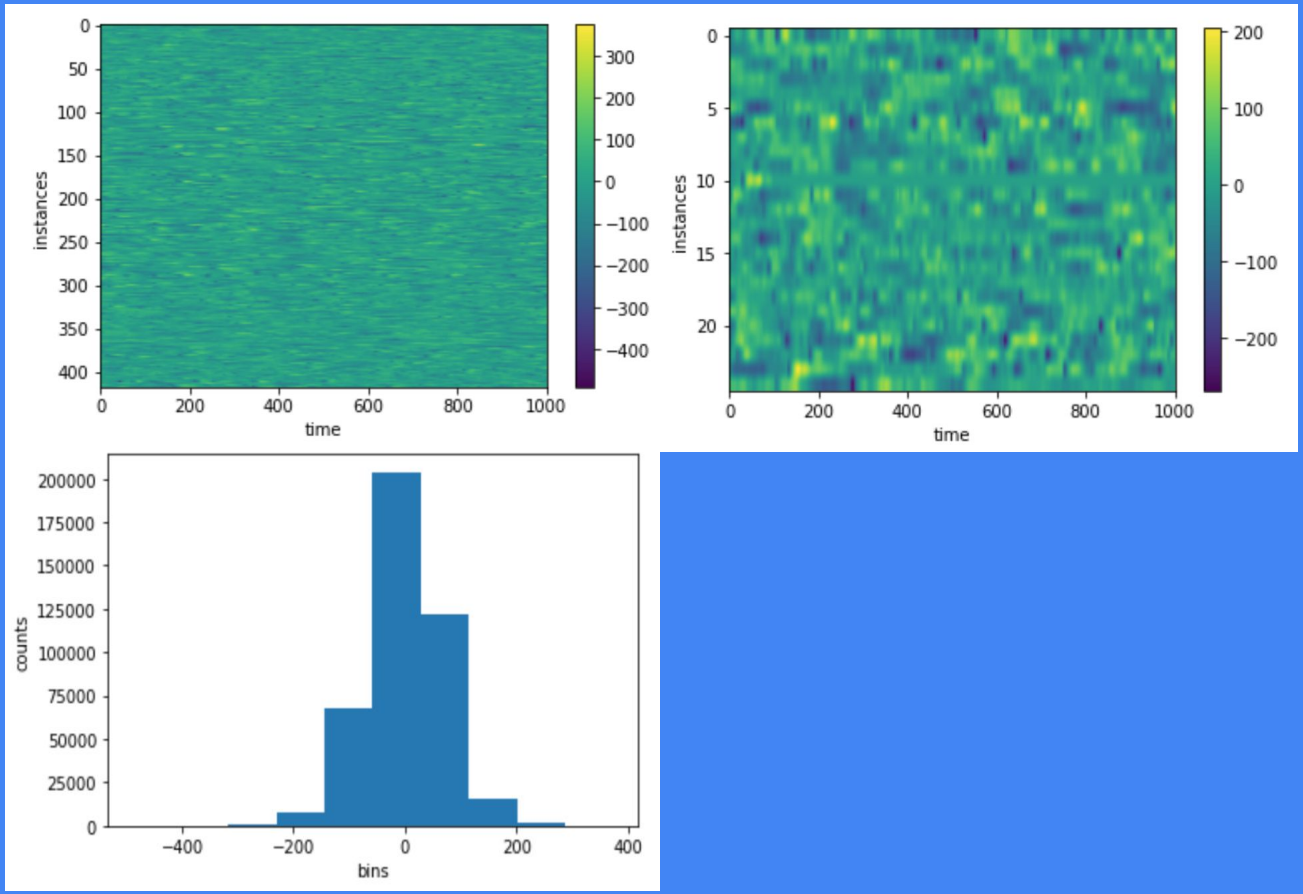

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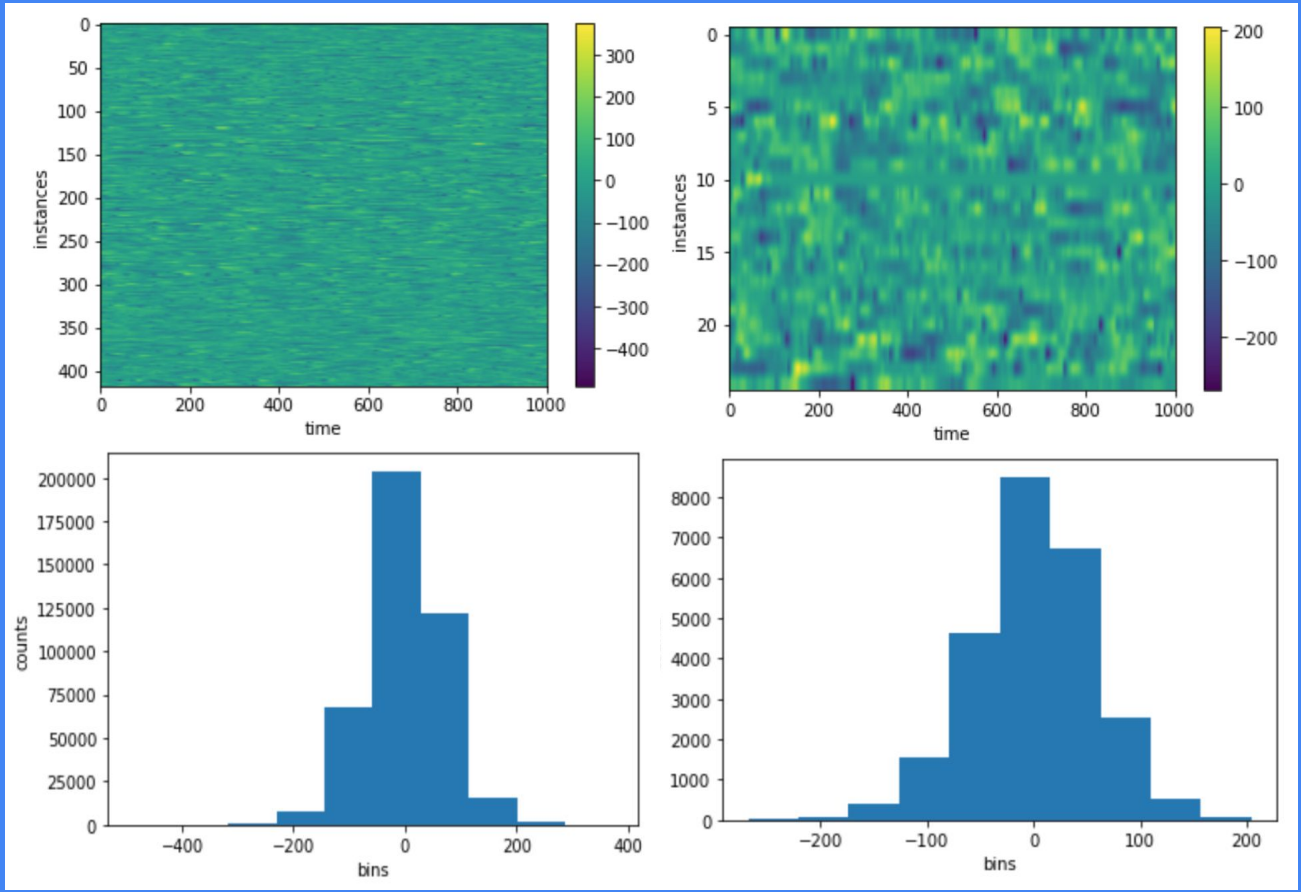

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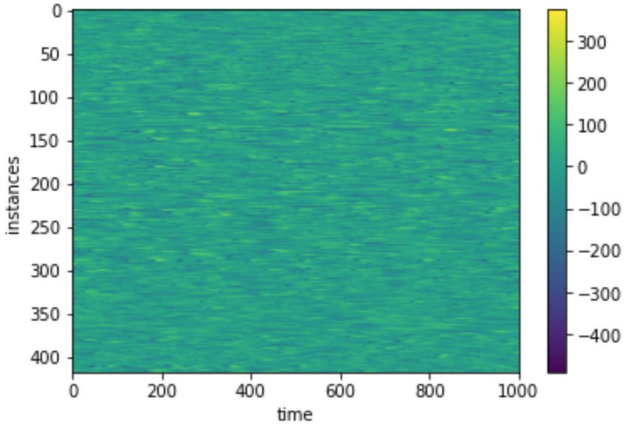
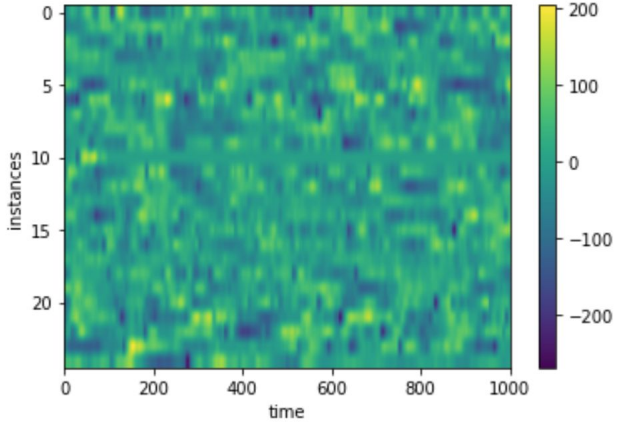
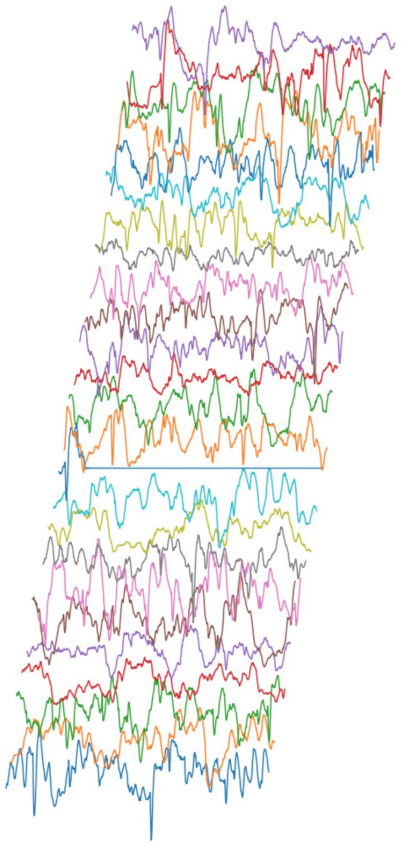
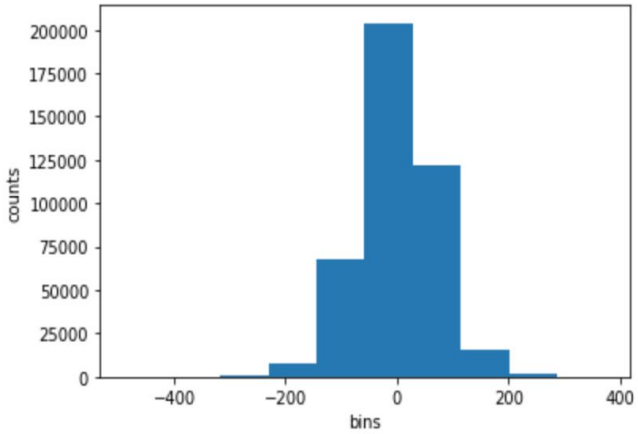
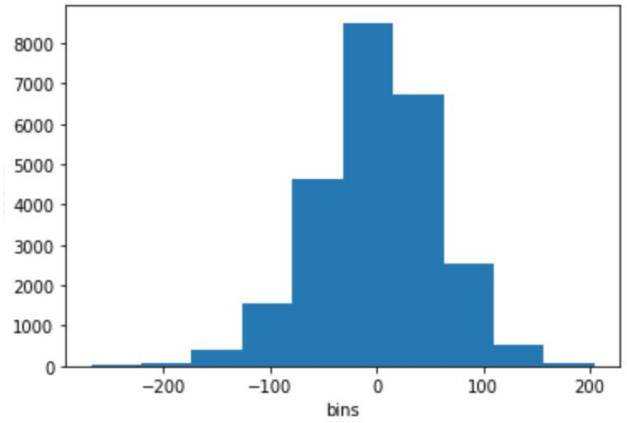










Signal Extraction

Signal Extraction

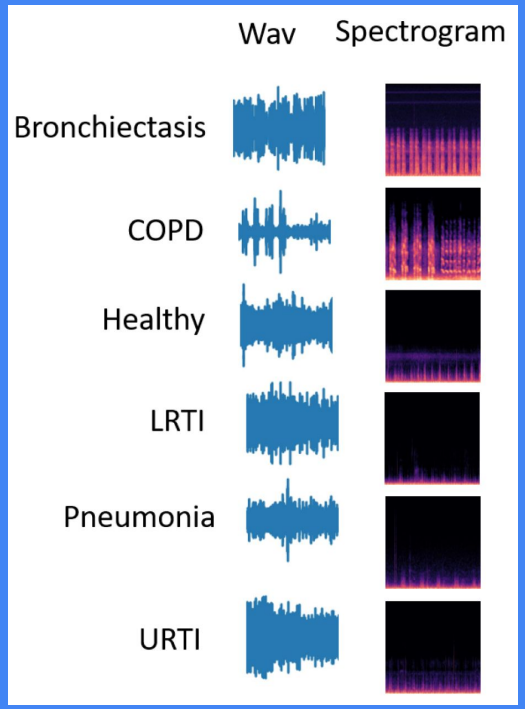
What types of signals might you have in your data?

Signal Extraction

- Lung Artifacts
- Heart Artifacts
- Stimulation Artifacts
- Movement Artifacts
- Electrical Noise
- …

Signal Extraction

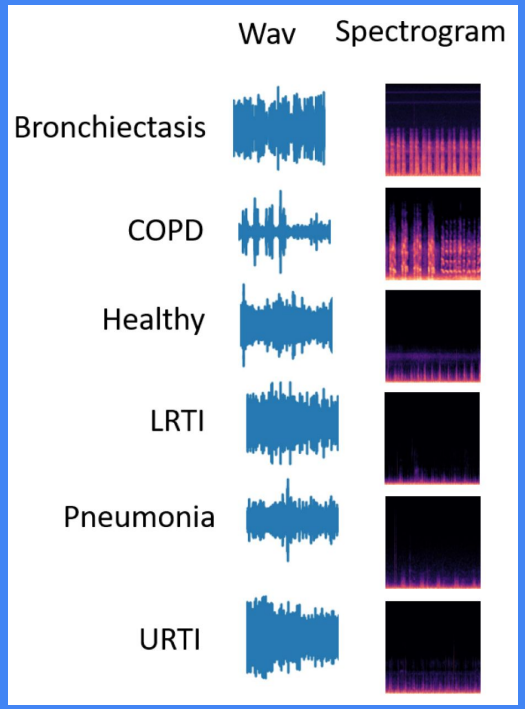
Lung Artifacts



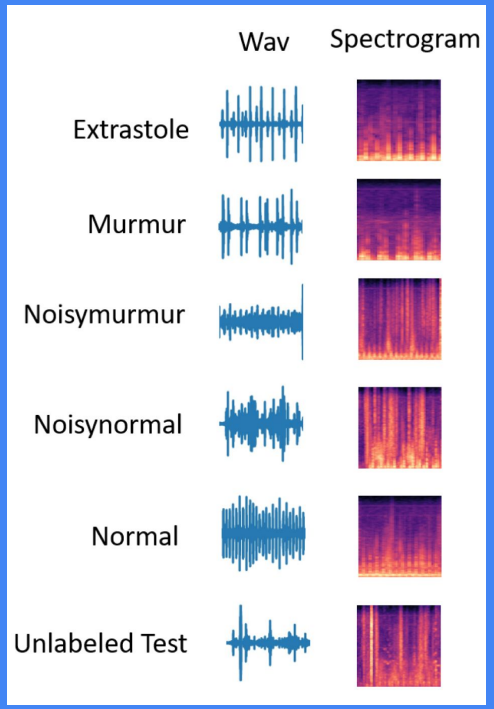
Tariq et al. 2022

Signal Extraction

Lung Artifacts



Heart Artifacts



Tariq et al. 2022

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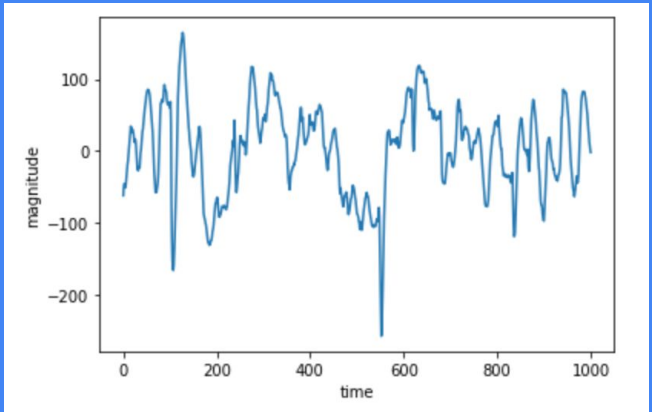

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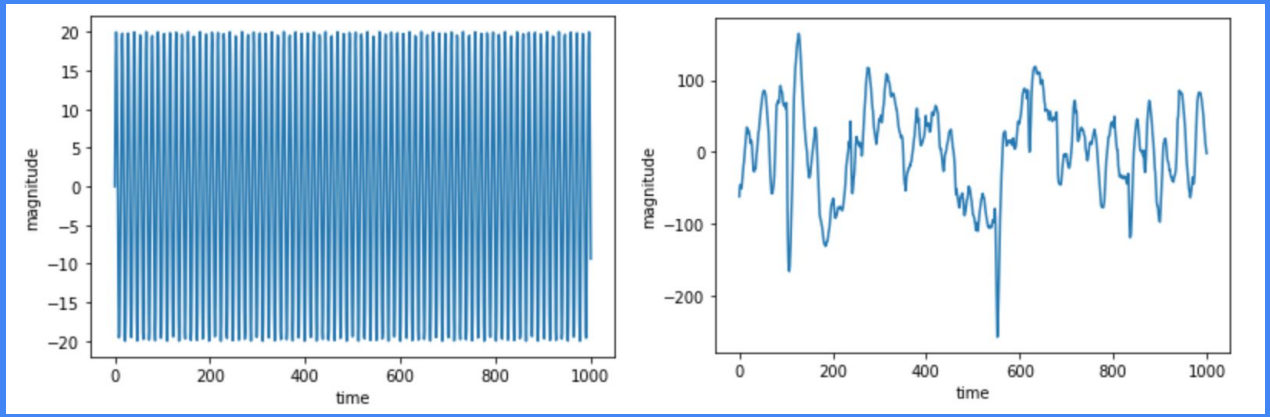

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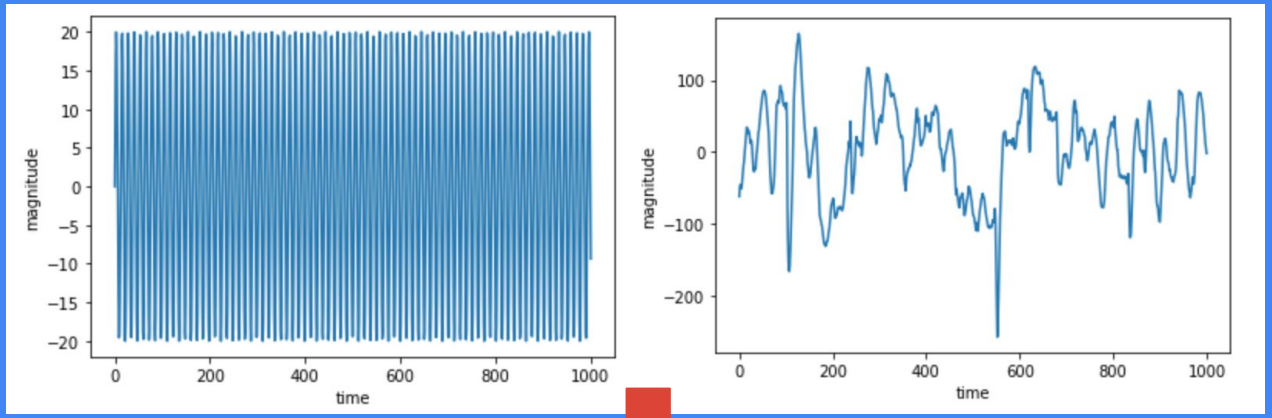

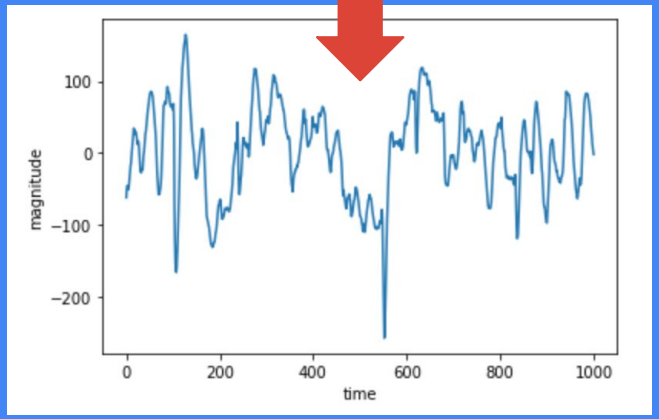

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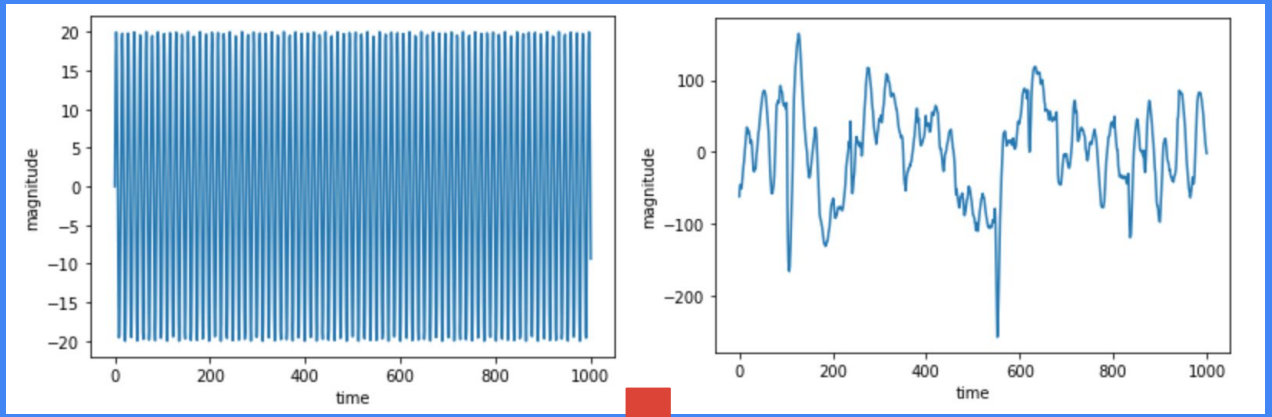

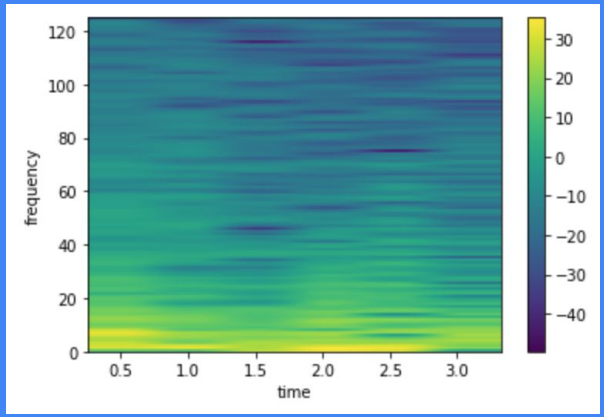

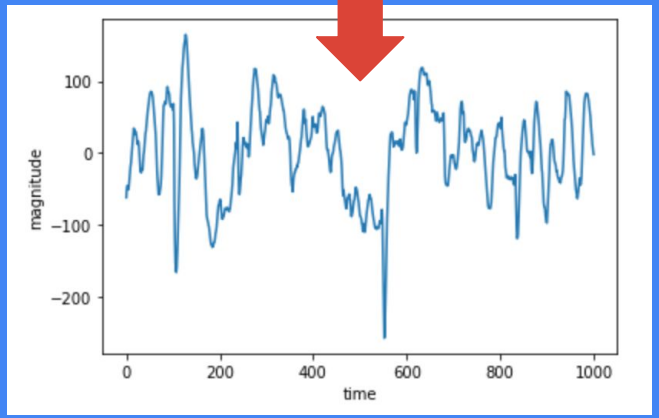

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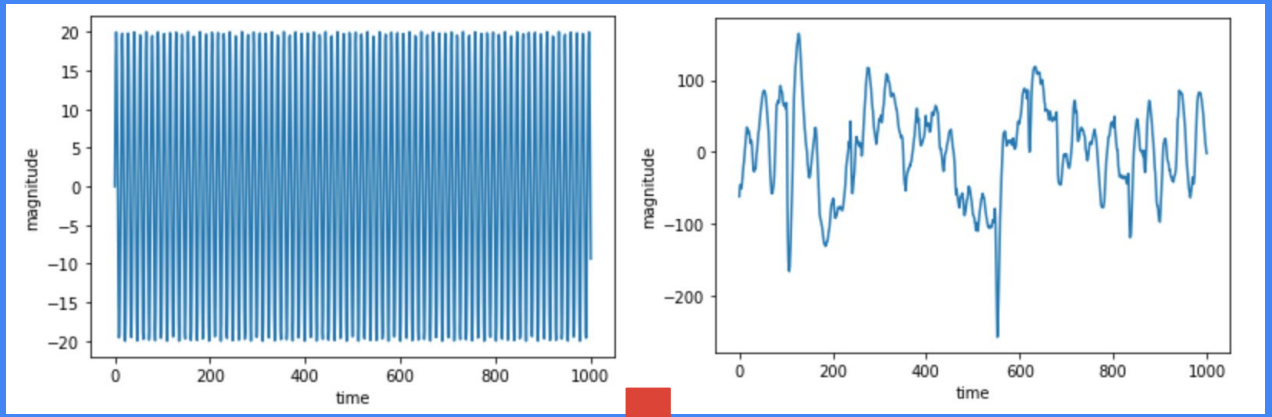

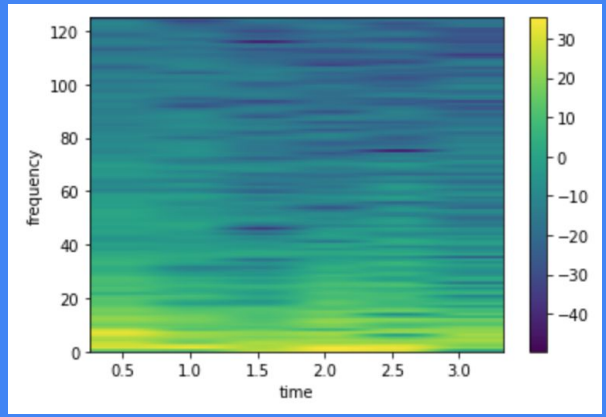

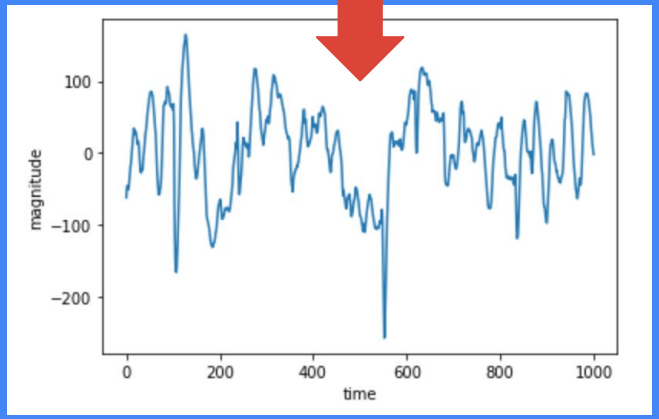

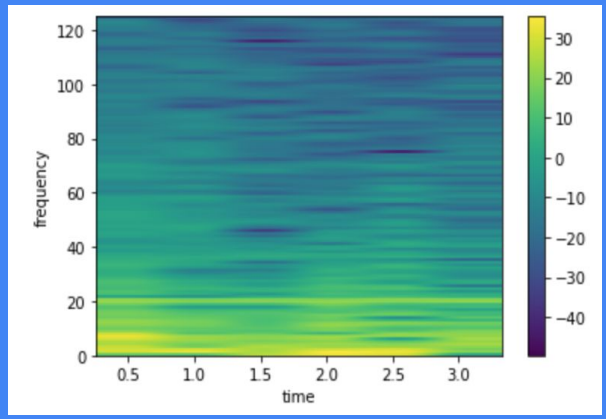

Dataset Augmentation

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Data augmentation in data analysis are techniques used to increase the amount of data by adding slightly modified copies of already existing data or newly created synthetic data from existing data.

https://en.wikipedia.org/wiki/Data_augmentation

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It acts as a regularizer and helps reduce overfitting when training a machine learning model.

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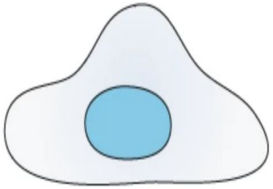
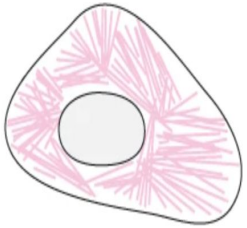
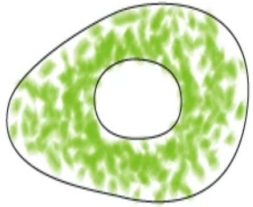


→ Nuclear



→ Cytoplasmic



→ Mitochondrial

Moen et al. 2019

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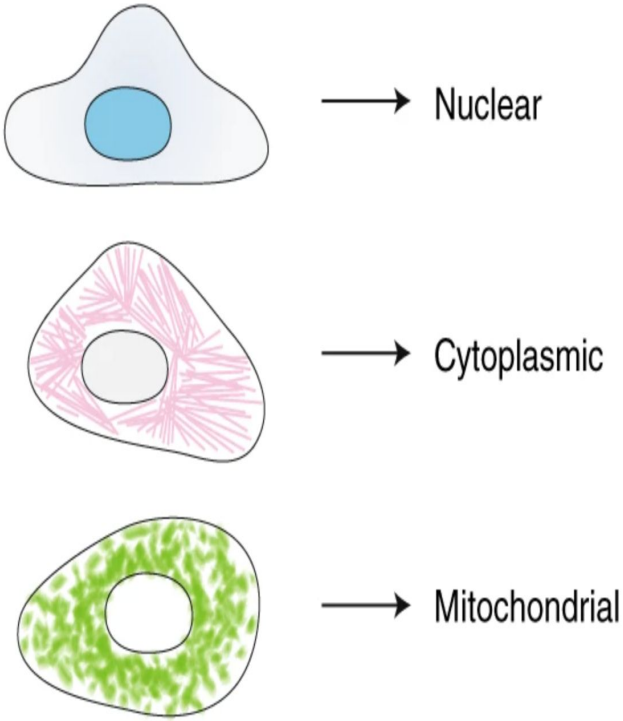

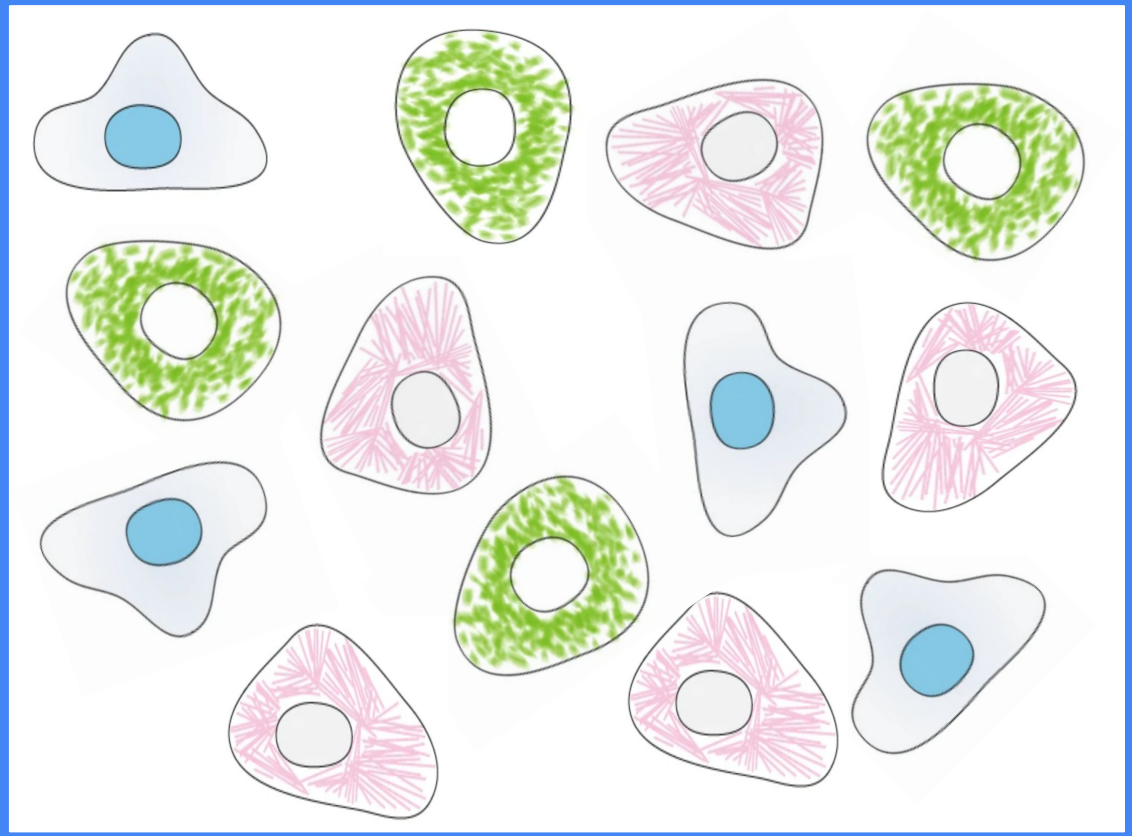

Moen et al. 2019

Normalization / Standardization

Normalization / Standardization

Normalization: Is adjusting values measured on different scales to a notionally common scale… [or] more sophisticated adjustments where the intention is to bring the entire probability distributions of adjusted values into alignment.

https://en.wikipedia.org/wiki/Normalization_(statistics)
https://en.wikipedia.org/wiki/Standard_score

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$$z = \frac{x - \mu}{\sigma}$$

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https://en.wikipedia.org/wiki/Standard_score

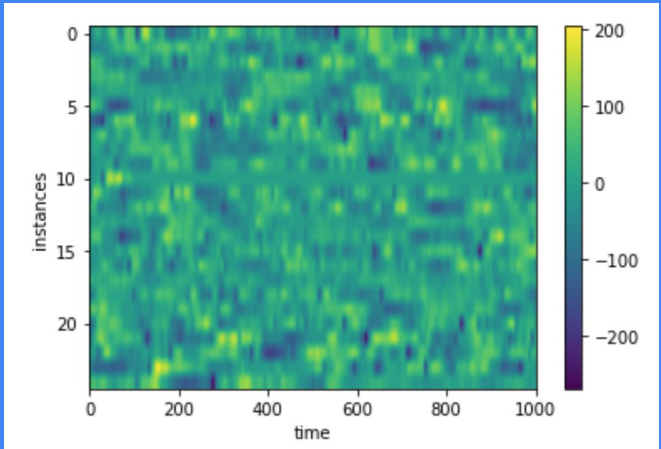
Normalization / Standardization

What does this help correct for in our data?

Normalization / Standardization

- Neural population drift across time.
- Electrode shift across days.
- Different dynamic ranges across patients.
- Habituation to stimuli.
- …

Normalization / Standardization



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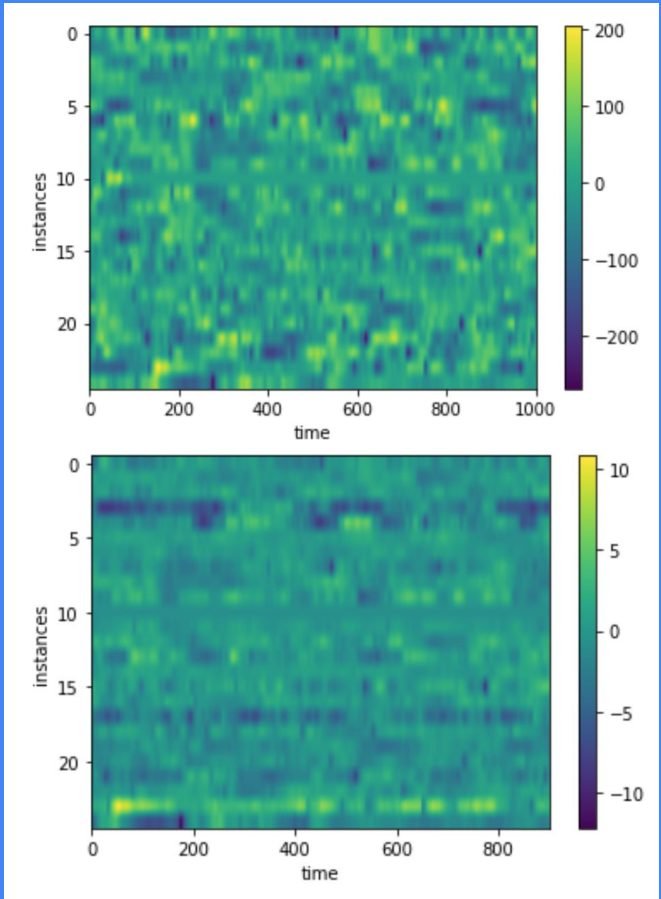

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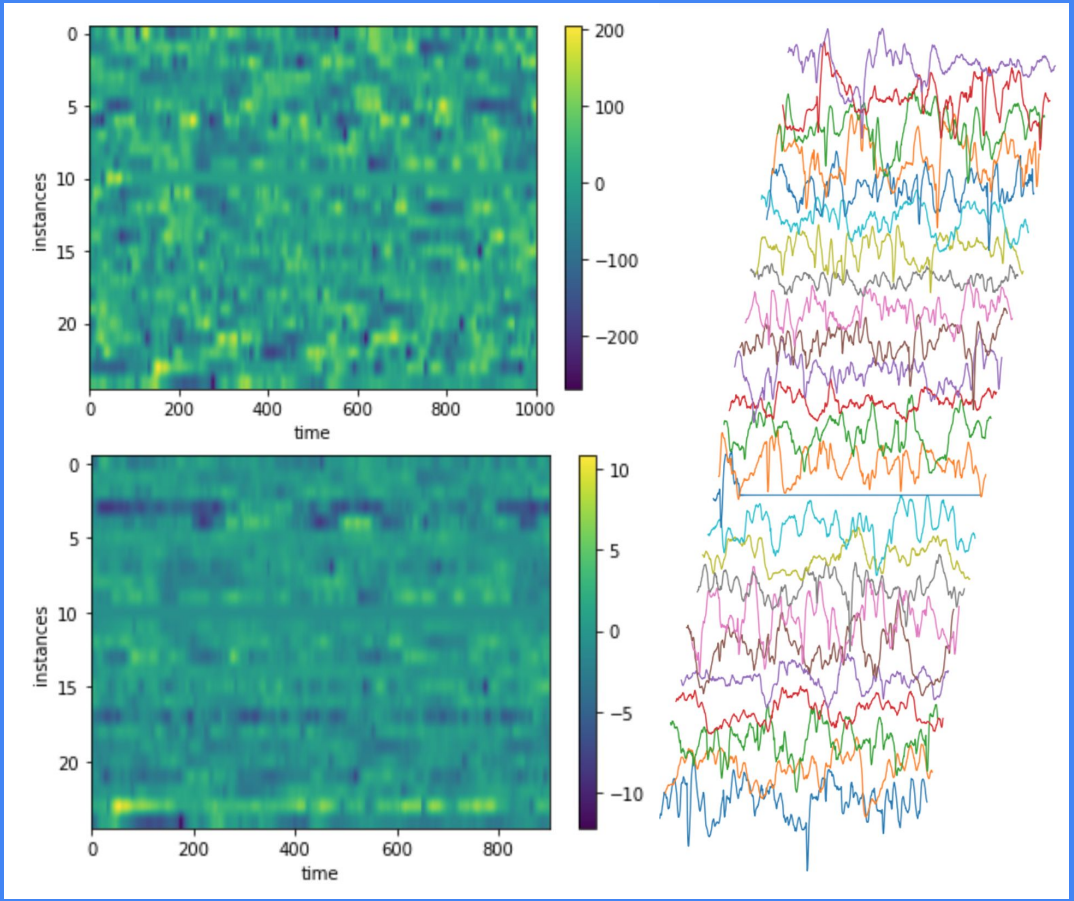

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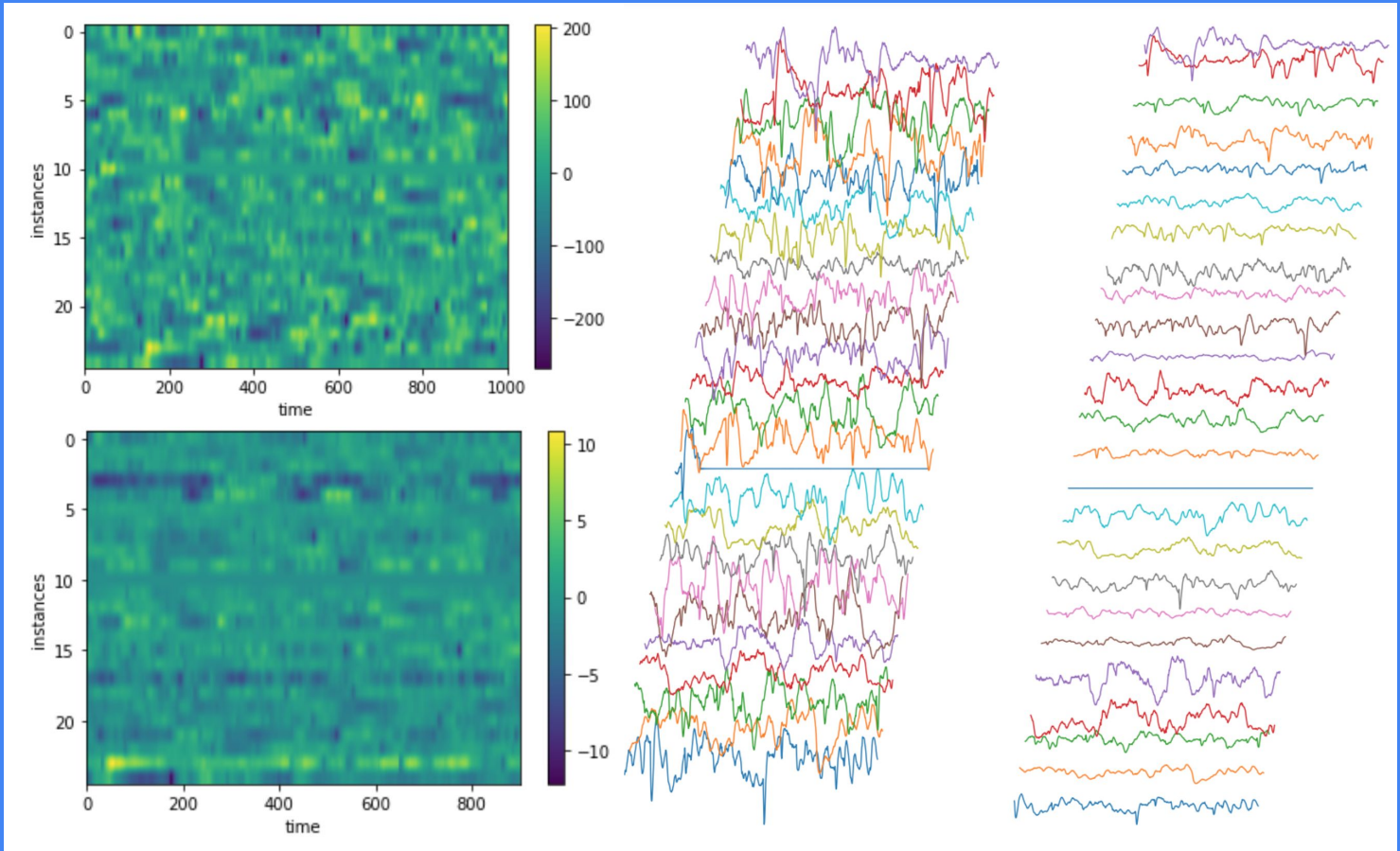

Train / Validation / Test Splits

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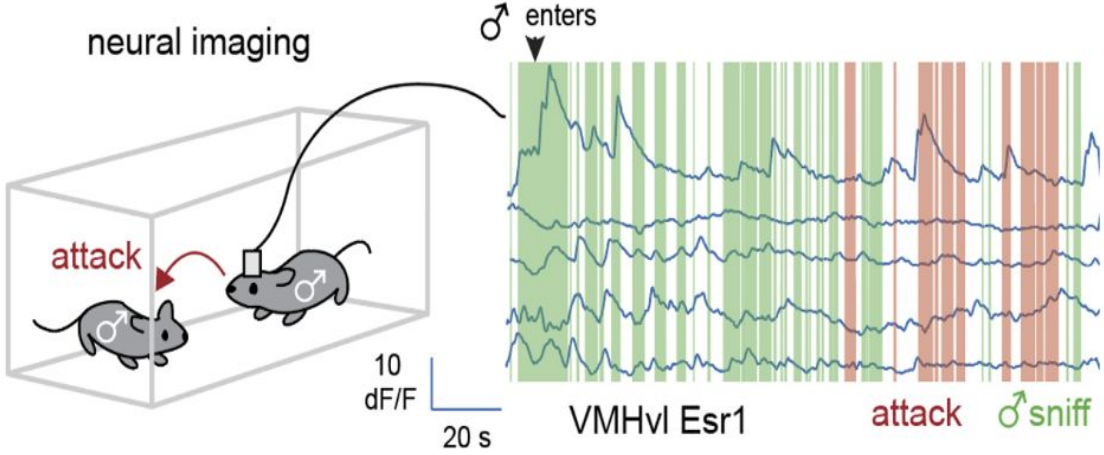

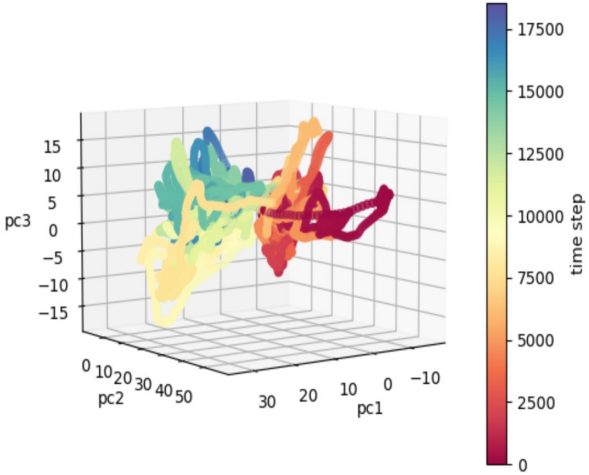

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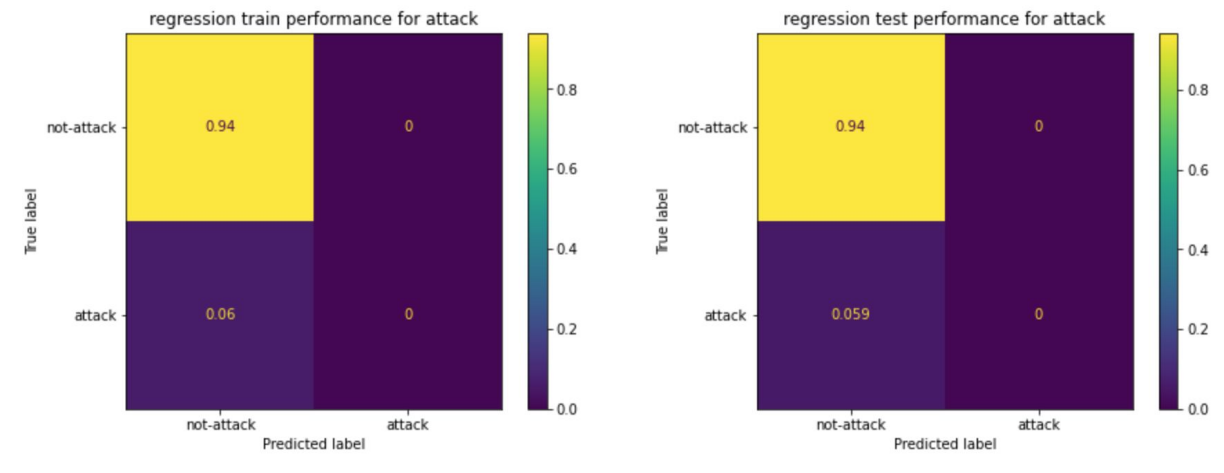

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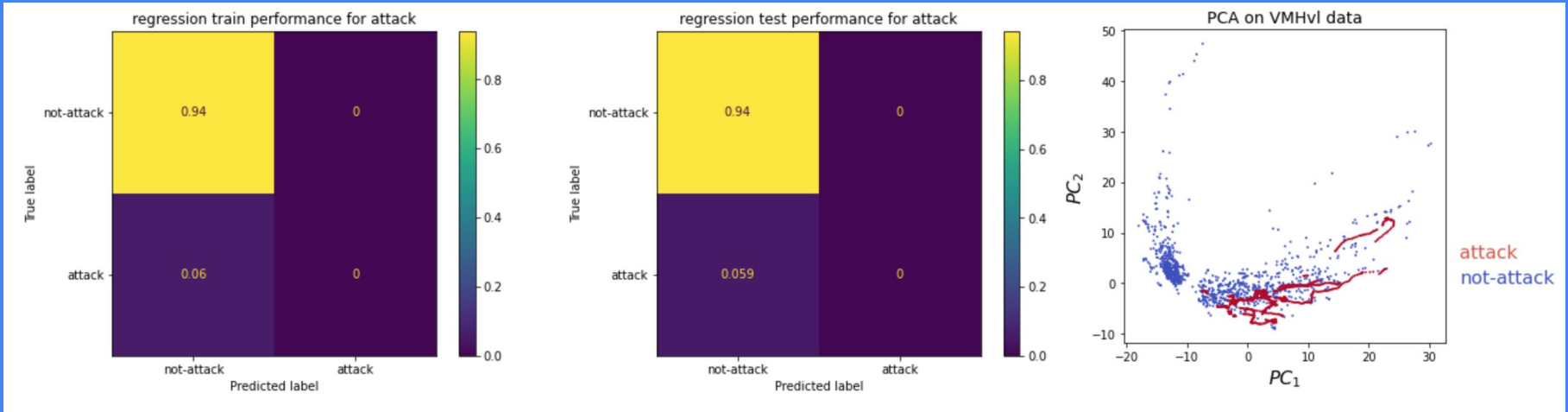

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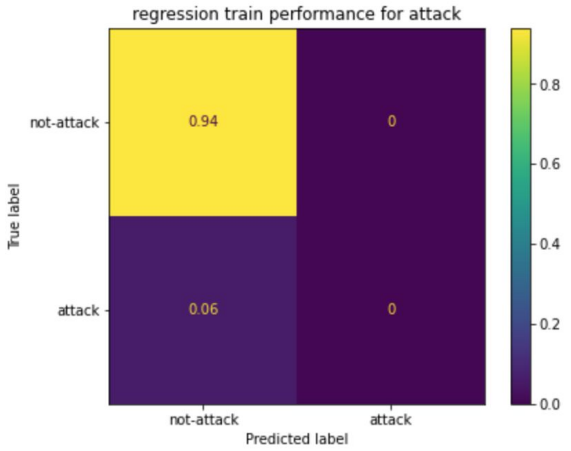

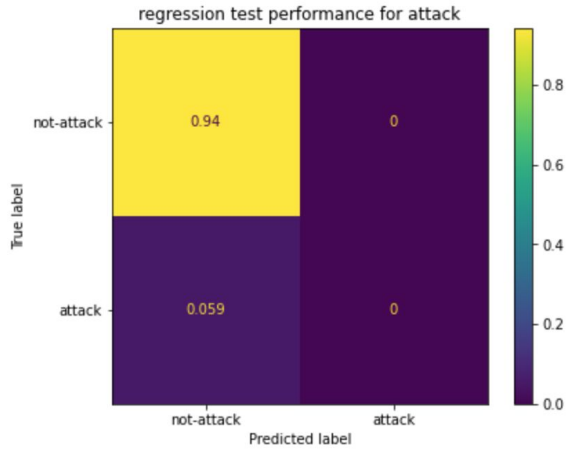

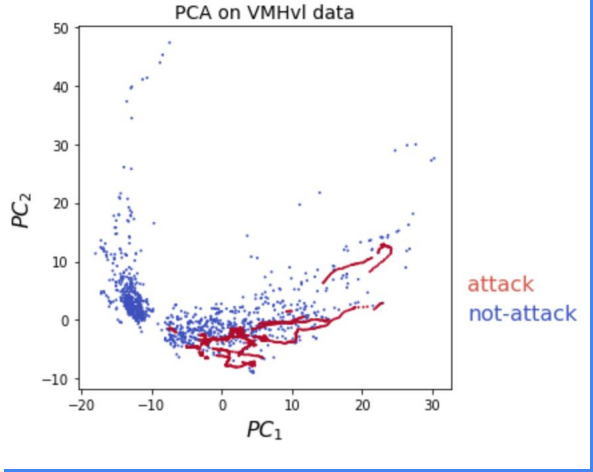

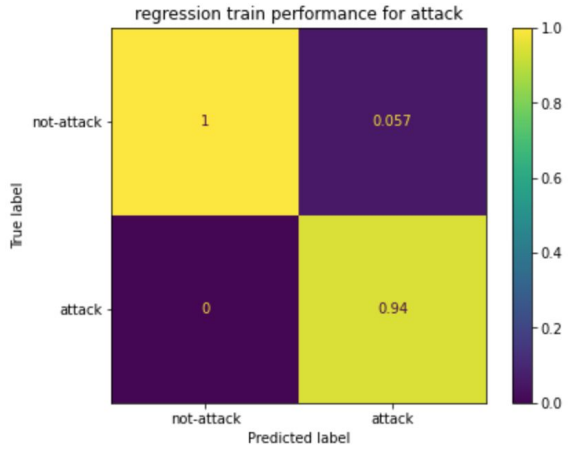

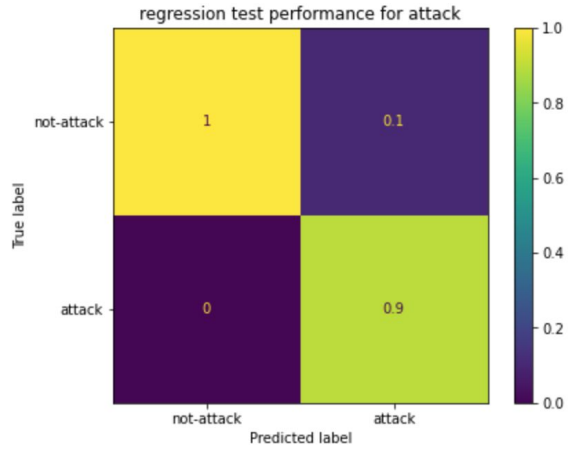

Train / Validation / Test Splits

https://github.com/SaberaTalukder/Chen_Institute_DataSAI_for_Neuroscience/blob/main/07_05_22_day1_overview/code/diy_notebooks/dataset_engineering.ipynb