Generating multivariate time series with COmmon Source CoordInated GAN (COSCI-GAN)

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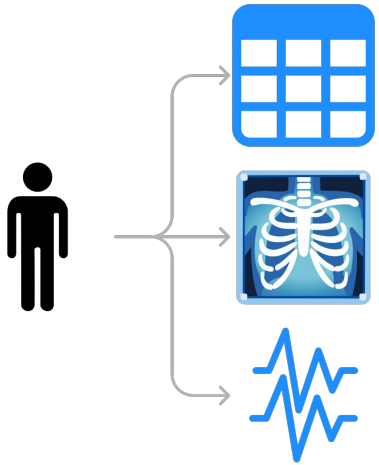
Neurips 2022

Why do we need COSCI-GAN?

- Various medical data coming from same patient:
  - Electronic Health Record (EHR)
  - Medical Imaging (MRI, CT, X-ray, etc.)
  - Multivariate time series (EEG, ECG, etc.)

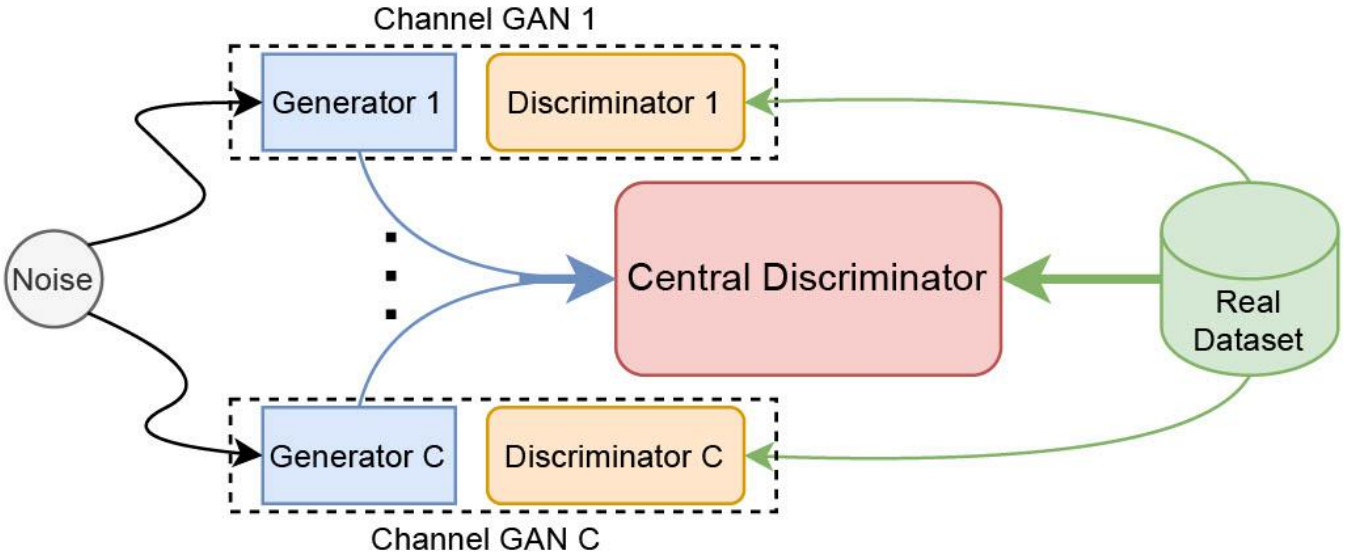


- Challenge of Data Scarcity due to privacy
  - Data Augmentation

- Poor performance of current State-of-the-art methods in synthesizing MTS

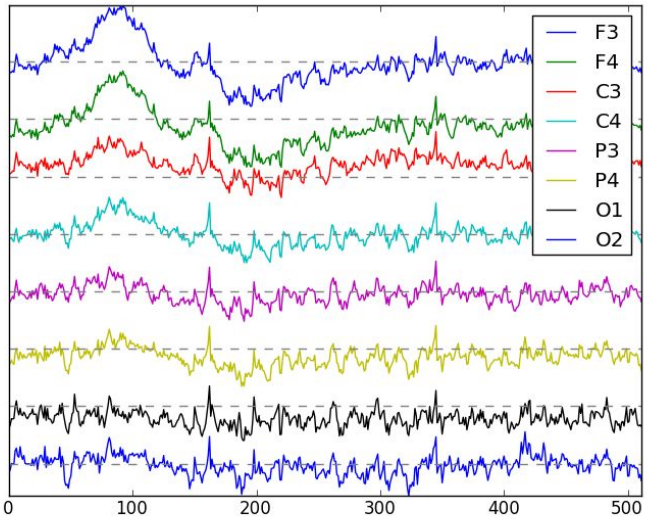
COmmon Source CoordInated GAN (COSCI-GAN)

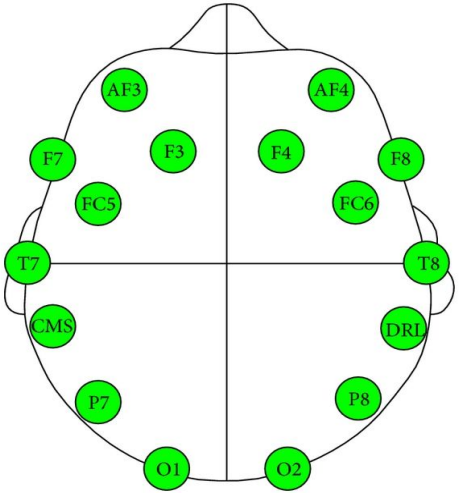
- Aims to preserve inter-channel/feature correlation.
- Assign a **Generator** for **each feature/channel** and add a **Central Discriminator** in the end.



EEG Eye State Dataset

- 14 channels
- Label indicates the eye state (Open or Close)





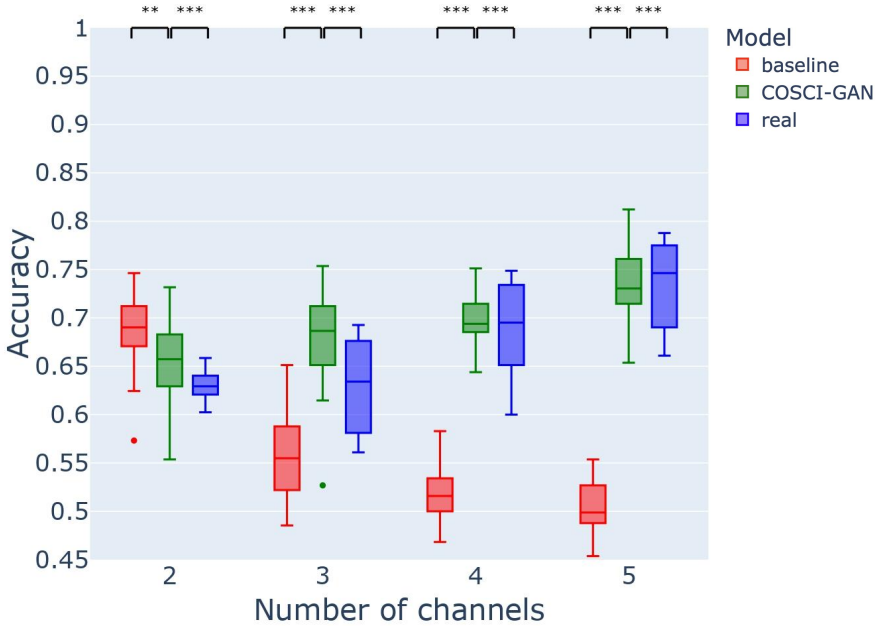
Classification experiment : Eye Blink Detection

- Compare COSCI-GAN against a baseline method
  - Baseline method : An LSTM-based GAN generating all channels together

- All-Synthetic Experiment
  - Using only synthetic data to train the classifier, test on real dataset

Synthetic Data could be as good as Real Data

- As we increase the number of channels:
  - Accuracy of real data ↑
  - Accuracy of baseline ↓
  - Accuracy of COSCI-GAN ↑



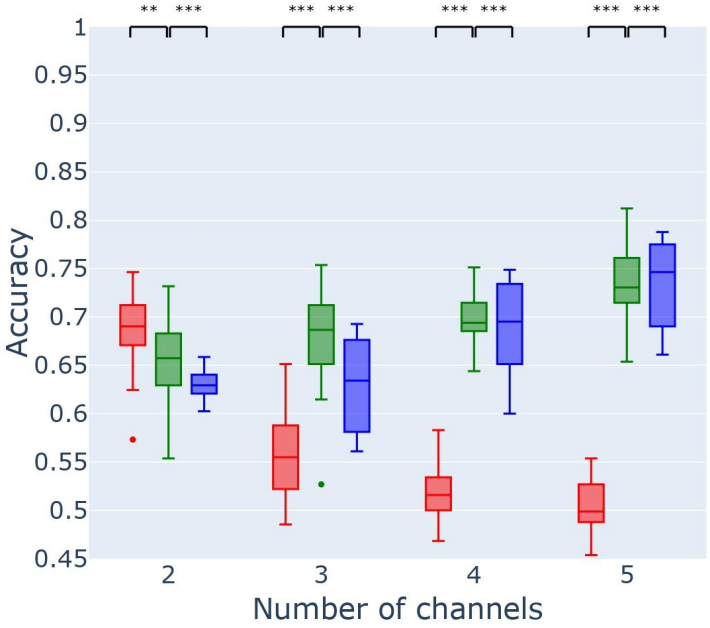
All-Synthetic Experiment

Classification experiment : Eye Blink Detection

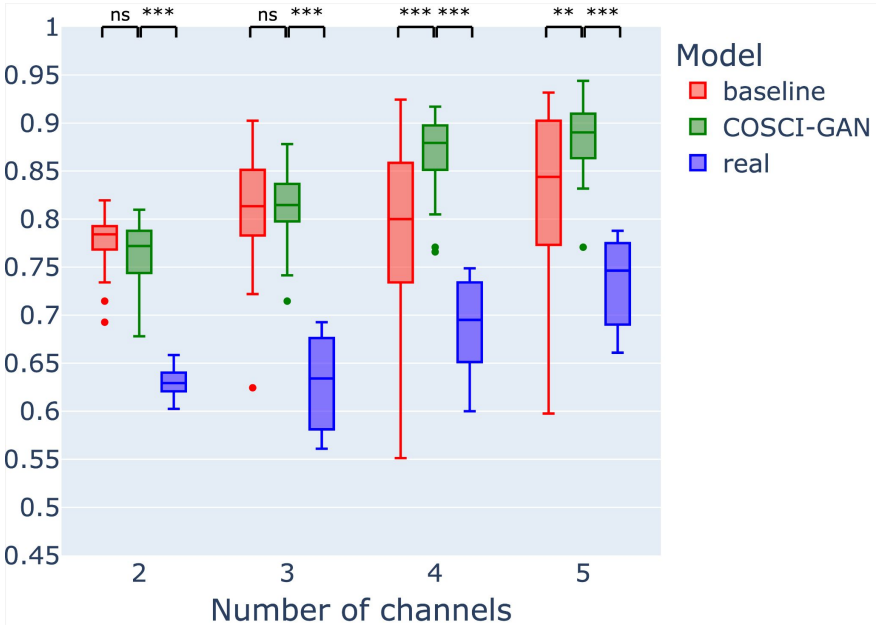
- Compare COSCI-GAN against a baseline method
  - Baseline method : An LSTM-based GAN generating all channels together

- All-Synthetic Experiment
  - Using only synthetic data to train the classifier, test on real dataset
- Augmentation Experiment
  - Augment the real dataset with an equal number of synthetic training samples
    - Will that increase the accuracy of the classifier?

Robustness of COSCI-GAN



All-Synthetic Experiment



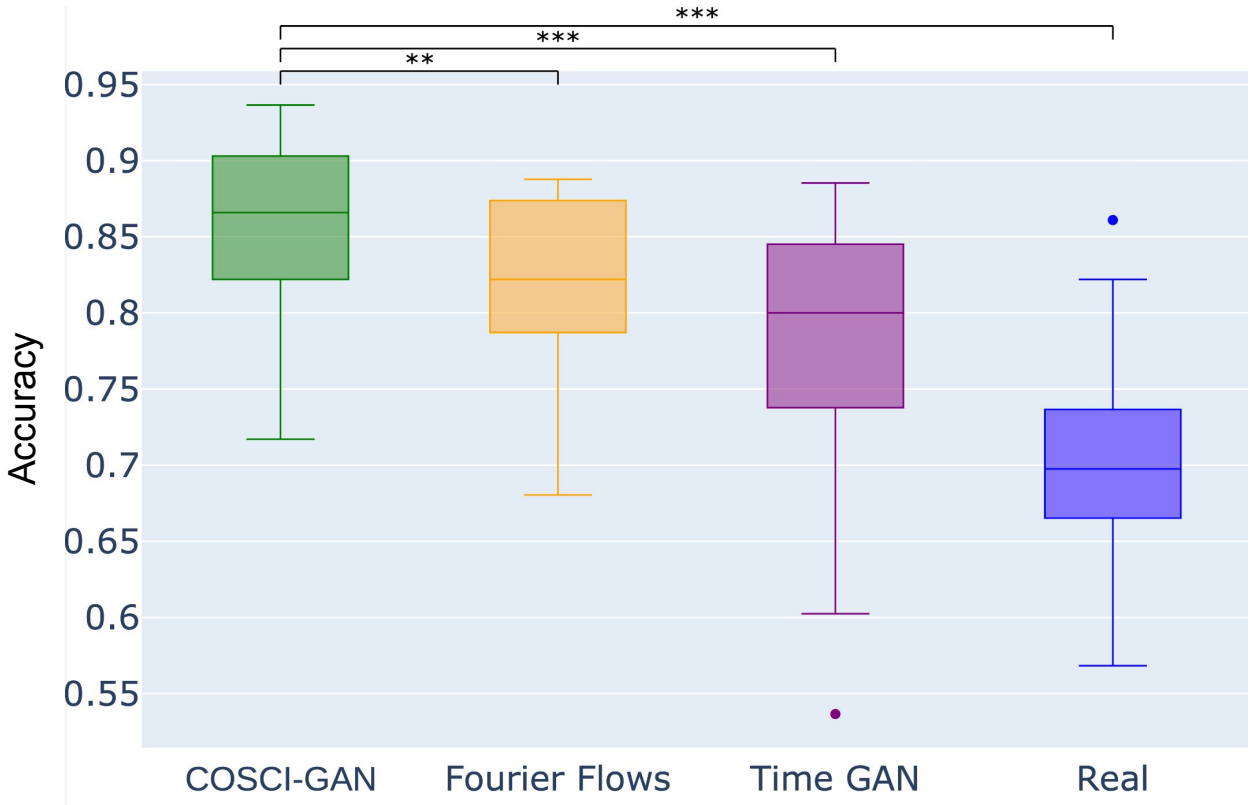
Augmentation Experiment

Comparing with State-of-the-art (SOTA) Methods

- Compare COSCI-GAN with:
  - TimeGAN, Yoon et al., NeurIPS 2019
  - Fourier Flows, Alaa et al., ICLR 2021 (Non-GAN method)

  - Use their code to generate EEG synthetic data
    - Repeat Augmentation experiment

COSCI-GAN is significantly better than SOTA in Augmentation



Conclusion

- COSCI-GAN
  - Designed to be well suited for generating MTS from a common source
  - Have a Central Discriminator to preserve inter-channel correlation

- Synthetic EEG MTS, COSCI-GAN vs SOTA
  - Better correlation
  - Better classification utility

- Future Directions:
  - Parallelize COSCI-GAN to speed up the training procedure
  - Implement COSCI-GAN with modern architectures such as transformers