Epileptic Seizure Prediction: A Semi-Dilated Convolutional Neural Network Architecture

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Introduction

- Epilepsy is the second most common brain disorder after migraine
- One-third of epileptic patients are drug-resistant
- Timely prediction of the impending seizure is extremely beneficial
- We present a neural network architecture named "semi-dilated convolutional network (SDCN)"
- The proposed SDCN seizure prediction method outperforms the baseline methods on two popular large-scale EEG datasets

EEG Datasets

- Dataset 1: American Epilepsy Society
  - Invasive EEG
  - Two Patients
  - Five Dogs
  - 400 Hz Sampling Rate, 16 EEG Channels
- Dataset 2: Melbourne University AES/MathWorks/NIH
  - Invasive EEG
  - Three Patients
  - 400 Hz Sampling Rate, 16 EEG Channels
- Pre-ictal (pre-seizure) EEG: 1-hour long (six epochs, 10-min each)
- Inter-ictal (between seizures) EEG: 1-hour (six epochs, 10-min each)

EEG Preprocessing

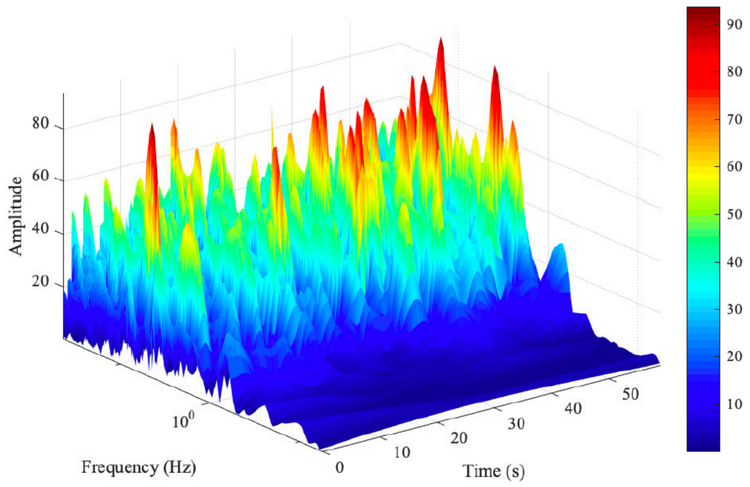
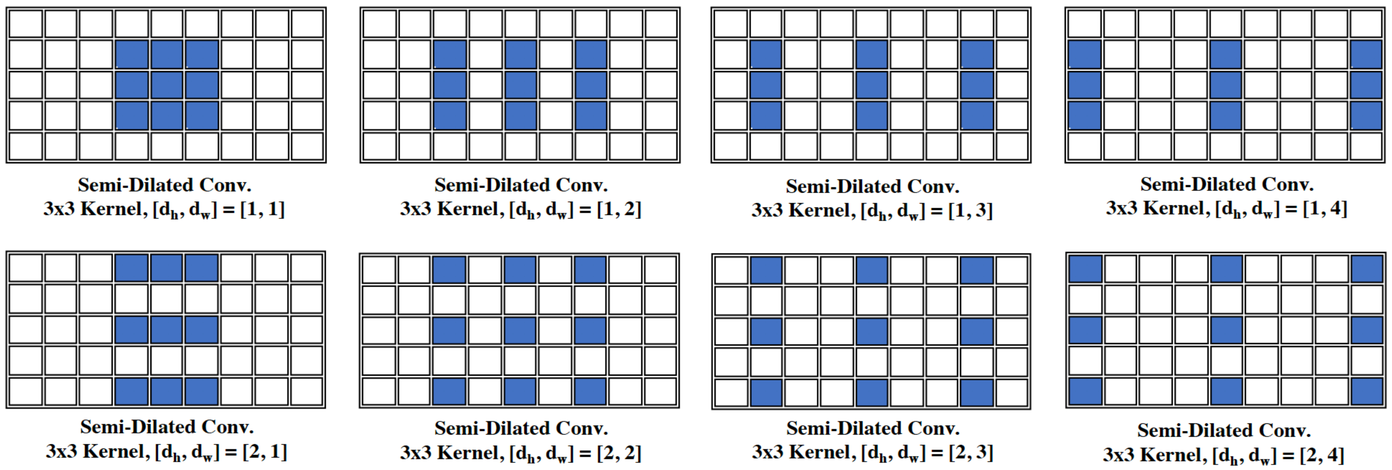
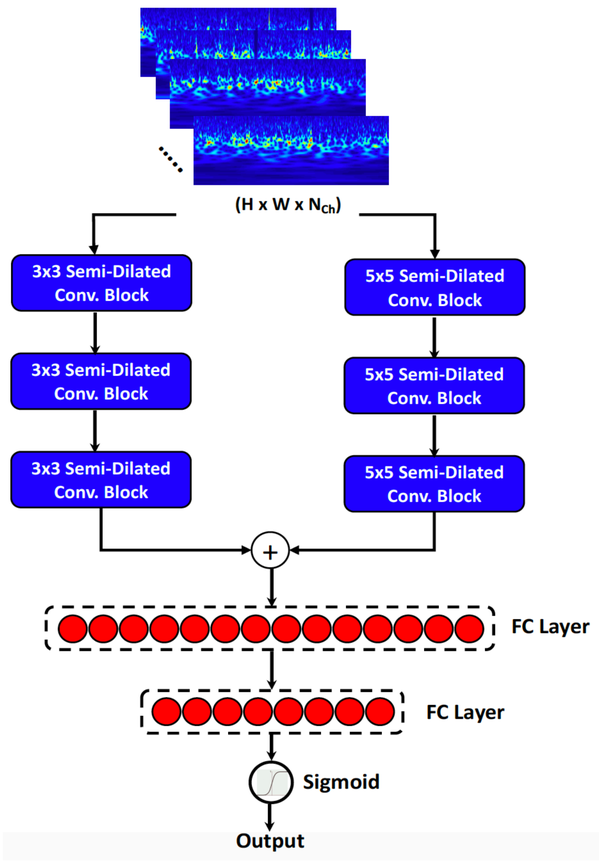


Figure 1. Scalogram of EEG

Methodology

- EEG Scalogram size: 100x600
- New Convolution Module: Semi-dilated Convolution (SDC)
- In 2015, dilated-convolution was proposed in [1].
- Dilation vector $[d_h, d_w]$
- d_h : vertical dilation (height), d_w: horizontal dilation (width)





- Multi-scale CNN
- Semi-dilated convolutional network (SDCN)
- Extract both local features and high-abstracted features
- Outputs of both paths are aggregated
- Sigmoid function to compute the class probabilities

Results

- The proposed SDCN outperforms baseline methods for both Datasets 1 and 2.
- Dataset 1: Sensitivity = 88.45% & AUC = 0.928
- Dataset 2: Sensitivity = 89.52% & AUC = 0.883

Conclusion

- Novel Convolution Module named Semi-dilated Convolution
- SDCN Structure for Seizure Prediction
- SDCN is tested on two clinical EEG datasets
- Superior Prediction Sensitivity and AUC score

References

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