

Sleep Stage Classification using TCN

Objective

The objective of this assignment is to apply a **Temporal Convolutional Network (TCN)** to the problem of **sleep stage classification** using electroencephalogram (EEG) signals.

Dataset

This assignment uses the **Sleep-EDF Expanded Dataset**, which is publicly available on PhysioNet.

Dataset link:

<https://www.physionet.org/content/sleep-edfx/1.0.0/>

Important Notes

- You are **not required to download the full dataset**.
- Use a **clearly defined subset of the dataset**, such as recordings from a specific number of subjects (e.g., 1–3 subjects) or a fixed number of sleep recordings. Using the full dataset is not required.
- Use **one EEG channel only** (e.g., Fpz–Cz or Pz–Oz) to simplify the problem and reduce computational complexity.

Understanding the Data

Each sleep recording consists of:

- EEG signal recordings stored in **.edf** files.
- A corresponding hypnogram file that provides the **sleep stage label for every 30-second epoch**.

The sleep stages to be classified are:

- Wake
- N1
- N2
- N3
- REM

Assignment Requirements

1. Data Selection and Segmentation

You are required to:

- Select **one EEG channel only**.
- Segment the EEG signal into fixed-length epochs of **30 seconds**.
- Assign the correct sleep stage label to each epoch using the hypnogram file.

2. Preprocessing

The following preprocessing steps should be applied:

- Normalization or standardization of EEG signals.
- Removal of invalid or corrupted samples if present.
- Splitting the data into training, validation, and test sets.

3. Model Design

You must design a model based solely on **Temporal Convolutional Networks (TCN)**.

The model should include:

- Causal convolutions.
- Dilated convolutions.

The use of the following models is **not allowed**:

- Autoencoders
- RNN, LSTM, or GRU

4. Training

You should:

- Select an appropriate loss function for multi-class classification.
- Use an optimizer.
- Choose suitable batch size and number of training epochs.

5. Evaluation

Model performance must be evaluated using:

- Accuracy
- Precision
- Recall
- F1-score

You are encouraged to include:

- Confusion matrix
- Training and validation loss curves

6. Analysis and Discussion

The report should include a discussion of:

- Overall model performance.
- Which sleep stages were most difficult to classify.
- Why TCN is suitable for EEG-based sleep stage classification.

Deliverables

You must submit:

1. A Jupyter Notebook (or Google Colab notebook) containing:
 - Data loading and preprocessing
 - Model implementation
 - Training and evaluation

2. A short written report (PDF or Word) including:

- Introduction
- Dataset description
- Model architecture
- Results
- Conclusion

Notes

- High accuracy is not the main objective; correct methodology and understanding are more important.
- Using a small subset of the dataset is completely acceptable.
- Clear explanation and clean implementation are strongly encouraged.