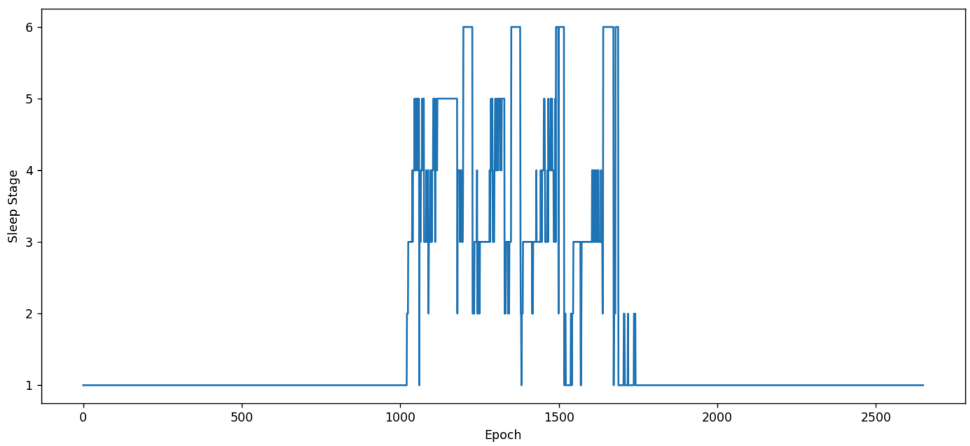
NeuroTech@Rice Challenge
2024 Rice Datathon

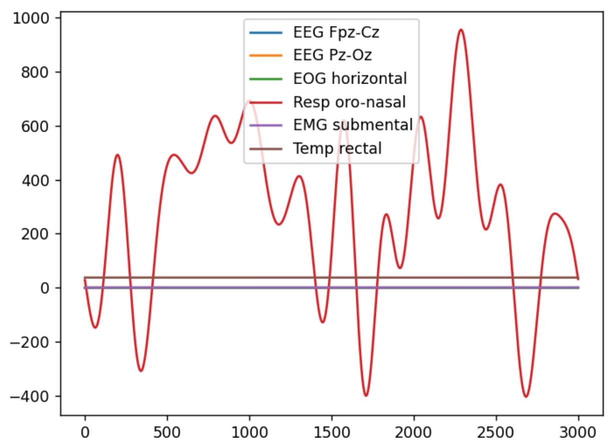
Problem Statement:
Scientists have long been interested in studying the neurophysiological correlates of sleep. In 1935, with a private laboratory and a curiosity about hypnosis, the physicist and investment banker Alfred L. Loomis was the first to measure fluctuations in electric potential at the scalp during sleep (Stone, 2013). He noted prominent features such as the K complex and sleep spindles, and he was the first to note the existence of different stages of sleep. Though standards have been changed over the years, identifying when a patient is experiencing different stages of sleep remains a difficult problem. In studies, sleep stages are typically manually identified by physicians. This is a time-consuming and error-prone process. To accelerate this process, researchers have begun using machine learning to classify sleep stages. See Papers with Code's leaderboard for the Sleep-EDF benchmark for a survey of state-of-the-art methods for this task.

Dataset:
We are using a modified version of the Sleep-EDF dataset. We have provided 43 nights of sleep data for training in the Training directory and 2 nights for evaluation in Evaluation. The file names of the training data indicate the patient and night of sleep. For example, a file `p00_n2_X.npy` is the first patient's second recorded night of sleep data. Each X array is of size N x 6 x 3000, where N is the number of epochs of data, 6 is the number of channels, and 3000 is the number of samples per epoch. Information about the channels is included below. Each epoch is 30 seconds long, and data is recorded at 100 samples per second. For each X array, there will be a corresponding N x 1 labels array `p00_n2_y.npy`. This will include N sleep stage labels. Each sleep stage label will be a number between 0 and 6 (inclusive). Information about these labels is included below. Feel free to reshape this data, for example by splitting or combining epochs.

Note that we do not expect your model to be trained on all of the provided training data. To start, we would recommend setting up your model with just one file. Also, this dataset is **not** balanced in terms of epochs per sleep stage. As an example, see the hypnogram below for one of the training files. For your model to perform well on the test data, you will need to ignore some (most!) of the waking epochs when training.



Channel Columns



0. EEG Fpz-Cz
    a. An EEG signal is a recording of electrical activity at the scalp of a patient. This channel includes information from the electrodes between FPZ and CZ.
1. EEG Pz-Oz
    a. This channel includes information from between PZ and OZ electrodes.
2. EOG horizontal
    a. Electrooculography (EOG) captures information about the movement of the human eye by measuring the electrical potential near the eyelid.
3. Resp oro-nasal
    a. This channel tracks the electrical potential of a diaphragm connected to the patient's respiratory system. This signal approximately measures position, so you may take its derivative to see the rate of inhalation/exhalation
4. EMG submental
    a. Electromyography (EMG) measures the electrical activity of some region of muscles. Submental refers to the fact that these measurements were taken below the patient's chin.
5. Temp rectal
    a. This channel is a measurement of the patient's body temperature.

Sleep Stage Labels

0. ? – not scored. Epochs with this label can be omitted.
1. W – Waking
2. 1
3. 2
4. 3
5. 4
6. R – REM

Goals:

Your goal is to create a model that extracts features from the epochs of multimodal sleep data and uses these features to predict the hypnogram, or sleep stage labels as a function of time, for a night of sleep. Your model should be trained only on the provided data. Feature extraction could be done with either conventional machine learning and signal processing methods or deep features. Additionally, feel free to take advantage of the temporal nature of this task. For example, researchers have used a Hidden Markov Model (HMM) to take the previous epoch's label into account. Your model will be evaluated on the accuracy of the labels you provide on the provided night of test data. With your Devpost submission, please upload a .zip file containing two NumPy files, `a_pred.npy` and `b_pred.npy`, containing the predicted sleep stage labels for evaluation files a and b. We will run an evaluation script comparing your submission to the true values.

When judging, we are interested not just in the raw performance of your algorithm in terms of test accuracy but also interesting/novel problem-solving approaches, insightful exploratory data analysis and visualizations, possibilities for future work, and the potential challenges your model may face if deployed in a real-world setting.

Note that while we encourage you to research existing classification methods, all submitted work must be a team's **own work** and referenced sources must be cited. Failure to follow these standards will result in disqualification.

Citations:

Stone, J. L., & Hughes, J. R. (2013). Early history of electroencephalography and establishment of the American Clinical Neurophysiology Society. *Journal of clinical neurophysiology : official publication of the American Electroencephalographic Society*, 30(1), 28–44. https://doi.org/10.1097/WNP.0b013e31827edb2d