# Deepsleep: Deep Learning for Automatic Sleep Scoring

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*Polysomnography* is a sleep study, where some signals like electroencephalograms (EEGs), electrooculograms (EOGs), electromyograms (EMGs) and leg movement are collected from a patient, for diagnosing various sleep disorders. A person goes through 5 sleep stages during his sleep - Wake, N1, N2, N3 and REM and analysis of these sleep stages is very important for the detection of various sleep disorders like abnormal sleep cycle and periodic leg movement syndrome. Currently, the sleep technicians manually annotate the sleep stages (known as *sleep scoring*) through visual analysis of the signals. It takes them approximately 2-3 hours to annotate sleep stages for a whole night ( 8 hours) of sleep. So, having an automatic system, which can identify sleep stages correctly, will make their task easier and diagnosis faster. As, no machine learning system is 100% accurate yet, there will always be a sleep technician checking the sleep stages predicted by the system, before assigning the final stages to a patient.

Some works have shown the use of traditional machine learning algorithms like Support Vector Machine and Neural Network, for automatic sleep stage prediction and using expert defined features, e.g. time-domain and frequency domain features of a signal, to train the model [2, 3]. Traditional machine learning algorithms are dependent on expert defined features for training, whereas, deep learning can automatically learn abstract feature representation from data. There are some works investigating the use of deep learning to predict sleep stages using either single EEG channel or multiple channels as input [1, 4].

In this work, we have developed a deep learning model for the automatic prediction of sleep stages, which takes as input a 30 second chunk of EEG, EOG and EMG signals, and predicts its sleep stage. We developed a model using the combination of convolutional neural network and recurrent neural network (Long Short-Term Memory (LSTM)), for incorporating both temporal and sequential information into the model. Our deep learning model was trained and tested on two publicly available datasets - Sleep Health Heart Study (SHHS) and SLEEP-EDF and another dataset collected from Medisch Spectrum Twente (MST) hospital, Enschede, Netherlands.

A downside of deep learning methods is that there is always some concern related to the adoption of deep learning methods, due to their blackbox nature. To make our results more transparent, we have also added post-hoc interpretability to our model, through the technique of occlusion in time-domain. This technique can show which parts of the signal are important for the decision making process of the model.

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## References

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