# Using R for automatic sleep analysis as a regular part of the clinical process.

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## INTRODUCTION & GOALS

Sleep medicine is the medical specialty devoted to the diagnosis and treatment of sleep disorders. The polysomnography (PSG) is the gold standard exam, conducted before any analysis. It consists of an overnight record of body functions, including electroencephalography, eyes movements, muscles activities, and heart activity.

PSGs produces many data, mostly in the form of high-frequency time series. In the classical clinical process, Medical Doctors or Sleep Technologists visually score records, assigning stages and events to the multivariate time serie. This is a time-consuming task, taking a few hours for each record; therefore automating the process is a real need.

**Figure 1**: Noxturnal, a visual sleep scoring software.

## METHOD & VISUALISATIONS

At the sleep center of the Hôtel-Dieu, Paris, we use R to visualize, analyze and automatically score sleep records. Heterogeneous sleep data can be easily displayed in an interactive and user-friendly way using Shiny. New representations, including 3D projections of sleep stages are provided to medical teams in order to get a more accurate understanding of sleep. Machine learning algorithms are trained on previous recorded and annotated records of the center. Reports are built using R Tex and publishing related packages to bring the information smoothly and pertinently in the existing clinical process.

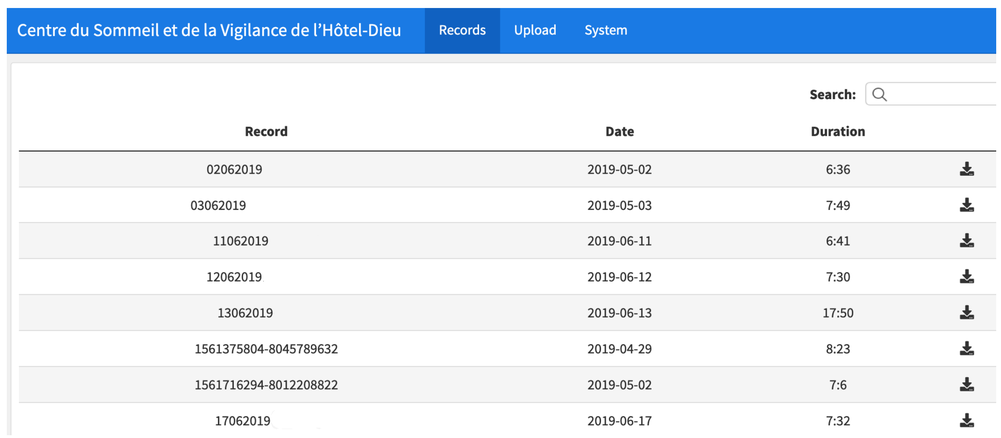



**Figure 2**: Providing access to automatic scoring through a Shiny web application.

**Figure 3**: A hypnogram, representing the sleep stages as a function of time.

- **AWA**: Awake
- **REM**: Paradoxical Sleep
- **N1, N2**: Light Sleep
- **N3**: Slow Wave Sleep

Sleep stages are historically scored over 30 seconds epochs. This hypnogram shows 15 seconds epochs scored by a DNN.

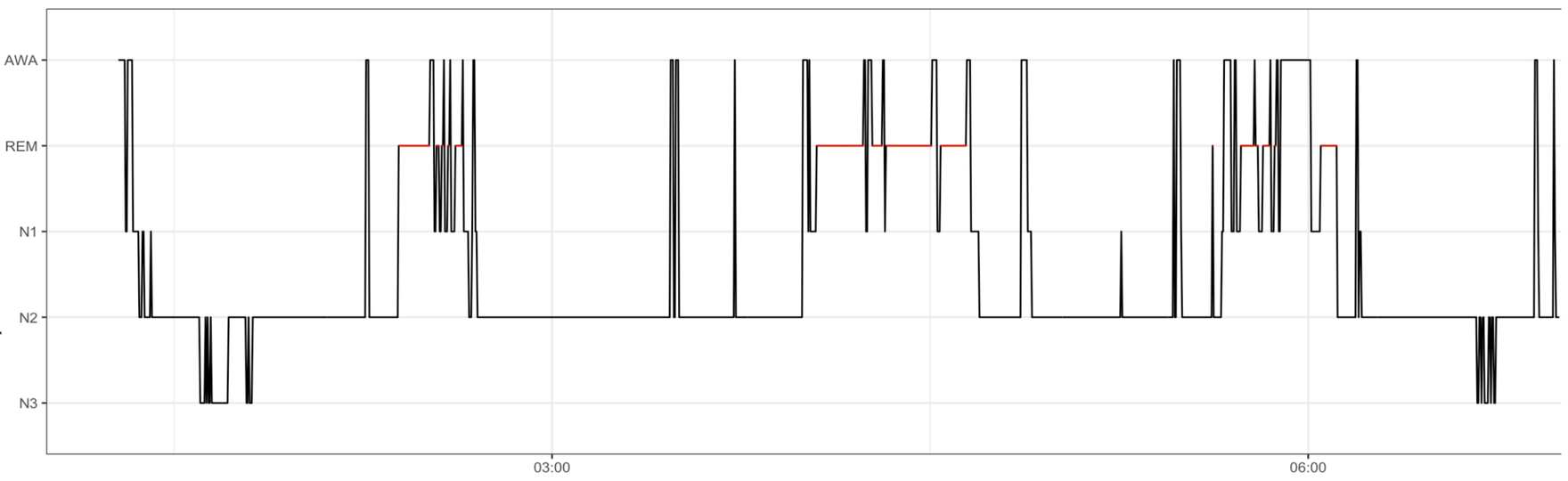



**Figure 4**: Hypnodensity, as introduced by Stephansen & Al. (2018). The graph shows the probability of each sleep stage, as seen by a DNN, over time.

State of the art DNNs applied to sleep stages classification from PSG signals show results similar to inter scorers variability.

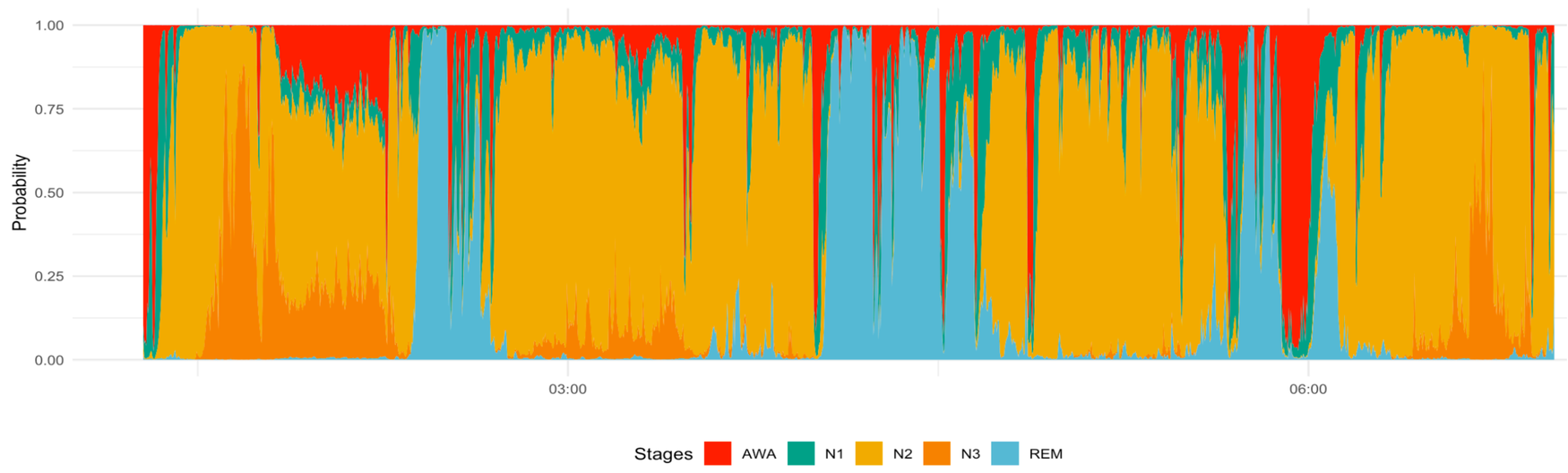



**Figure 5**: Sleep periods transitions graph, showing sleep structure with stages as nodes and probability of sleep stage change as edge.

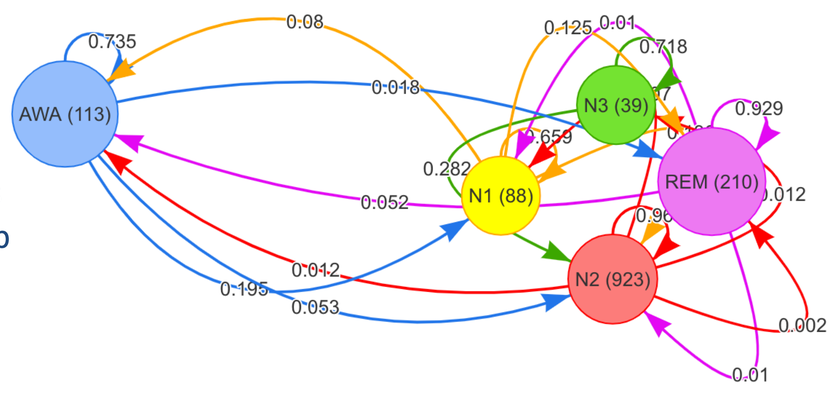
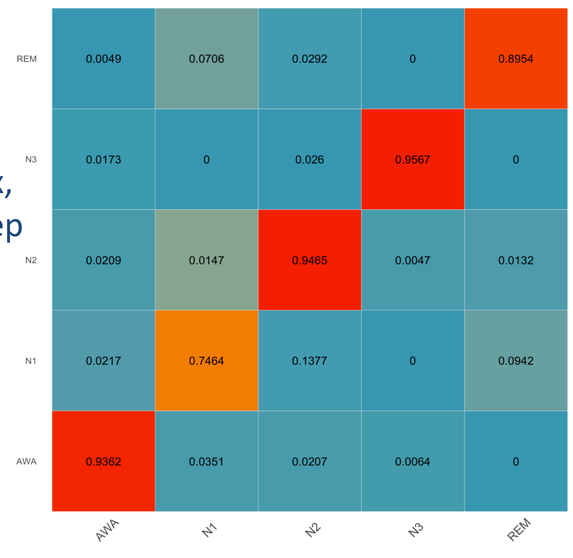



**Figure 6**: Sleep stages probability of transition matrix, showing sleep stability. As sleep is scored on 15 or 30 seconds periods, probability to stay in the same stage is higher.




## CONCLUSION

Automatic sleep analysis has not yet reached consensus in the medical community. However, it is already a valuable decision helping tool for sleep analysts.

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