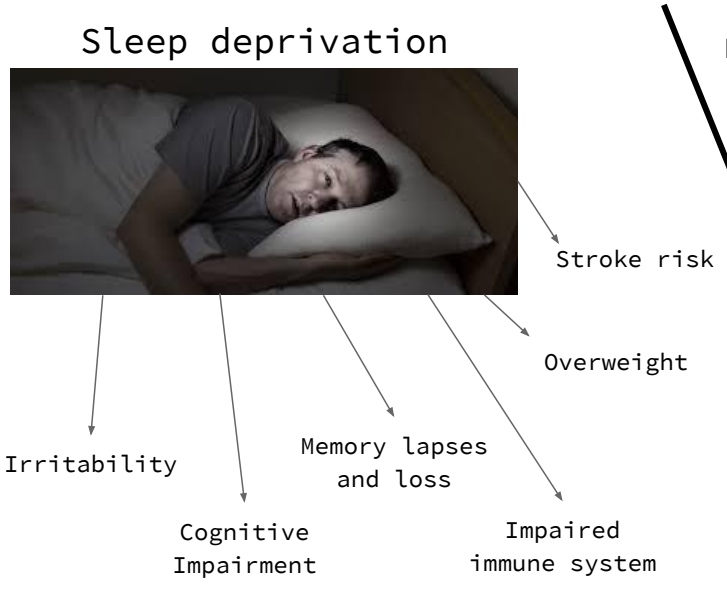
Automatic Sleep Staging

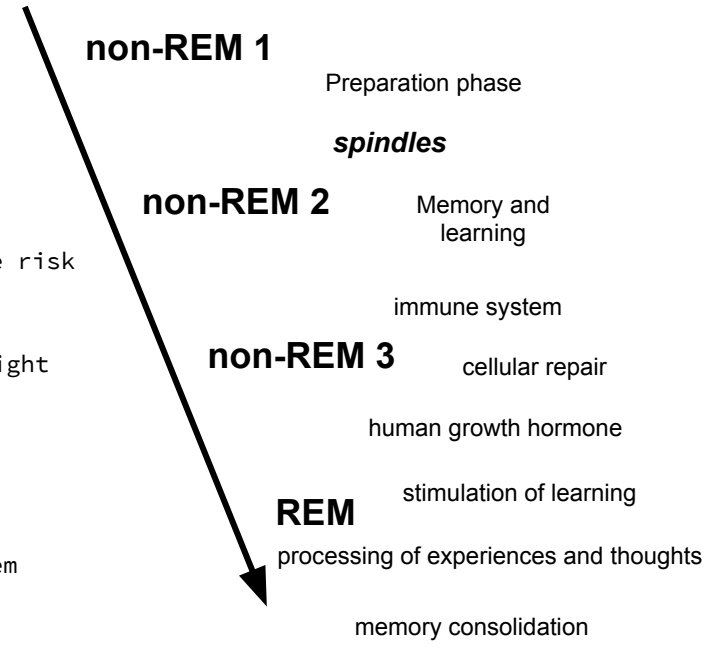
Đorđe Miladinović

Advanced Machine Learning – Fall 2020

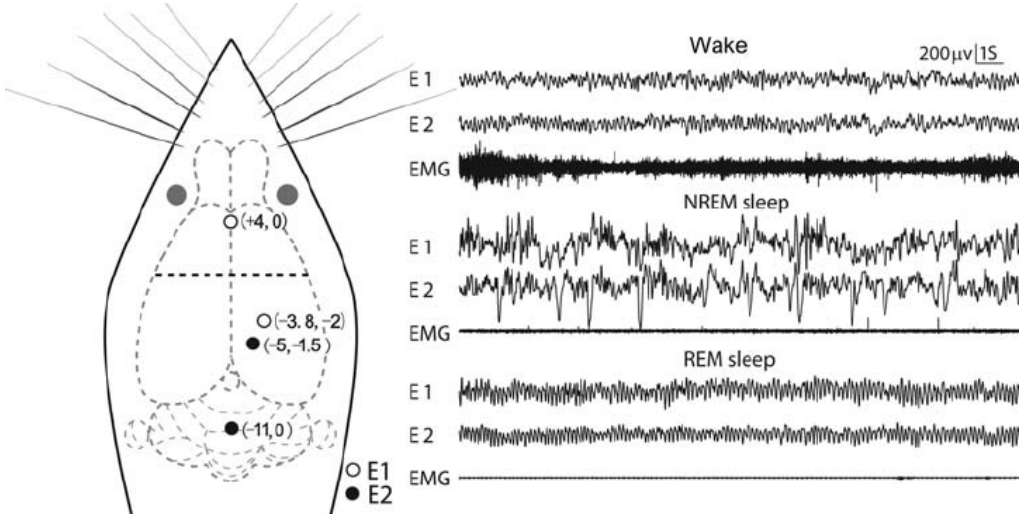
Introduction

Motivation


Sleep deprivation
Stroke risk
Overweight
Irritability
Cognitive Impairment
Memory lapses and loss
Impaired immune system

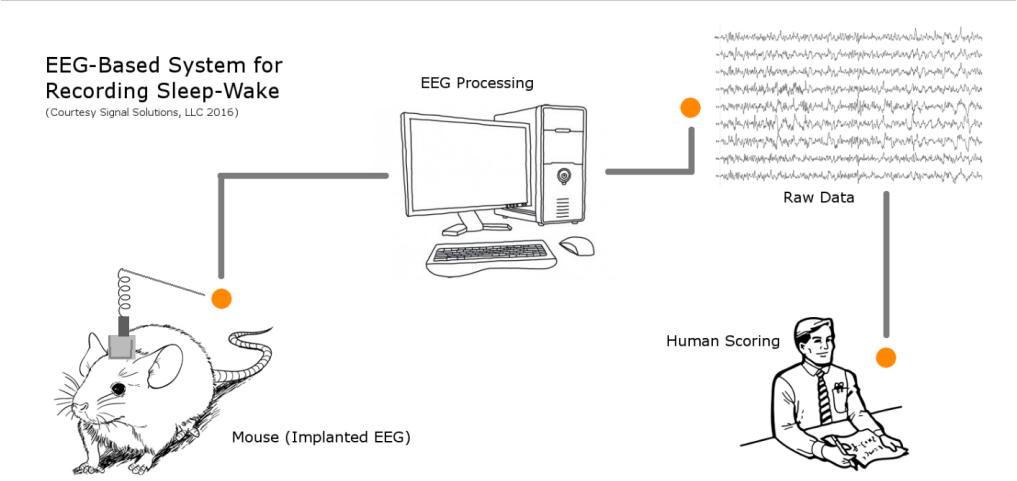

non-REM 1
Preparation phase
spindles
non-REM 2
Memory and learning
immune system
non-REM 3
cellular repair
human growth hormone
stimulation of learning
REM
processing of experiences and thoughts
memory consolidation

EEG/EMG for brain-state analysis



- Sleep monitoring in animals is commonly done through vigilance state classification of EEG/EMG recordings
- EEG/EMG signals are partitioned into short epochs of equal size
- Each epoch is then individually scored accordingly, w.r.t. corresponding vigilance state

Typical experimental pipeline



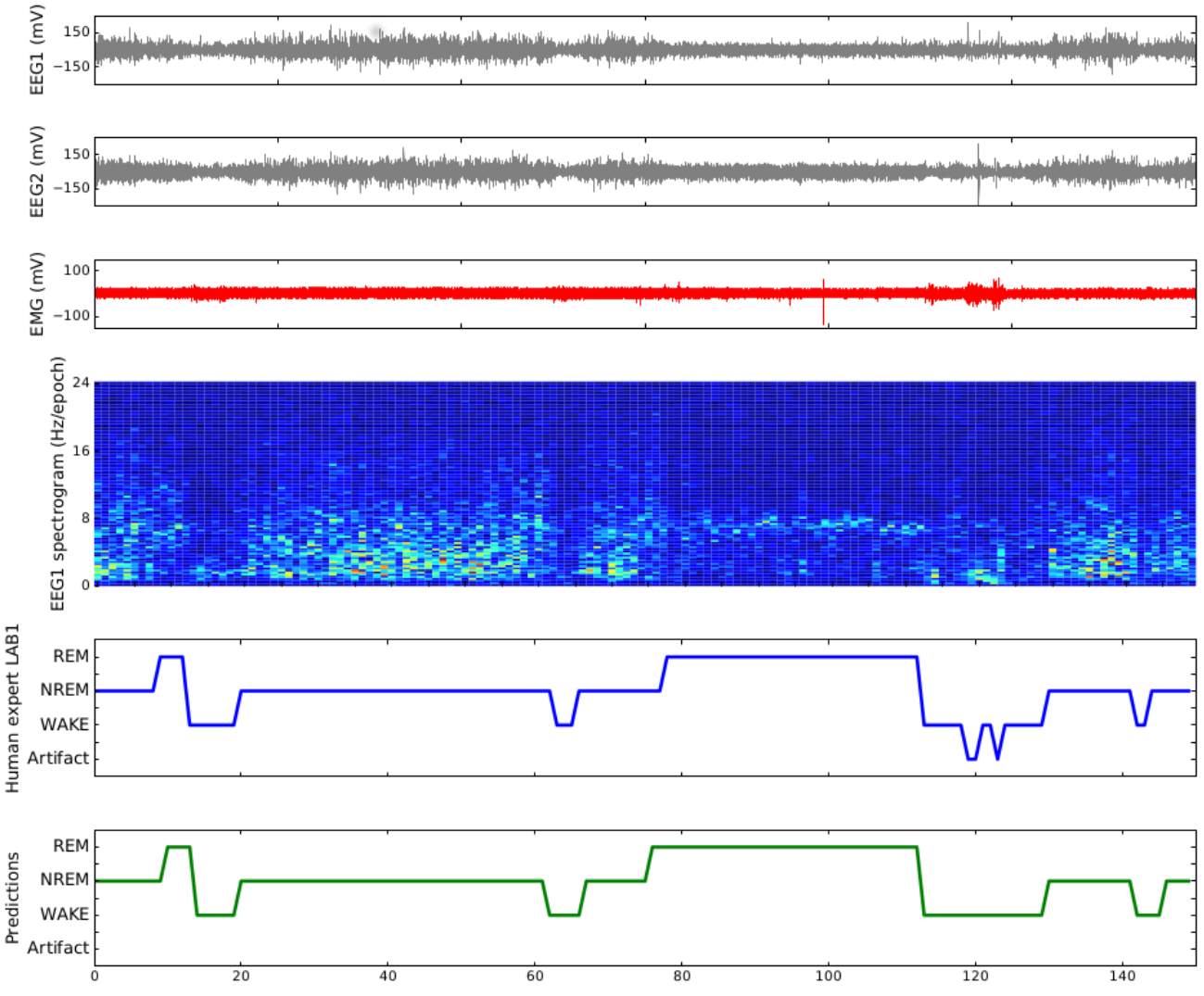
1. Perform "intervention" on an animal subset
2. Record EEG/EMG signals over some period of time
3. Manually score EEG/EMG
4. Perform statistical posthoc analysis on scored data

Manual sleep scoring is a bottleneck

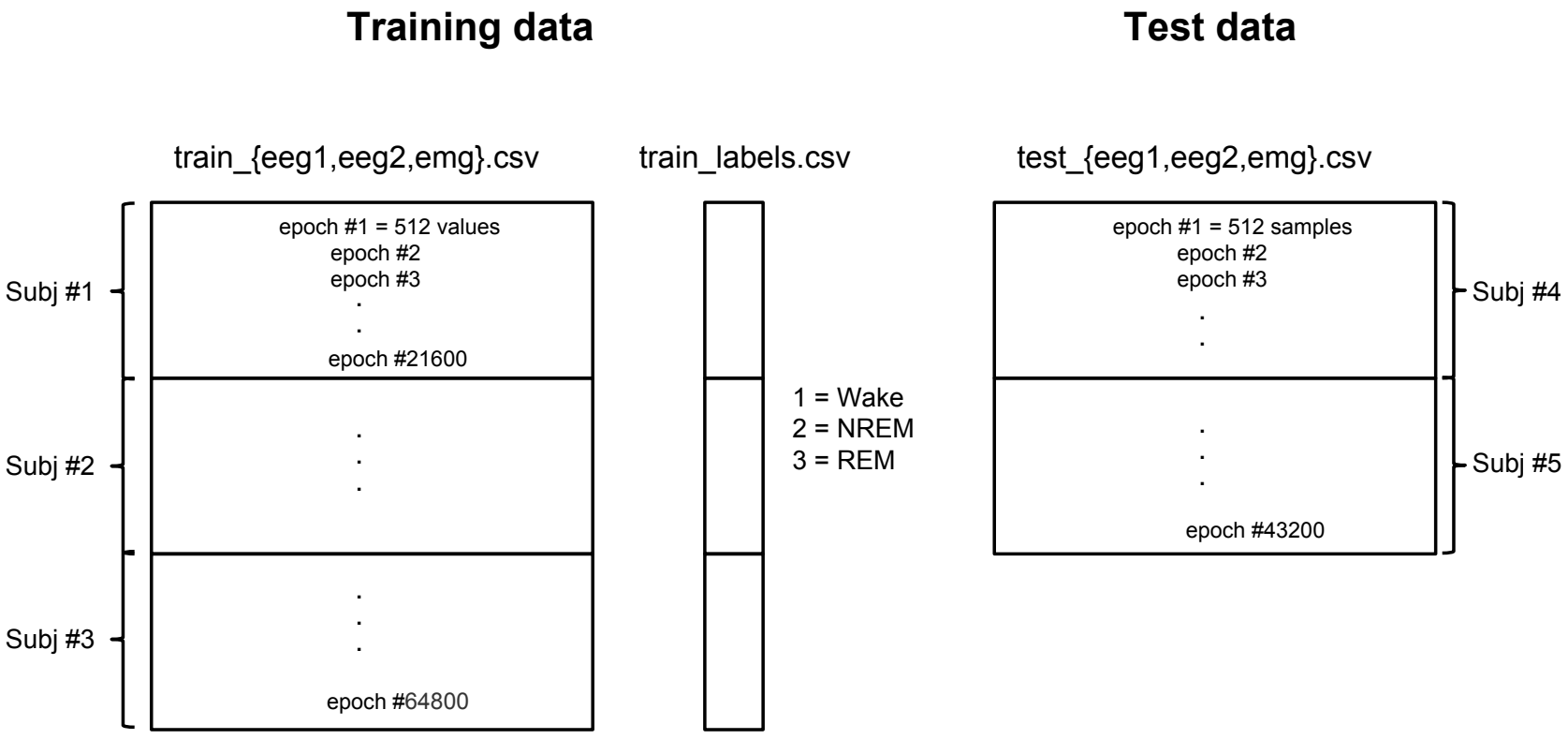
- Slow!
- Laborious
- Prone to human errors
- Non-standardized
- Decoupled from posthoc analysis

Problem and data description

Automating sleep scoring



Data description



Tips and tricks

Class imbalance

- There is a significant imbalance in classes, REM phase is underrepresented.
- The scoring system takes this into account!
- Recall the task 2 and use the same principles e.g. balanced training.

Temporal consistency

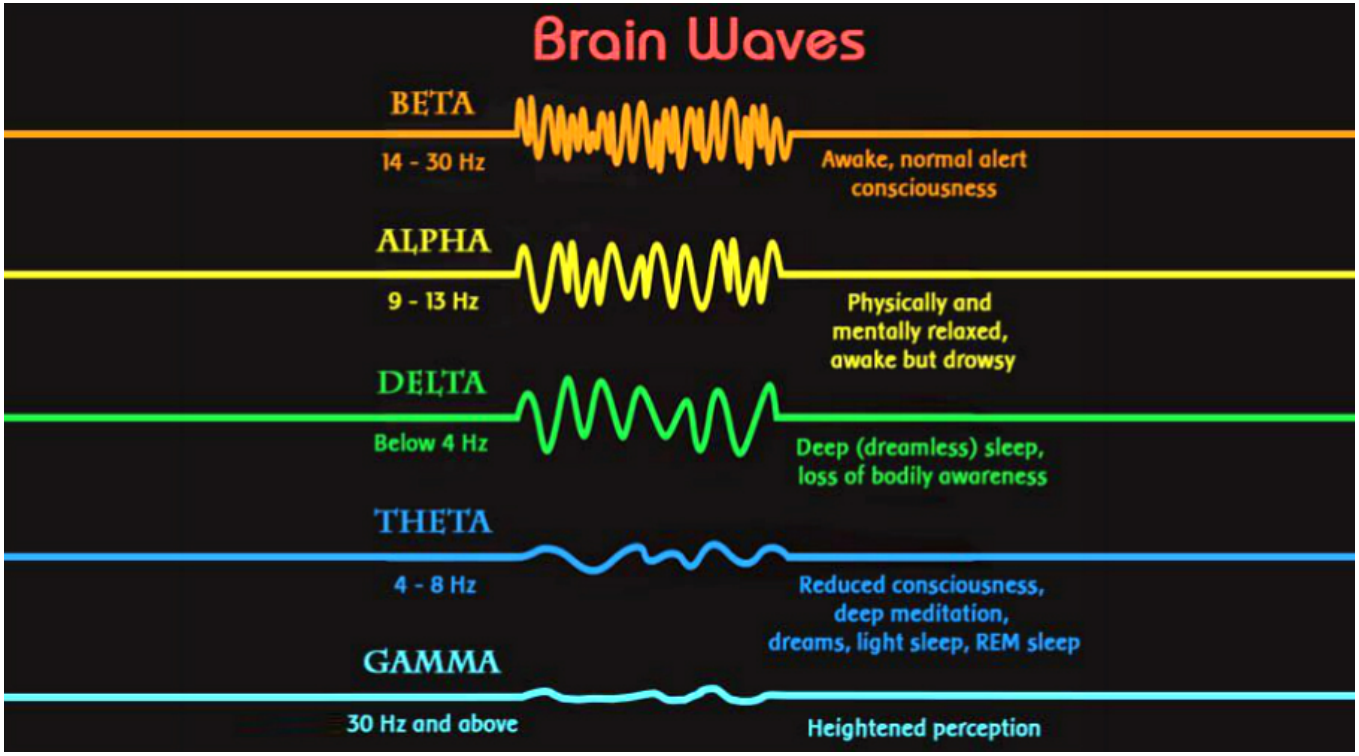
- Just like task 3, this one is also resembles time-series classification.
- However, the subsequent epochs are temporally coherent and there could be a way to exploit this structure in the data.
- Another very similar real-life problem is speech recognition.

Inter-subject variability

There is a significant variance in EEG/EMG patterns across subjects

- Take this into account when validating your method.
- Be careful not to overfit! (recall previous task)
- Tip: cross-validate your method such that in data samples from one subject do not appear in training data e.g. leave-one-subject-out validation.

Fourier features



- Think of building your features from energies of standard frequency bands.
- These are well known signatures of sleep states.

Questions?