EVALUATION OF ASR PERFORMANCE
The data

- Passive **Auditory oddball** experiment
- **13 participants** (7 male, 6 female), [24 - 48] years old
- Normal tone: 500Hz, 50ms
- Oddball tone: 1000Hz, 50ms (Counting)
- **3 Sessions**, 10 minutes each

**SETUP**

**PREPROCESSING PIPELINE**
- Concatenation
- Bad channels removal
- HP 0.5Hz
- LP 45Hz
- 512 Hz Resampling
- ASR (k = 1 - 100)

**ANALYSIS PIPELINE**
- ERP ROI Detection
- Single ch./sub. ERP SNR
- Grand Average ERP SNR
- Abs Single ch./sub. PSD
- Abs Grand Average PSD
- Relative PSD
- Noise Subj. Sorting
SNR is defined as the ratio between the P300 amplitude (max in the interval [250 – 750]ms) and the pre-stimulus noise (PSN) defined as the RMS of pre-stimulus signal, SNR0.
Grand-average ERP across all subjects, attenuation starts with $k = 10$. Visually, $k = 20$ seems to be a better choice than using no ASR.
P300 ERP, all subjects, summary measures

ERP characteristics for three electrodes over all the subjects:
- PSN amplitude with respect to baseline decreases less than P300 amplitude
- **SNR significantly decreases starting from ASR 10**
- PSN significantly decreases starting from ASR 5
About Power Spectral Density (PSD)

Average PSD for all frontal electrodes
Largest power at lower frequencies, PSD is globally attenuated by ASR
Delta, theta, alpha bands seems to be the most impacted
PSD attenuation, all subjects

Relative normalized attenuation across frequencies, Fz
Starting from $k \leq 20$, significant **delta** frequency attenuation
Starting from $k \leq 5$, significant **alpha** frequency attenuation
Alpha and Delta PSD attenuation, all subjects

Frontal Channels (F3, Fz, F4)
Starting from $k \leq 10$, significant theta frequency attenuation
Starting from $k \leq 5$, significant alpha frequency attenuation

ASR Alpha Attenuation

ASR Delta Attenuation
Proportion of epochs modified by ASR

Proportion of epochs modified in relation to the ASR cutoff parameter

The most modified clusters are also those with the highest percentage of epochs with high Z value (noisier)

Z is defined as RMS ratio between post-stimulus and pre-stimulus

- Knee at $k = 20$
- Group1: $AUC<10$, 5 Subj 0.1% Z>3
- Group2: $10 \leq AUC < 20$, 4 Subj 0.6% Z>3
- Group3: $AUC > 20$ 2 Subj 0.7% Z>3
Sorting epochs according to Z values

Examples of epochs according to their Z value

Distribution of the maximum ASR cutoff at which epochs are modified, sorted by Z value
Sorting epochs according to Z values

K \geq 20 seems to be the best threshold to clean the data while maintaining integrity

Noisy data

Group 1, 0.1% Z>3

Group 2, 0.6% Z>3

Group 3, 0.7% Z>3
Take-Home messages

Watch out for SNR, it is important to find the right balance between artifact rejection and rejection of data of interest.

Starting from $k = 20$ delta power is mostly removed, from $k = 5$ alpha is removed.

ASR 20-50 is likely the best tradeoff for data SNR maximization.