**\*This if all for MEG!!!**

**\*Have different pipelines we could utilize!!!**

# Identify bad channels

[PREP] – all of them are using 5 standard deviations for detecting outliers & They choose all of them & have codes for EEG lab

(<https://github.com/VisLab/EEG-Clean-Tools)>

(temporary high pass at 1 Hz)

1. Deviation criteria - Extreme amplitudes (noisy channels – variance): "0.7 IQR" (+/-0.7 z values for normal curve) of amplitudes -> robust z relative to channels > 5

* Not identify channels that capture eye blinks and most muscle activity as noisy.
* Works well for detecting of unusual high amplitidues but not work well for extremely low, non zero amplitudes.

Amplitude(c) = 0.74 \* IQR (samples)

Z\_A(c) = [A(c) – median(A)] / [robust std (A)], where robust std(A) = 0.74 \* IQR (A)

One way to look at larger amplitude

1. Correlation criteria Lack of correlation with any other channel: 50 Hz low pass, 98th percentile absolute correlation with other channels, per 1 s time windows. Bad if < 0.4 for at least 1% of windows.

* Low frequency portion of EEG is somewhat but not too much correlated among channels
* Time window (1), threshold (0.4), and certain percentage of the windows (1) are default – so we could change

They put the channels (we have 275) in order: xxxxxx….. xxxx | xxxxxx.

And, get the correlation of corresponding “|” (98% of 275) to test whether it is bad.

1. Predictability criteria - Lack of predictability by other channels: RANSAC (random sample consensus) (spherical splines), correlation < 0.75 with predicted time courses for at least 40% of 4-s time windows.

* Also rely on the channel correlations of the low frequency portion of EEG signals
* Threshold (0.75) and certain fraction of the windows (0.4) and window size (4) are default – so we could change

Similar with #2 method, but they get predictions (use spherical splines to predict) and compare them with real data, and get cor of these.

1. Noisiness criteria - High high-frequency noise: MAD of > 50 Hz signal / MAD < 50 Hz signal for each channel -> robust z relative to all channels, > 5 for non-overlapping 1-s time windows

* Use a robust estimate of ratio of power of high freq components to power in low freq comp.
* MAD = median absolute deviation
* Time window (1) is default – we can change

MAD = | x – median(A) |

And, get ratio of [MAD > 50] / [MAD < 50]…

MAD > 50 is not good, and MAD < 50 is normal!

1. Significant periods of constant or very small values

Small/constant values for some time window (0.5 ~ 1sec) are not really possible for MEG…

[HAPPE] – this one is using Z = 3 & Codes are in free github

(<https://github.com/lcnhappe/happe)>

1. Normed joint probability of the average log power from 1 to 125 Hz across channels. Z > 3 are removed. Performed twice

[MNE]

(amplitude threshold, flat signal detection) to reject segments, channels

[FASTER] – Codes should be in EEG lab

(<http://www.mee.tcd.ie/neuraleng/Research/Faster)>

(all z > 3)

1. Variance
2. Mean correlation with other channels
3. Hurst exponent (measure of long-range dependence within a signal)

(Channels in epochs: -> for step 9 (identify bad segments [channel is consisted of many segments]))

1. Variance
2. Median gradient
3. Amplitude range
4. Deviation of epoch from whole channel mean amplitude

\*Note: Maybe we can add the condition that no step cannot remove certain numbers just to retain sufficient information (pg 3 of PREP paper)

-> <https://www.ncbi.nlm.nih.gov/pubmed/16012656> This article talks about how many channels are usually good – so we can use it for our interval…???

-> PREP correlation criteria (second one) is effective detection of the most bad channels! – so we should include this no matter what!

-> Also, if a channel fails with some of the conditions, and does not fail with some – we need to think of cases and decide whether we would consider them unstable or not. -> In this case, we could make iteration, and change threshold for not failing conditions, and check again! (we would delete the channel if any of the condition fails)

-> Prep tends to detect borderline edge channels as bad more frequently than other channels

-> Prep paper pg 15 methods!

<Conclusion>

* PREP 1, 2 (maybe want to do correlation in entire channels), 5 & HAPPE -> The algorithms we would try for the first time