Artifact Rejection and Correction

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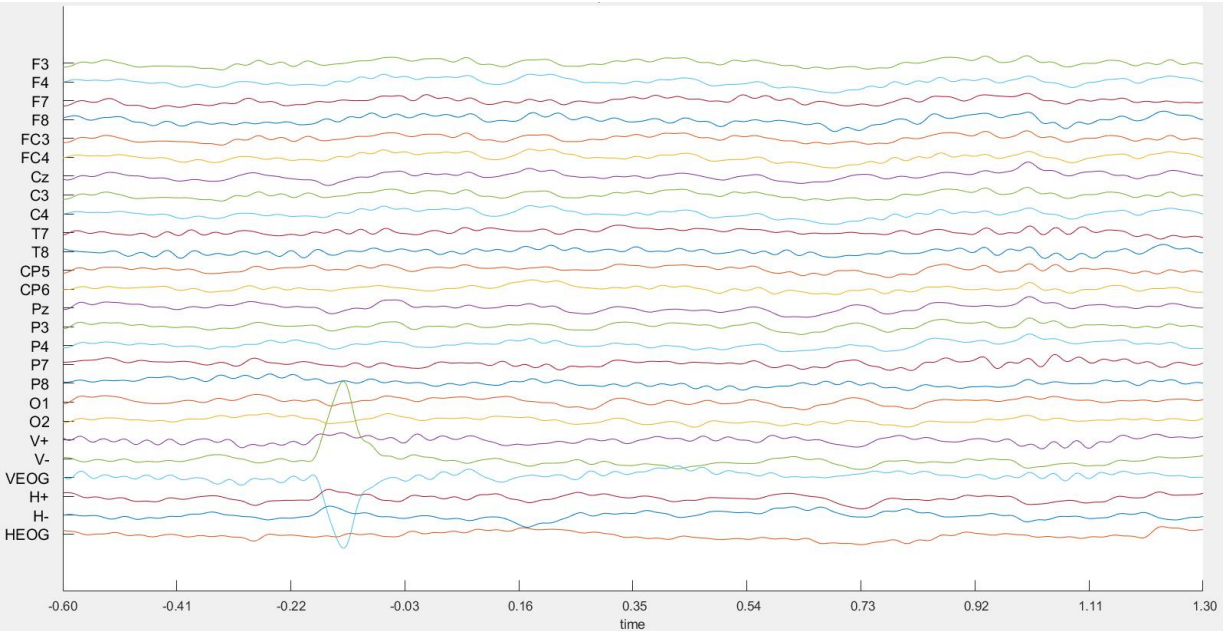
Artifacts

- Artifacts are noise in the EEG signal
- They can be caused by the participant (movements, blinking, sweating)
- Or by the hardware (jumps, line noise)

Blinks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F4
F7
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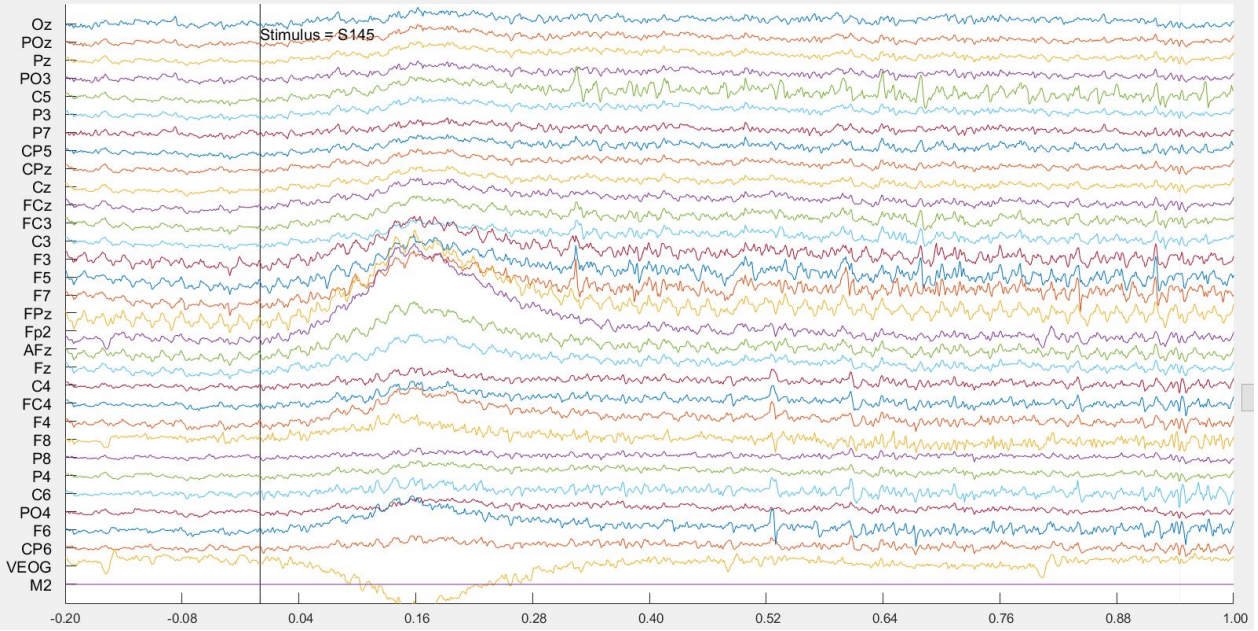
FC3
FC4
Cz
C3
C4
T7
T8
CP5
CP6
Pz
P3
P4
P7
P8
O1
O2
V+
V-
VEOG
H+
H-
HEOG
-0.60
-0.41
-0.22
-0.03
0.16
0.35
0.54
0.73
0.92
1.11
1.30
time

Blinks


Stimulus = S145
Oz
POz
Pz
PO3
C5
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P7
CP5
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Cz
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FC3
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F3
F5
F7
FPz
Fp2
AFz
Fz
C4
FC4
F4
F8
P8
P4
C6
PO4
F6
CP6
VEOG
M2
-0.20
-0.08
0.04
0.16
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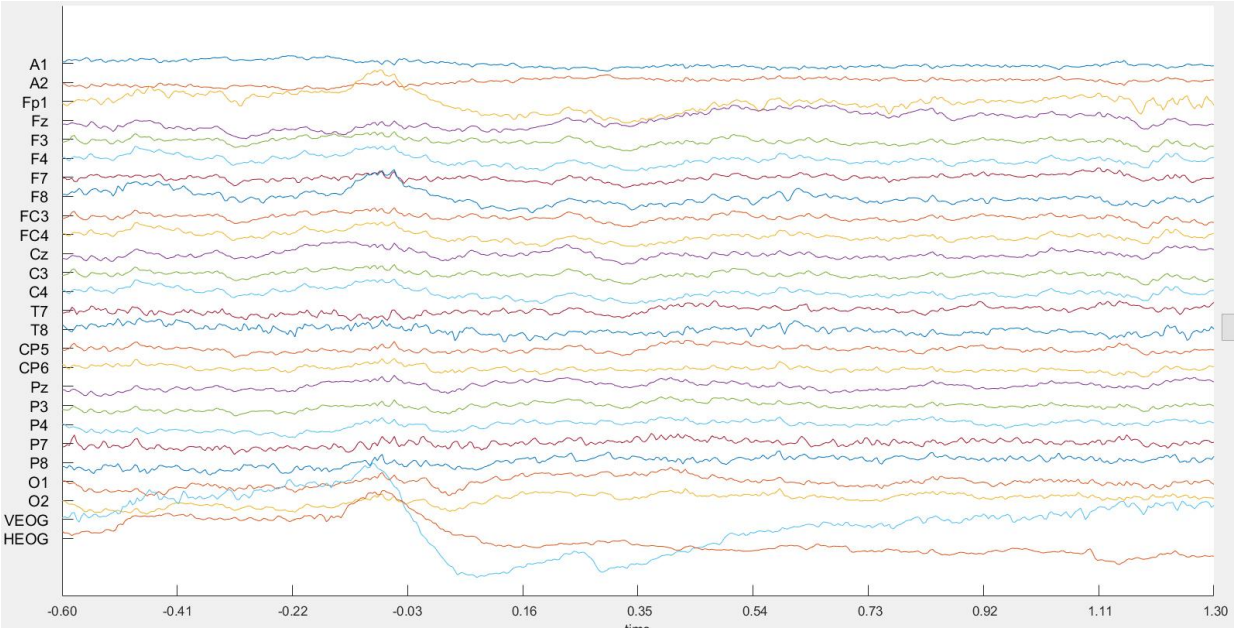
0.40
0.52
0.64
0.76
0.88
1.00

Saccades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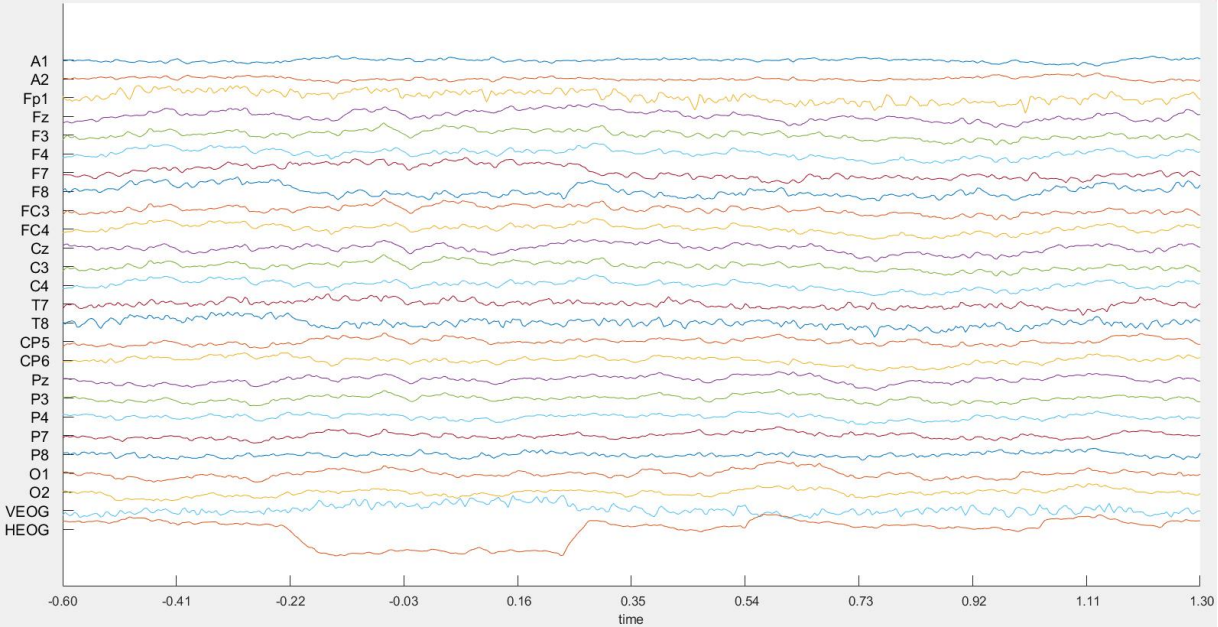
Saccades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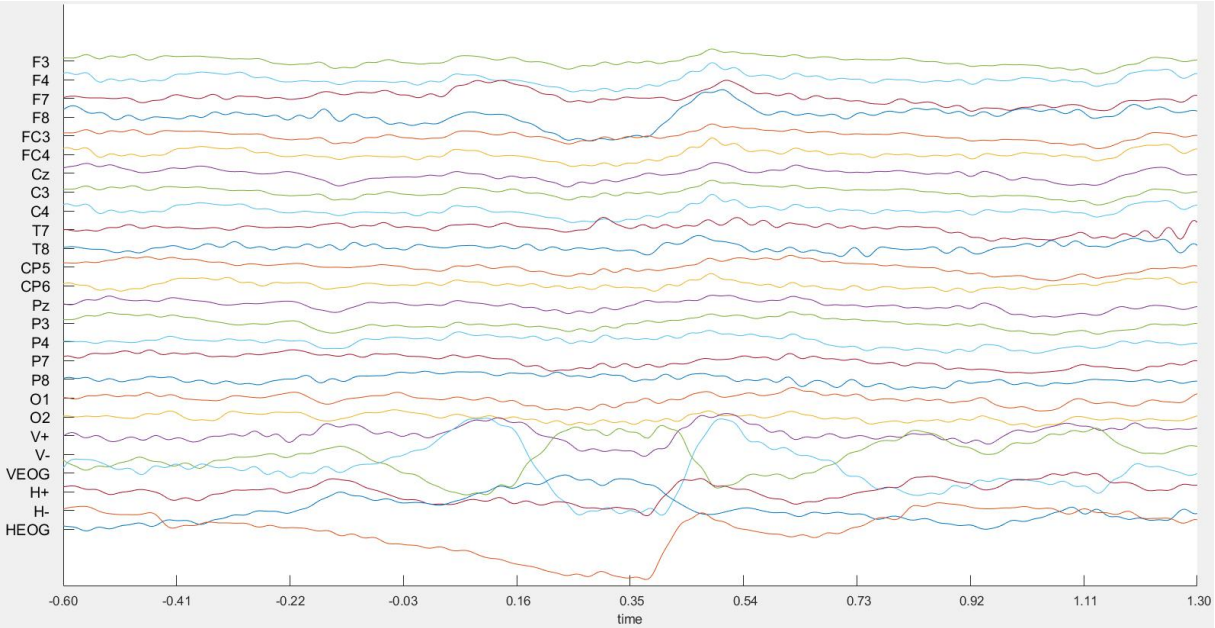
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-0.22
-0.03
0.16
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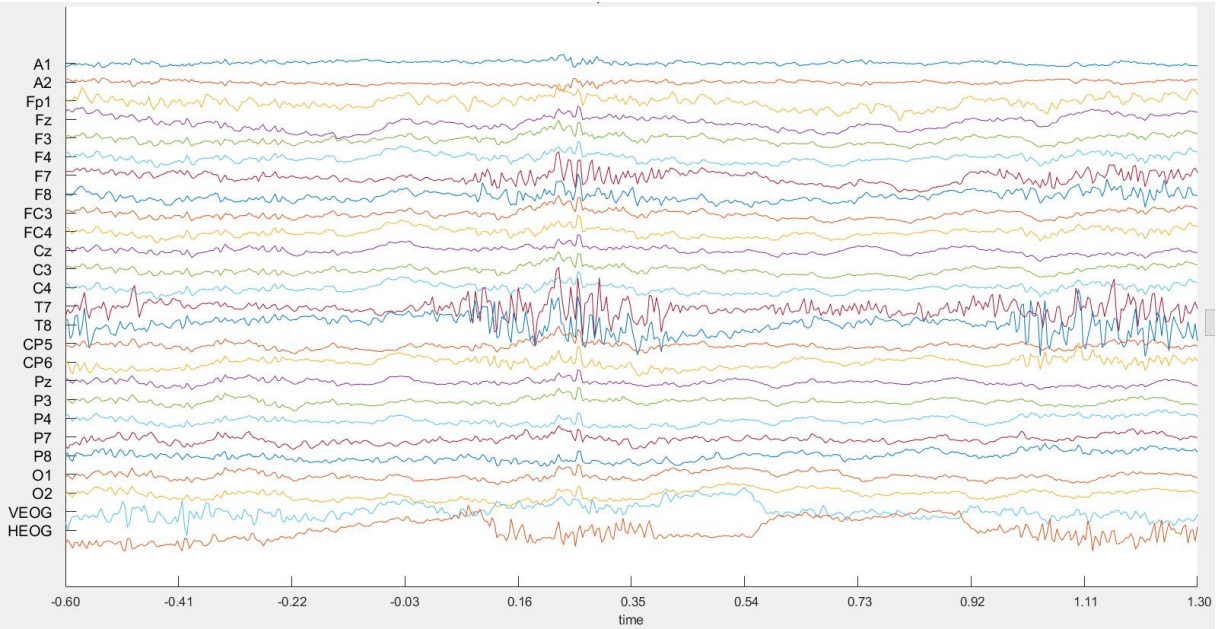
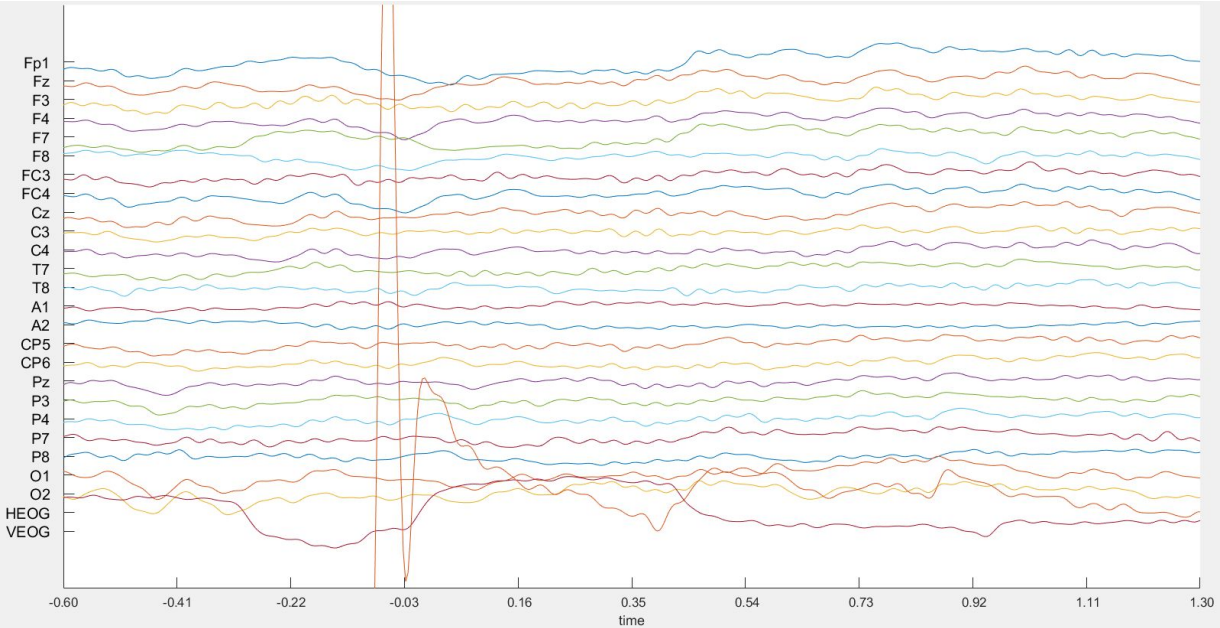
Muscle artifacts



Jumps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Rejection vs. Corrections

- There are two ways to deal with artifacts
- **Rejection** means throwing trials (or time segments) out that contain artifacts
- **Correction** means keeping trials that contain artifacts by inferring the signal underneath the artifact
- Correction is preferable, but not always possible

Artifact rejection

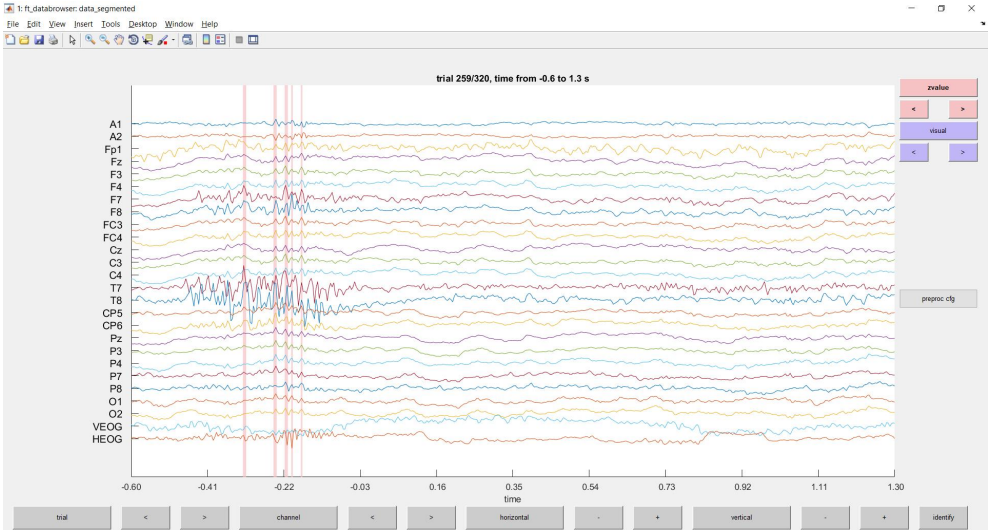
- Artifact rejection can be performed **automatically**, **manually,** or **semi-automatically**

Automatic rejection

- FieldTrip uses a **z-value** approach
- z-value expresses how many **standard deviations** (SD) a given value deviates from the mean
- e.g. a z-score of -3 expresses that that value is 3 SDs lower than the mean
- FieldTrip uses the z-scores to first **highlight** and then **reject** artifacts

Manual rejection

- FieldTrip offers a graphical user interface for data inspection: `ft_databrowser`



Rejection in FieldTrip

- Before we start with artifact rejection, build a for loop around your preprocessing script to perform preprocessing for all of your subjects
- to create a variable with all the subject names, use the template “initiate name_subj” on moodle

Rejection in FieldTrip

- Inspect your data using ft_databrowser and highlight artifacts; this does NOT reject artifacts yet
- **For now, do not highlight or reject blinks and eye movements; we will correct those later**
- Reject artifacts using `ft_rejectartifact`; reject each trial that contains an artifact
- save your cleaned data

Artifact Correction

- one of the most commonly used methods for artifact correction is called independent component analysis (ICA)
- ICA deconstructs the EEG signal into components, which we can inspect and reject if needed

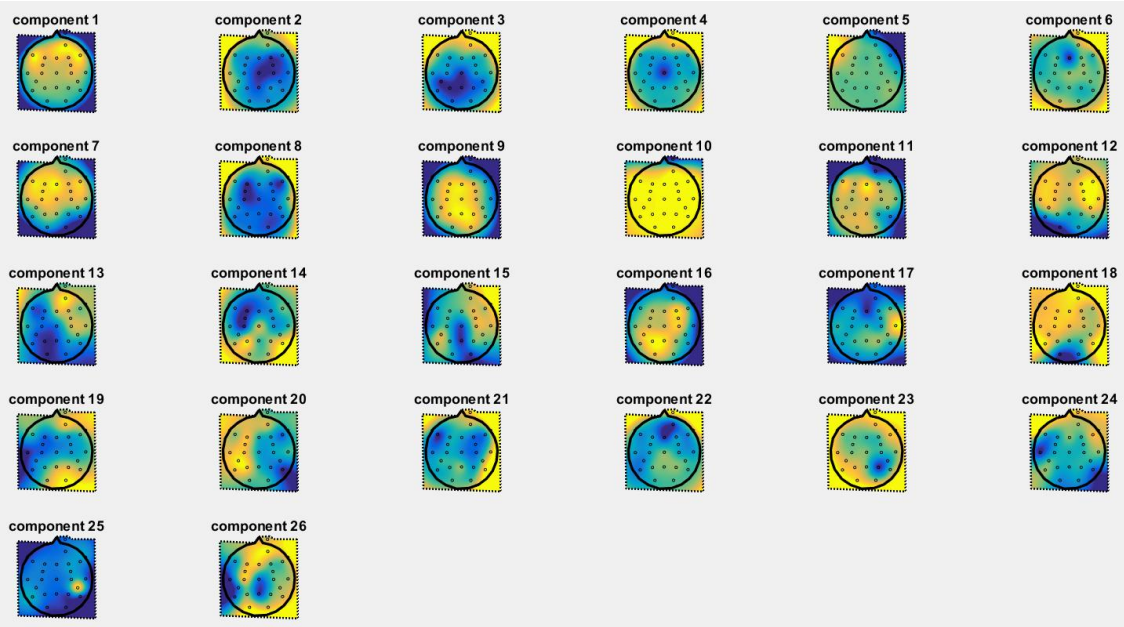
ICA

- ICA outputs components that, added together, best explain the data
- each component explains a certain aspect of the variance of the data
- ICA can best be used to correct artifacts that occur **randomly**, but look **similar** each time they appear

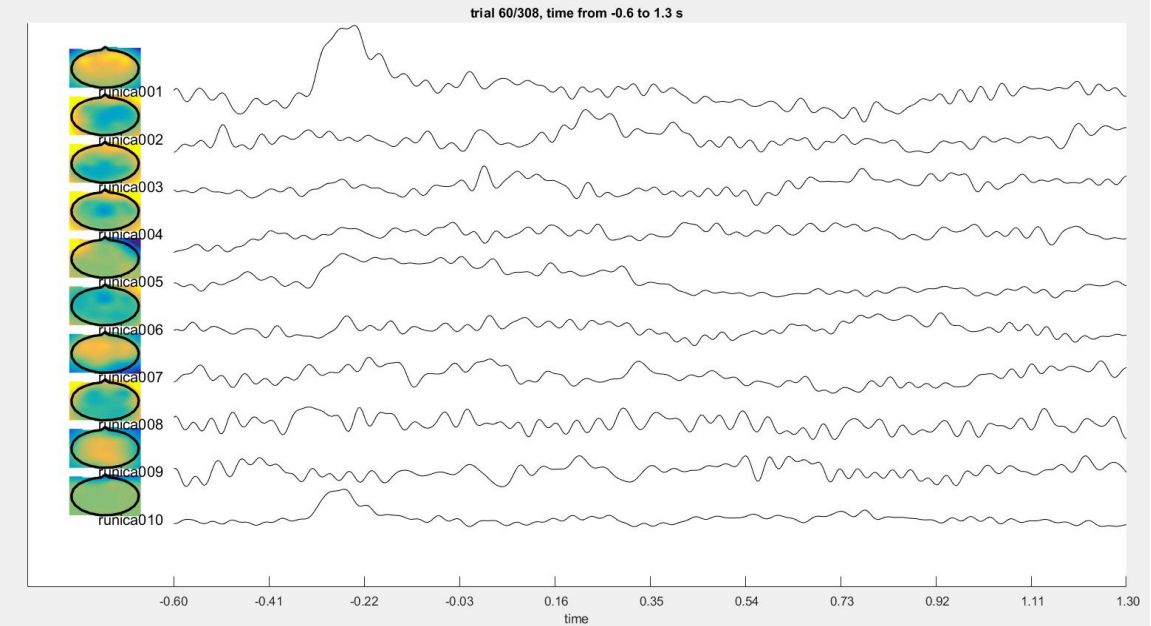
ICA output

- ICA outputs (1) topographies and (2) time representation of your components
- Using these, you can identify components that contain artifacts
- Components are sorted by how much variance they explain - the first component explains the most variance
    - usually, this means that blink components are among the first

ICA topographies



ICA time representation



Independence

- components of an ICA are assumed to be **independent**, so the data you give it should be independent
- your ICA should compute one component less than you have electrodes
- **temporal independence** means that the components have to occur in random intervals
    - this means ICA cannot be applied to correct blinks when participants don't blink randomly

Backprojection

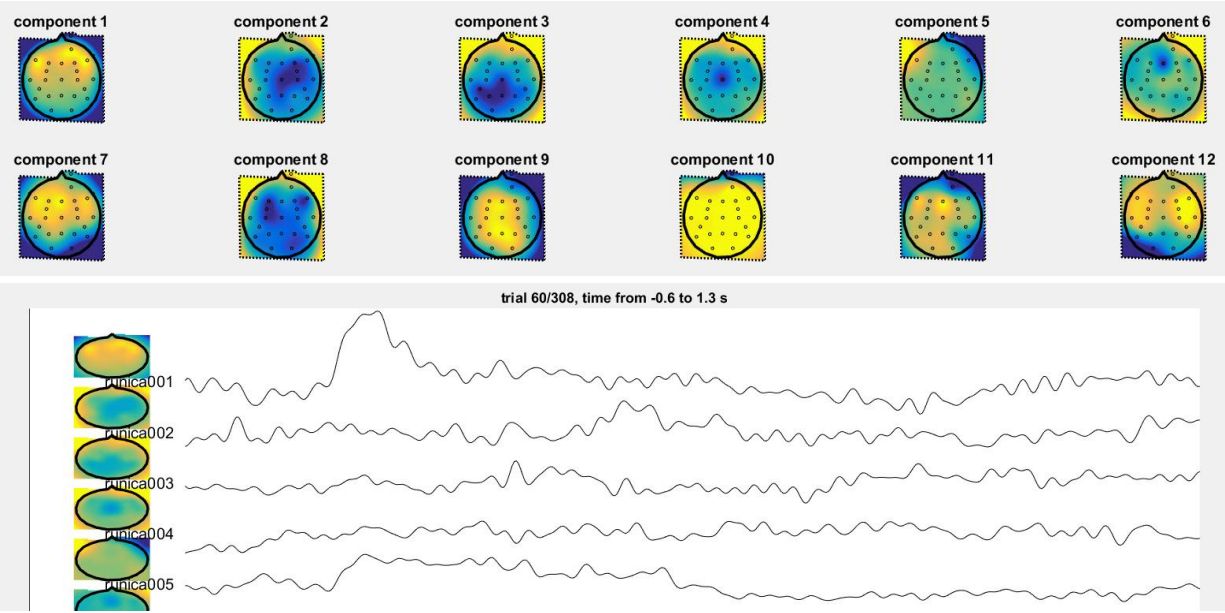
- once you have rejected a component, ICA **backprojects** the rest of the components
- they are added up to the original signal without the rejected component

Correcting eye movement

- ICA is especially useful for correcting blinks and horizontal eye movements, because they
  - can be identified easily based on their topography and time representation
  - make up a large part of the variance; you will usually find them among the first few components

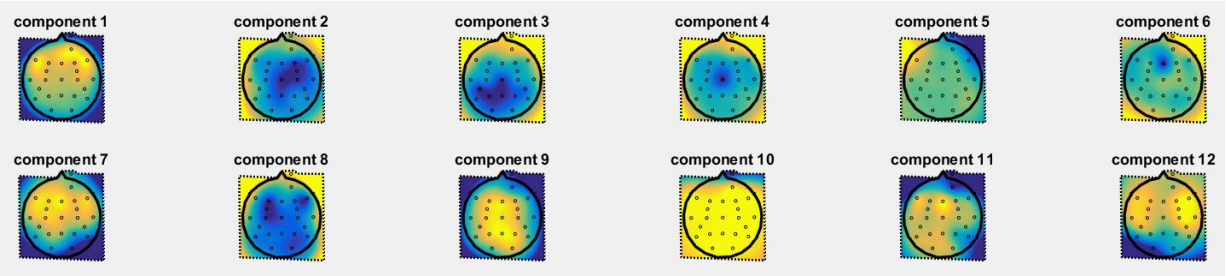
Identifying ICA components: brain components

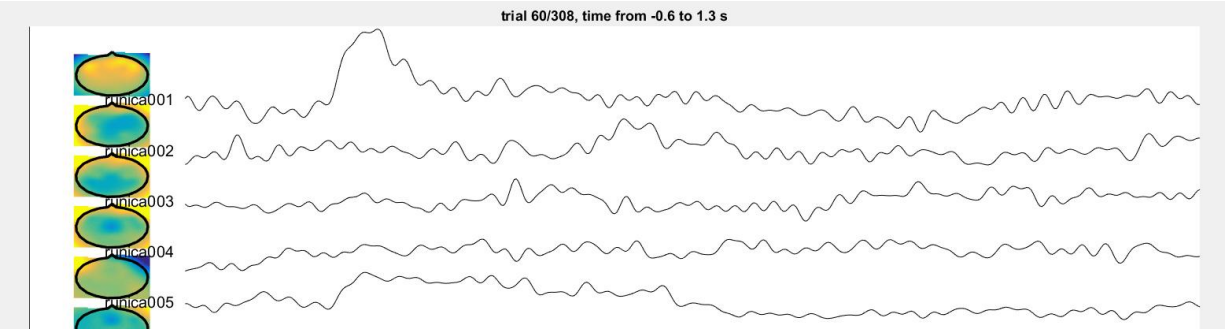
brain components (non-artifact components) are characterized by **dipole-like topographies**



Identifying ICA components: blinks

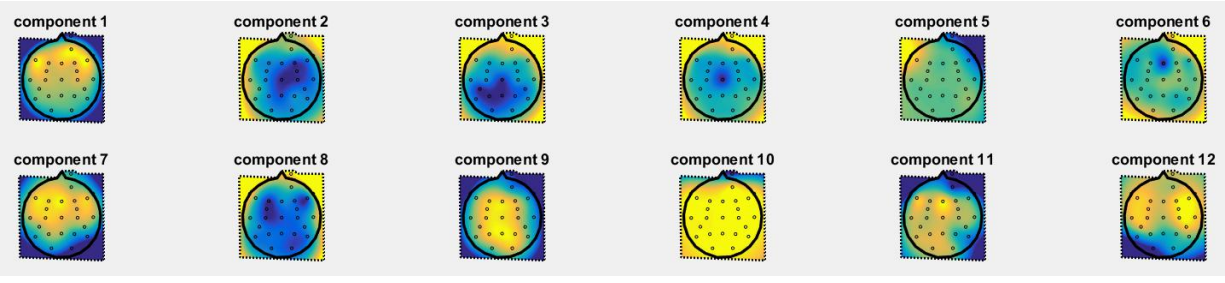
blink components are characterized by **far-frontal topographies** and **individual blinks** in the time course;
they are usually among the first components

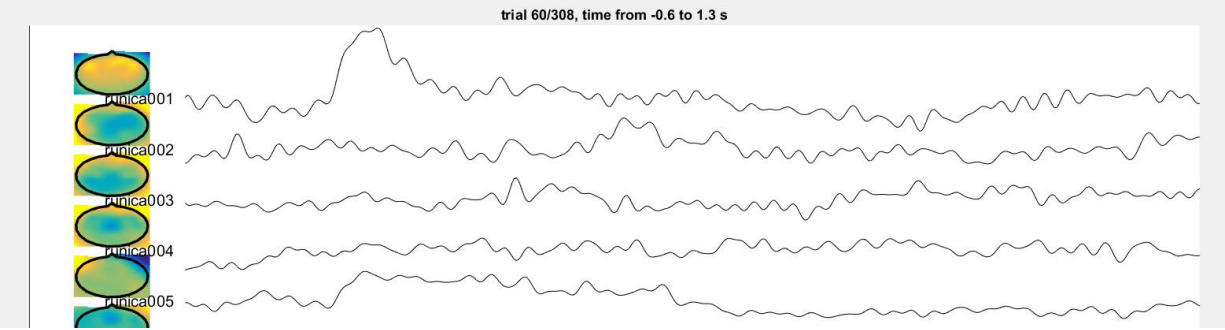




Identifying ICA components: eye movements

eye movement components are characterized by **far-frontal dipoles** in the topography and **saccades** in the time course





ICA in FieldTrip

- use `ft_selectdata` to exclude LEOG because it's not independent
- use `ft_componentanalysis` with the method `'runica'` to compute an ICA; specify the number of components you want to compute
- plot the topographies of the components using `ft_topoplotIC`; you'll need to specify a layout - you can download that from FieldTrip
- browse through components and trials using `ft_databrowser`
- using `ft_rejectcomponent`, reject the components you think correspond to blinks or eye movements
- use `ft_databrowser` to browse your cleaned data and reject artifacts again
- save your cleaned data!