Multivariate EEG analysis via generalized eigendecomposition

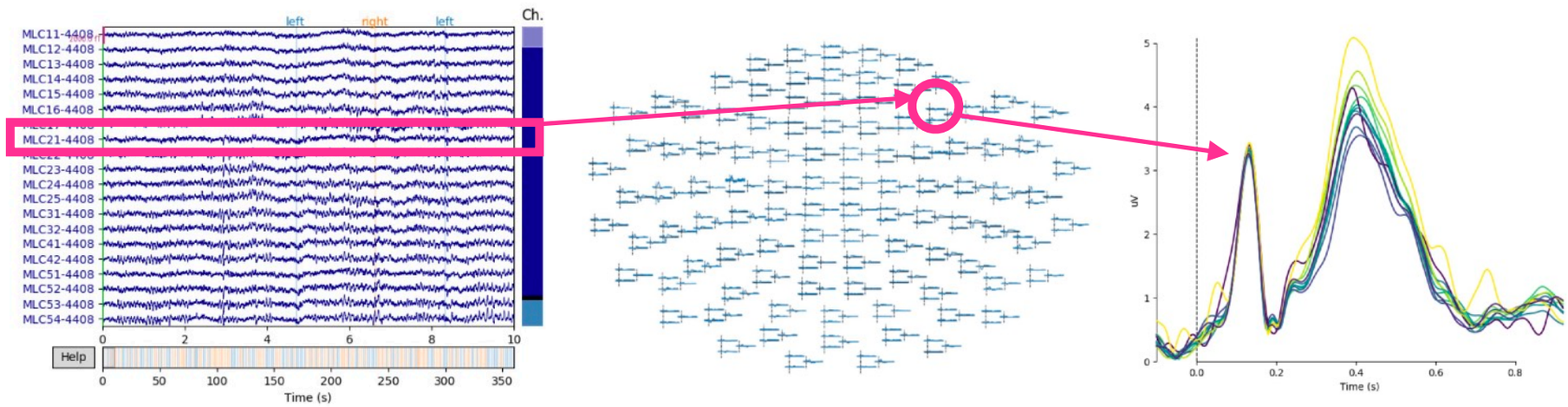
(Fischer’s linear discriminant analysis)

Mike X Cohen

Why multivariate analyses?

- Neural data are **multivariate** (but we often pretend they're **univariate)**

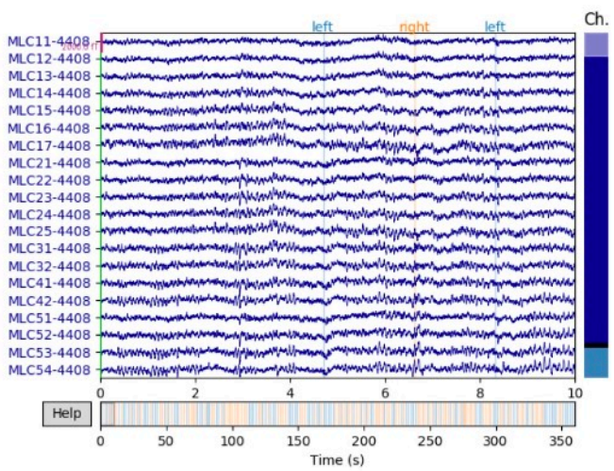
for c *in* channel:
    for t *in* time
        perform computations

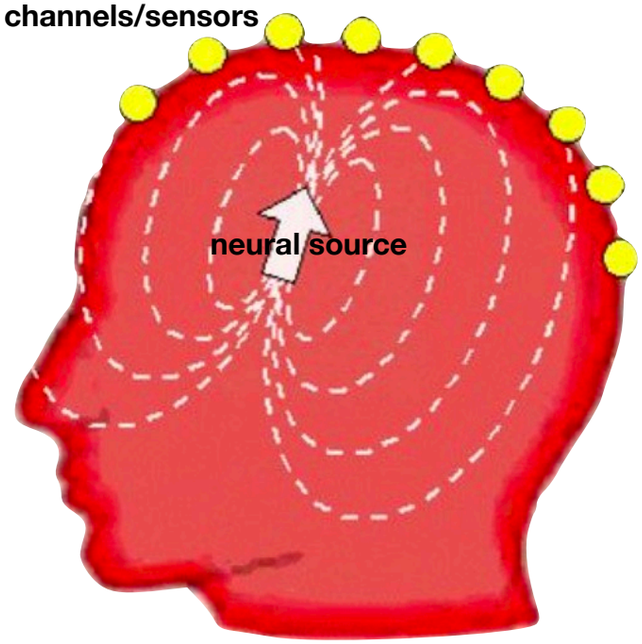


Differences in EEG activity across conditions at one channel

Why multivariate analyses?

- Neural data are **multivariate**
- Different EEG **channels/sensors** contain overlapping info



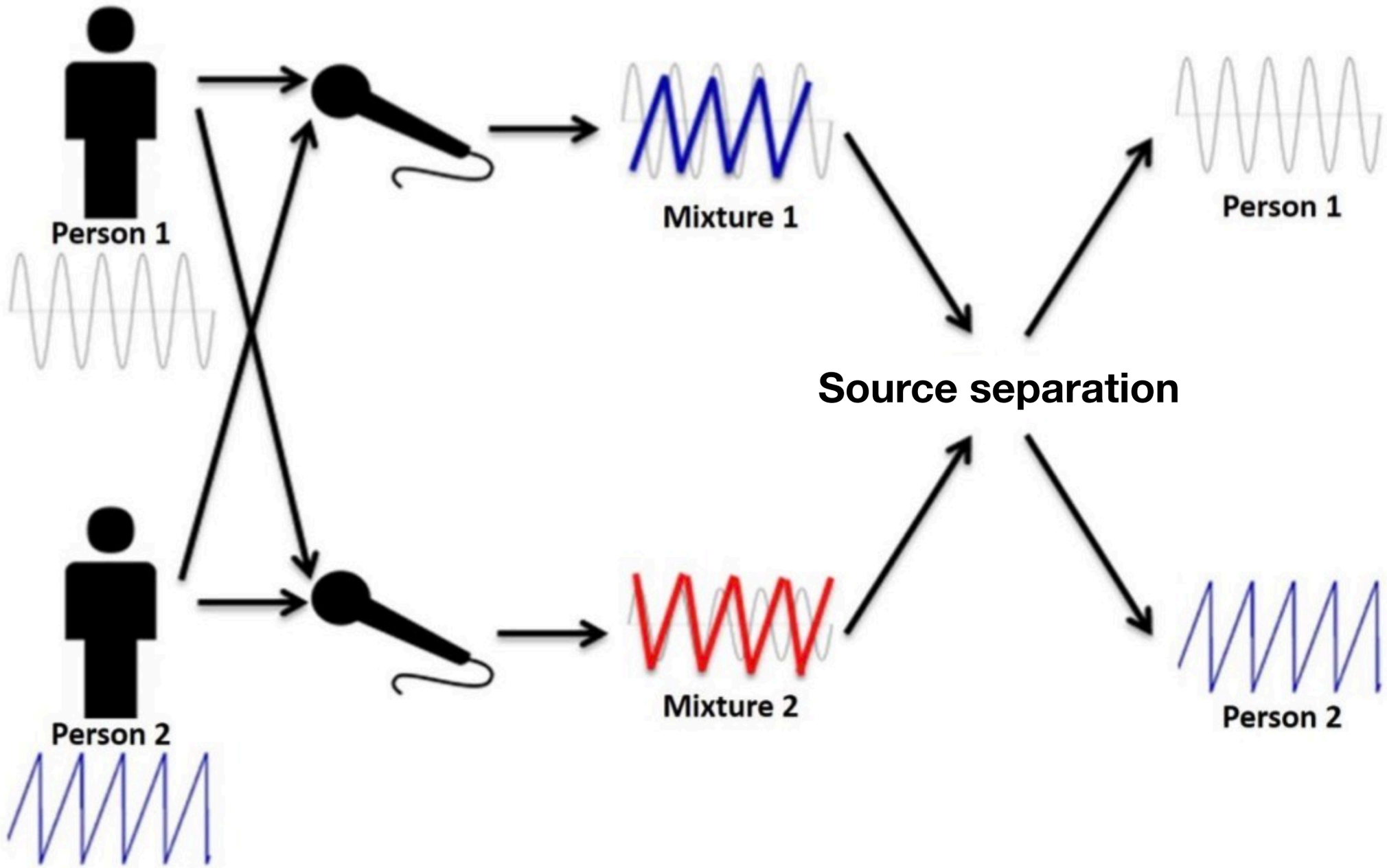


activity from one **source** propagates via **volume conduction** to multiple **channels/sensors**

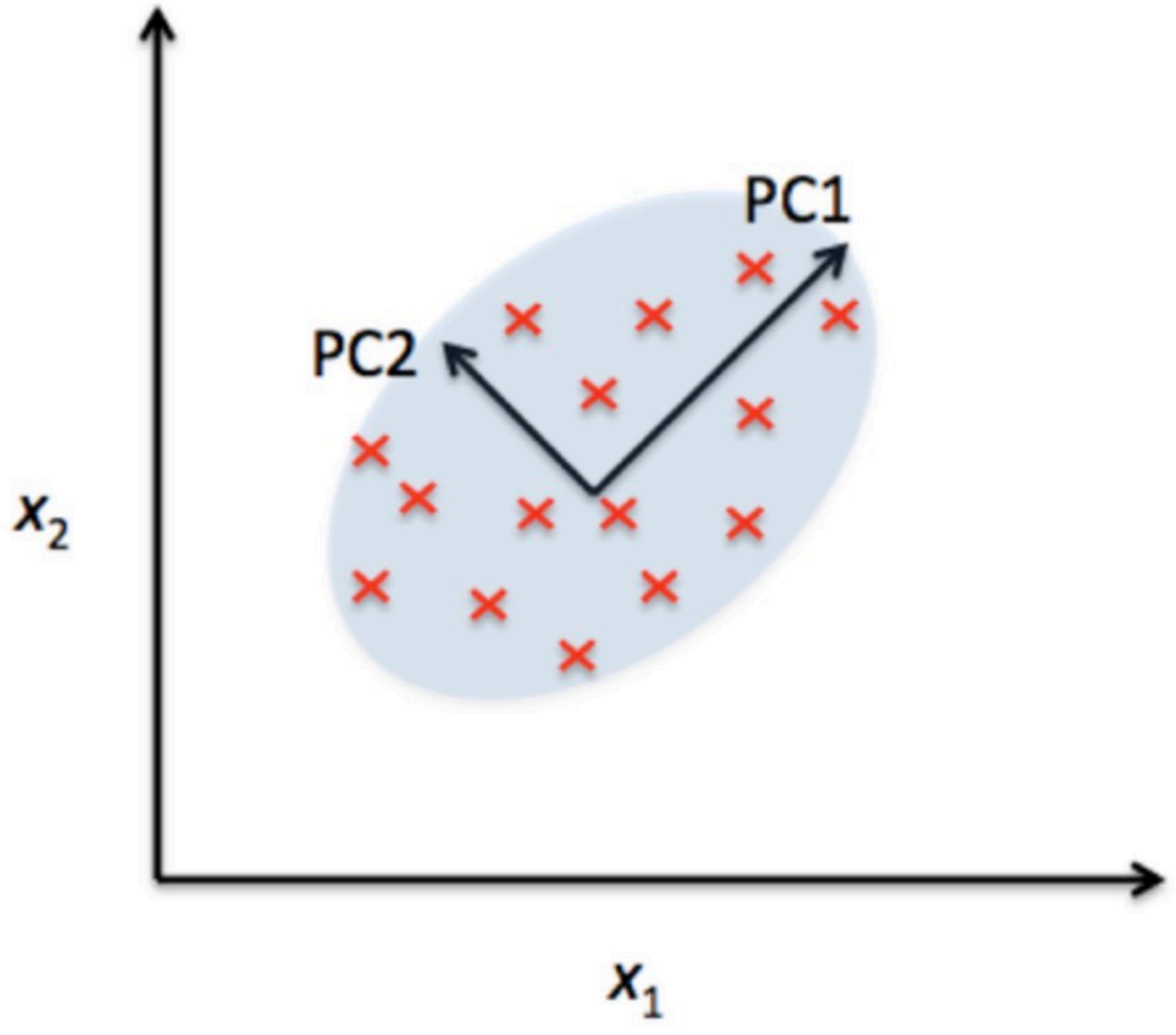
Why multivariate analyses?

- Neural data are **multivariate**
- Different EEG **channels/sensors** contain overlapping info
- Need to “unmix” or separate different neural sources
  - **Statistical**, anatomical, computational sources
  - Spectral/frequency analyses also separate sources

What is source separation?

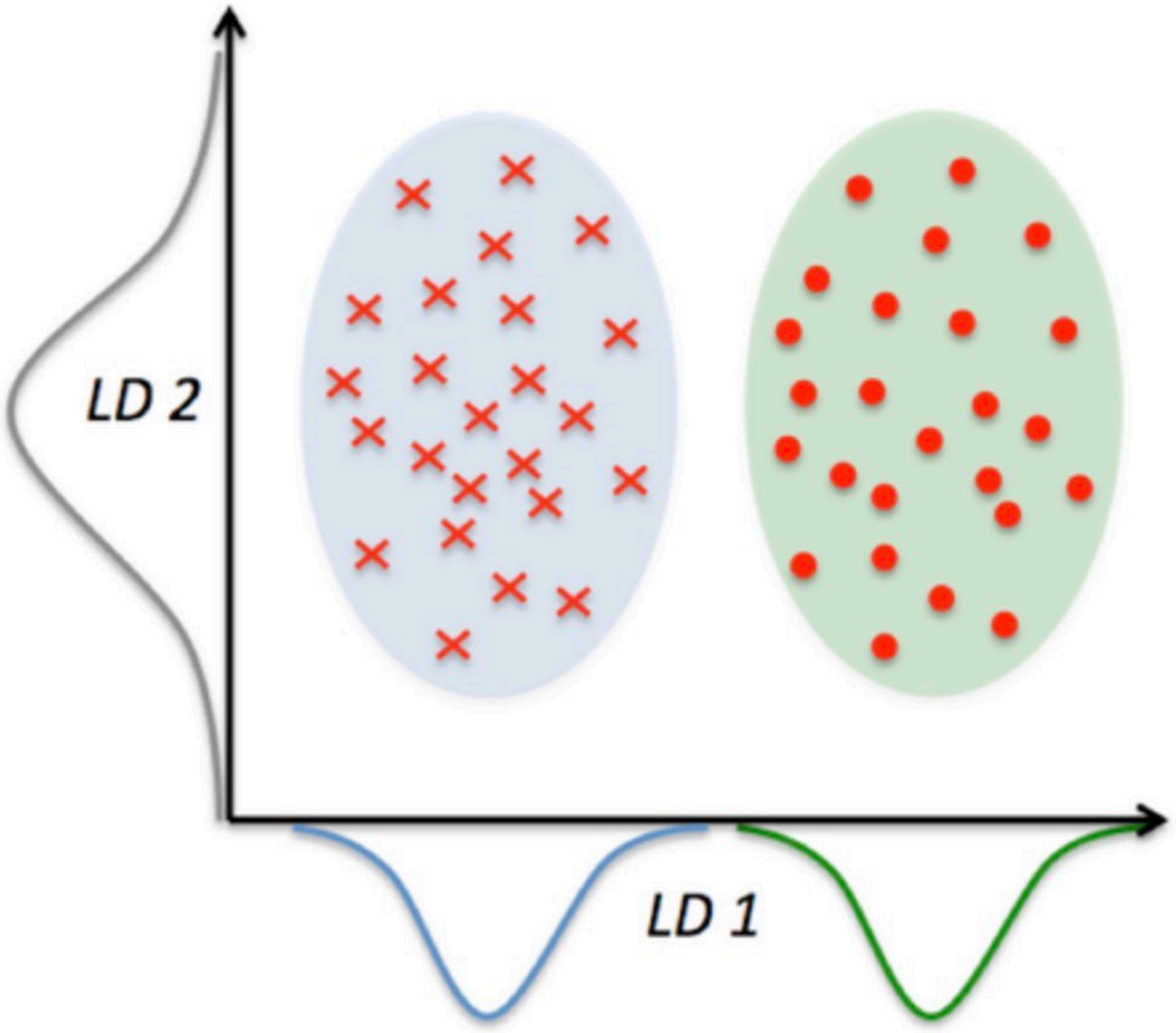


Principal components analysis (unsupervised)



https://sebastianraschka.com/faq/docs/lda-vs-pca.html

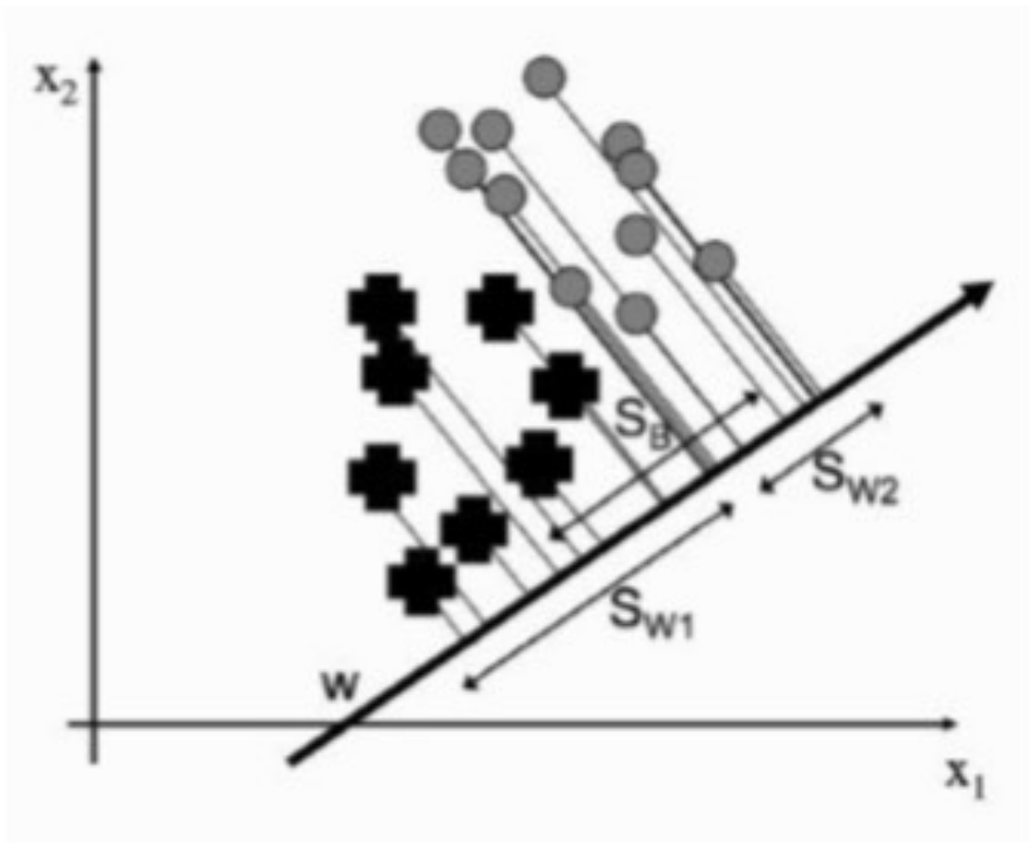
Linear discriminant analysis (supervised)



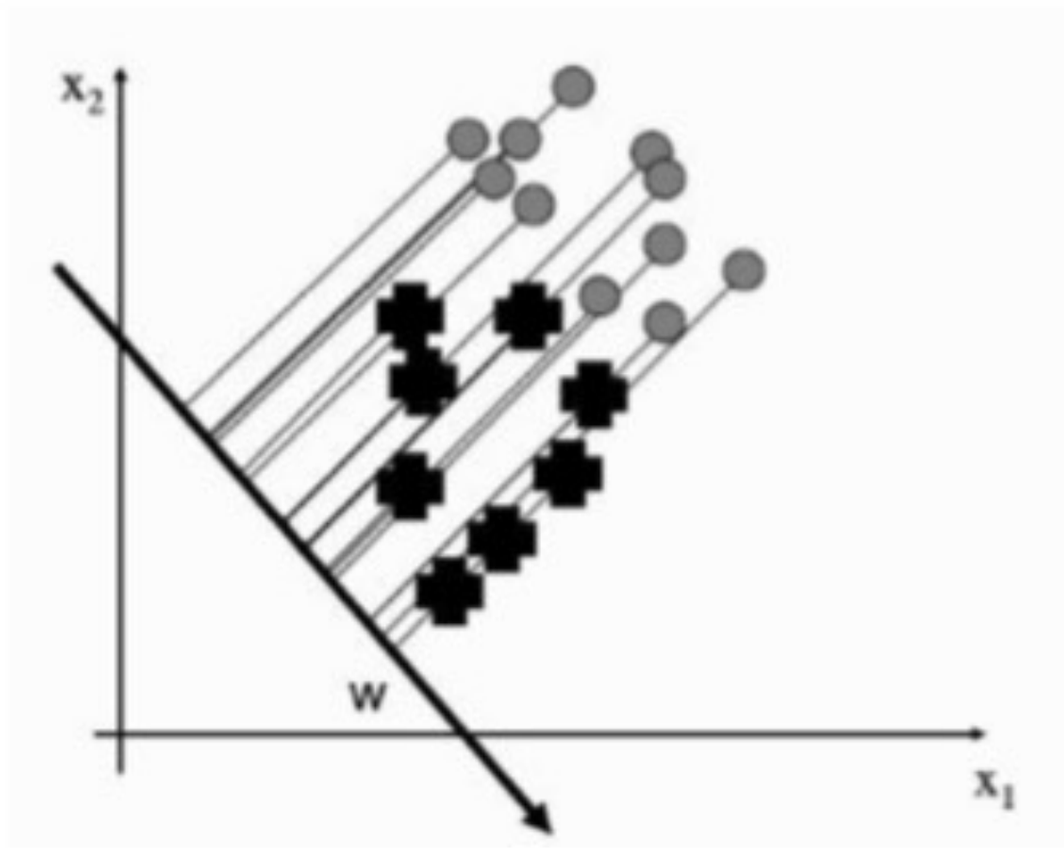
https://sebastianraschka.com/faq/docs/lda-vs-pca.html

Linear discriminant analysis (supervised)

Good



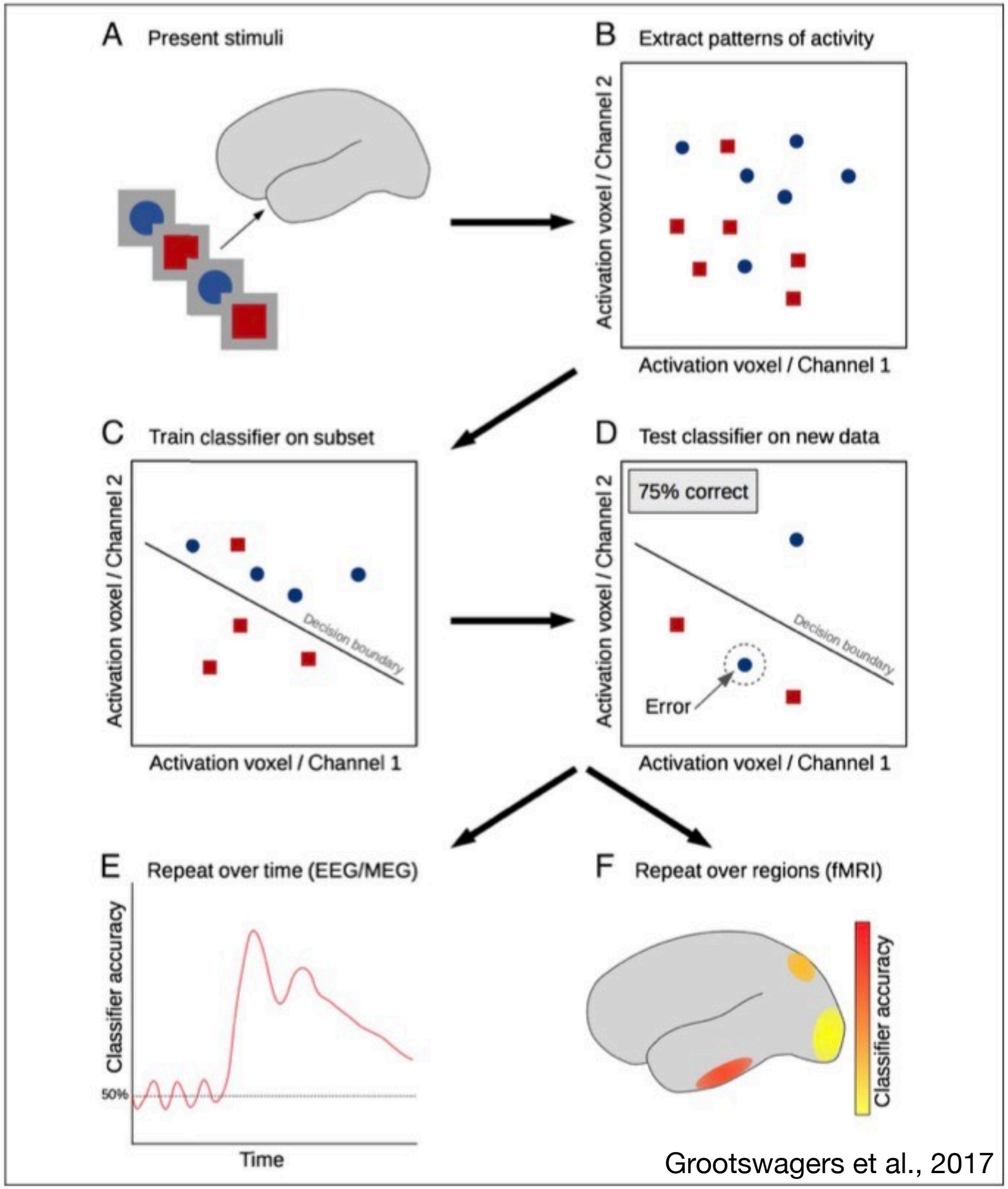
Bad



Marsland, S. (2015). Machine learning: An algorithmic perspective (2nd ed.). CRC Press.

Why linear discriminant analysis?

- Uses data from all channels (each channel is one feature)
- Reduces dimensionality of EEG data
- Separates overlapping spatiotemporal activity
- Produces meaningful neural components/sources (independent but non-orthogonal components)
- Computationally cheap (generalized eigendecomposition)
- Flexible hypothesis testing! (supervised machine learning)



Grootswagers et al., 2017

Tutorial