

The background of the slide features a pattern of horizontal, wavy black lines on a white background, resembling a stylized ocean or a textured paper.

# **Seminar psyM1-1**


## **Data Science in Theory**

# Letzte Woche: P300 speller

Psychology/Psychiatry

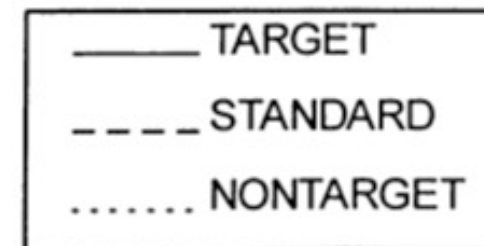
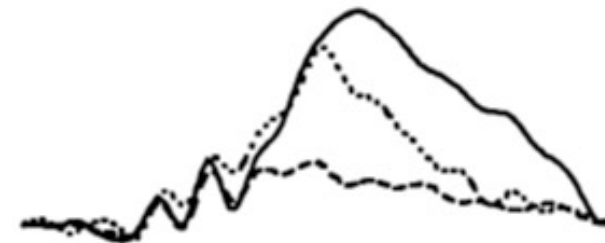
## Visual P300 Mind-Speller Brain-Computer Interfaces: A Walk Through the Recent Developments With Special Focus on Classification Algorithms

Jobin T. Philip<sup>1</sup> and S. Thomas George<sup>1</sup> 

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Brain-computer interfaces are sophisticated signal processing systems, which directly operate on **neuronal signals** to identify specific human **intents**.

- What is the P300 and what does it represent?
- What are the basic principles of classifiers?
- Are the P300 spellers useful yet?



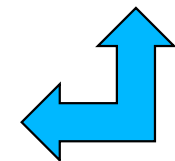
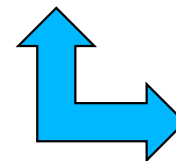
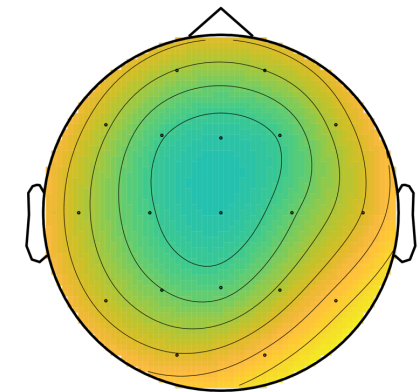
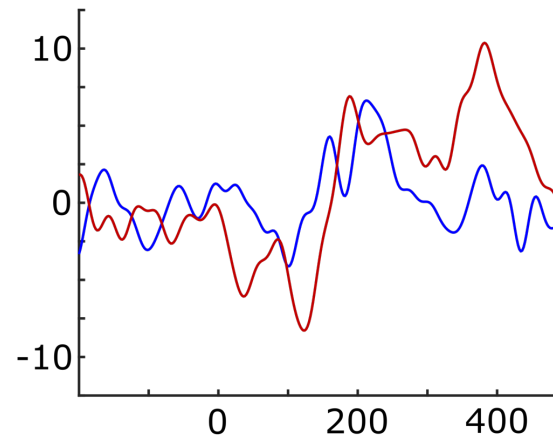
# Inverses Problem

## Ziel:

- Quelle eines Signals finden
  - Zeit
  - Topographie

## Problem:

- Keine eindeutige Lösung für Raum
  - Nur Messung an der Oberfläche
  - Zusammenhang zwischen neuronaler Quelle und Signal an Oberfläche unklar



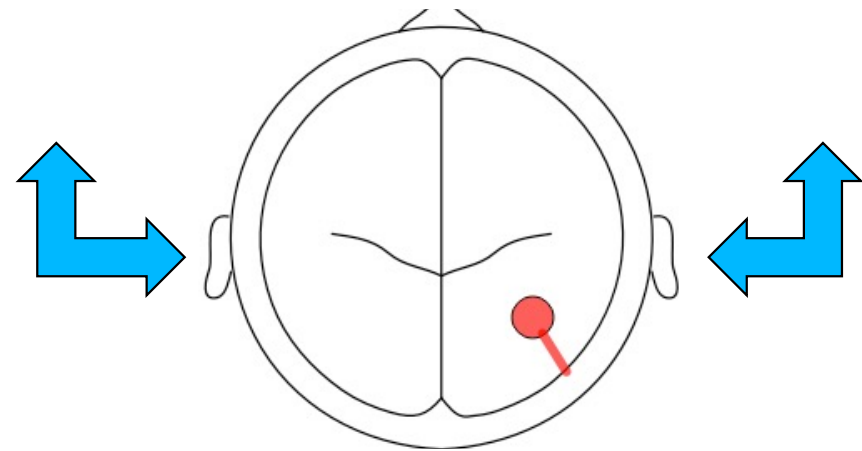
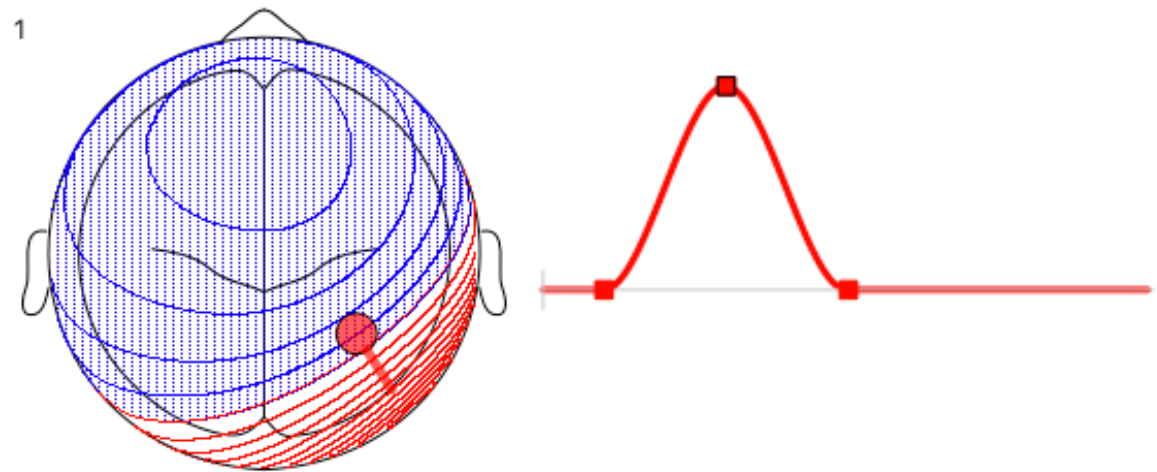
# Quellanalyse: Dipole Fitting

## Ziel:

- Quelle eines Signals finden
  - Zeit
  - Topographie

## Lösung:

- Vorwärts-Rechnung
  - Was ist eine mögliche Quelle für Topographie
  - Keine eindeutige Lösung!
- Rückwärts-Rechnung
  - Welche Quellen erzeugen welche Topographie



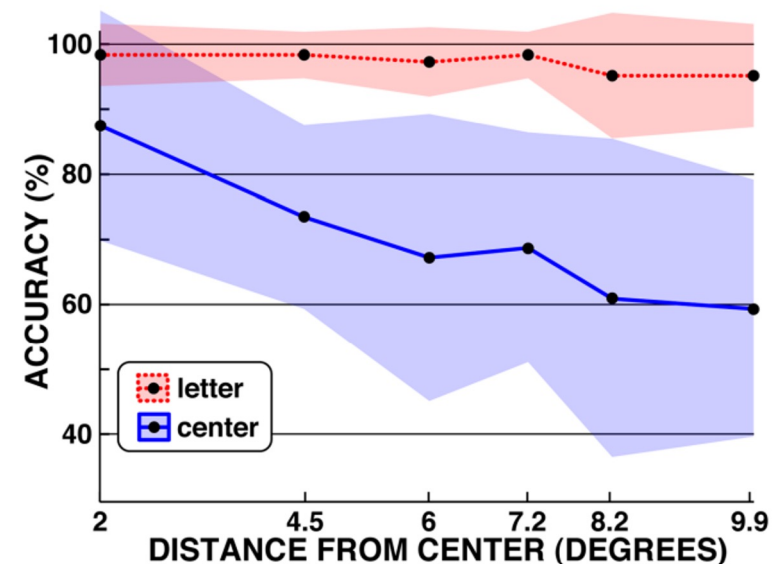
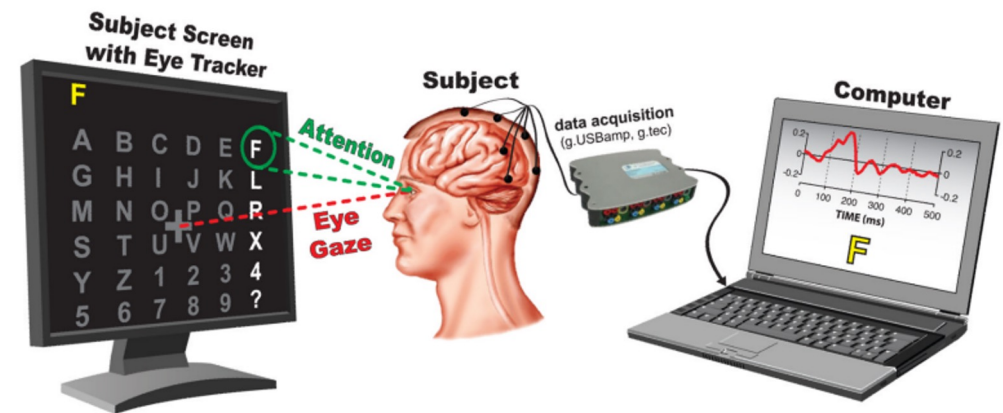
# Eindeutige Lösungen?

## Ziel:

- Trennung zwischen „Signal“ und „Rauschen“

## Problem:

- Ohne Vorwissen und Zusatzannahmen nicht lösbar
  - Nur weil ein Algorithmus eine Lösung findet, muss die nicht korrekt sein
- Gefahr der Überinterpretation



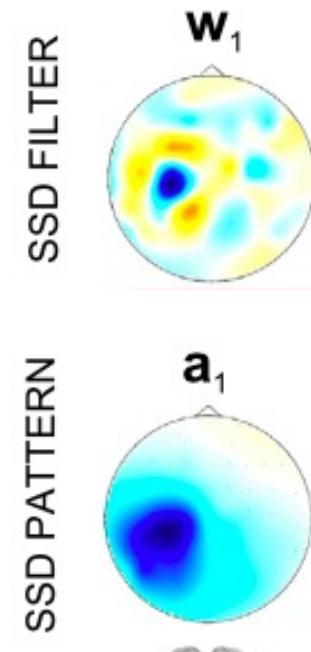
# Diese Woche: Weight Vectors? Was ist das?

## On the interpretation of weight vectors of linear models in multivariate neuroimaging<sup>☆</sup>

Stefan Haufe<sup>a,b,\*</sup>, Frank Meinecke<sup>c,a</sup>, Kai G rgeren<sup>d,e,f</sup>, Sven D hne<sup>a</sup>, John-Dylan Haynes<sup>d,e,b</sup>,  
Benjamin Blankertz<sup>f,b</sup>, Felix Bie mann<sup>g,a,\*</sup>

Often it is desired to interpret the outcome of these methods with respect to the **cognitive processes under study**. Here we discuss **which methods allow for such interpretations** [...].

- What are “forward” and “backward” models?
  - What are **key concepts**?
- How can we **interpret** the parameters (results) of these models?
- What is the **problem** with the interpretation?





## Decoding mental states from brain activity in humans

*John-Dylan Haynes<sup>\*‡§</sup> and Geraint Rees<sup>\*§</sup>*

Recent advances in human neuroimaging have shown that it is possible to accurately **decode a person's conscious experience** based only on non-invasive measurements of their brain activity. [...] Such applications raise important **ethical issues** concerning the privacy of personal thought.

- Review: What is the idea of “decoding”?
- What current **technical challenges** exist?
- What **ethical issues** arise from this?

- Philip, J. T., & George, S. T. (2020). Visual P300 Mind-Speller Brain-Computer Interfaces: A Walk Through the Recent Developments With Special Focus on Classification Algorithms. *Clinical EEG and Neuroscience*, 51(1), 19–33. <http://doi.org/10.1177/1550059419842753>
- Haufe, S., Meinecke, F., Görgen, K., Dähne, S., Haynes, J.-D., Blankertz, B., & Bießmann, F. (2014). On the interpretation of weight vectors of linear models in multivariate neuroimaging. *NeuroImage*, 87(C), 96–110. <http://doi.org/10.1016/j.neuroimage.2013.10.067>
- Haynes, J.-D., & Rees, G. (2006). Decoding mental states from brain activity in humans. *Nature Reviews Neuroscience*, 7(7), 523–534. <http://doi.org/10.1038/nrn1931>
- <https://www.besa.de/products/besa-simulator/besa-simulator-overview/>