

This document is work in progress. Materials listed for each topic are initial guesses (mostly by myself). Please discuss the literature with your supervisor (this is, what counts!).

Michael

Legend:

Group of Wolfram Burgard

Group of Tonio Ball

Group of Michael Tangermann

unassigned topics

Topics Bachelor (Proseminar)

Basics + Decoding

- **B1 Introduction to EEG / ECoG** -> Alexander Rudmann (Sup: Lukas Fiederer)

generation zone dendrite tree, large groups of neurons, describe sensors and recording gear, role of referencing, types of signals (1) oscillations just briefly and (2) time-locked potentials... Literature: e.g. BCI book by Wolpaw and Wolpaw. Brain-Computer Interfaces: principles and practice. Oxford Univ. Press, 2011.

- **B2 / B7a Basic analysis and decoding of ERP signals with emphasis on error potentials** →

Ann-Kathrin Klumpp (Sup: Martin Völker + Lukas Fiederer)

Buch: "An Introduction to the EventRelated Potential Technique" and Buchkapitel: (2012 Gehring Oxford Handbook ERP components) The error-related negativity and (2015 Chavarriaga ,frontiers in Neuroscience) Errare machinale est - the use of error-related potentials in brain-machine interfaces

- **B3 Basic classification of ERP signals** → Aleksandar Petrov (Sup: Sebastian Castano)

Intro target/non-target e.g. with simple BCI spelling application (z.B. Originalpublikation von Farwell and Donchin <http://www.sciencedirect.com/science/article/pii/S1532046500001496>)

Then ERP classification with LDA (Single-trial analysis and classification of ERP components—a tutorial B Blankertz, S Lemm, M Treder, S Haufe, KR Müller, NeuroImage 56 (2), 814-825 by Blankertz et al. 2009)

- **B4 Interactions between pre-processing and classification** -> Laura Kahle

methods for event-related-potential classification, J Farquhar, NJ Hill - Neuroinformatics, 2013 - Springer.

- **B5 Basic classification of ERD / ERS signals** → Norbert Balazs (Sup: Sebastian Castano)

Applications:

- **B6 Decoding the attended speaker in cocktail party situations** -> Michael Zinner (Sup: Michael Tangermann)

Identifying the attended speaker using electrocorticographic (ECoG) signals by KV Dijkstra, P Brunner, A

Gunduz, W Coon, AL Ritaccio, J Farquhar, ... Brain-Computer Interfaces 2 (4), 161-173, and paper on EEG signals by O'Sullivan et al., [<https://cercor.oxfordjournals.org/content/25/7/1697.full>]

- **B7b Application of error-decoding in EEG for Robotics & Autonomous Systems** → Maya Schöchlin (Sup: Martin Völker)
(2015 Zhang, J Neural Eng.) EEG-based Decoding of Error-Related Brain Activity in a Real-World Driving Task and (2015 Iturrate Nature Scientific Reports) Teaching brain-machine interfaces as an alternative paradigm to neuroprosthetics control and (2015 Chavarriaga, frontiers in Neuroscience) Errare machinale est - the use of error-related potentials in brain-machine interfaces

Topics Master (Seminar)

Decoding:

- **M1 Transfer learning for ERP-BCIs** -> Maria Moloci (Sup: Camilo Andres Gordillo Chaves)
Transfer learning and active transfer learning for reducing calibration data in single-trial classification of visually-evoked potentials [http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6974353&tag=1] and Integrating dynamic stopping, transfer learning and language models in an adaptive zero-training ERP speller. [<http://www.ncbi.nlm.nih.gov/pubmed/24834896>]
- **M2 Transfer learning for ERD/ERS BCIs** -> Maximilian Ernestus (Sup: Andreas Meinel)
z.B. Lotte, Fabien. "Signal Processing Approaches to Minimize or Suppress Calibration Time in Oscillatory Activity-Based Brain-Computer Interfaces." *Proceedings of the IEEE* 103.6 (2015): 871-890.
- **M4 Probabilistic Co-adaptive BCI** -> Jan Sosulski (Sup: Camilo Andres Gordillo Chaves)
MS Treder, AK Porbadnigk, FS Avarvand, KR Müller, B Blankertz, NeuroImage 2016 Probabilistic co-adaptive BCI
- **M5 Random forest classifiers for BCI** -> Axel Perschmann (Sup: Andreas Meinel)
z.B. Steyrl, David, Reinhold Scherer, and Gernot R. Müller-Putz. "Random forests for feature selection in non-invasive brain-computer interfacing." *Human-Computer Interaction and Knowledge Discovery in Complex, Unstructured, Big Data*. Springer Berlin Heidelberg, 2013. 207-216.
- **M6a Convolutional Networks for EEG Decoding** (diverse) -> Keshav Deep Verma (Sup: Robin Schirrmeister)
z.B. P. Bashivan, I. Rish, M. Yeasin, and N. Codella, "Learning Representations from EEG with Deep Recurrent-Convolutional Neural Networks," ICLR 2016. (evtl auch zusammen mit Joint optimization of algorithmic suites for EEG analysis)
- **M6b Recurrent Networks for EEG Decoding** (diverse) -> Aditya (Ad) Bhatt (Sup: Robin Schirrmeister)
- **M7 Data augmentation methods for BCI** → Janosch Dobler (Sup: Tobias Schubert)
Signal processing approaches to minimize or suppress calibration time in oscillatory activity-based Brain-Computer Interfaces and Data augmentation in Riemannian space for Brain-Computer Interfaces
- **M8 Non-stationarities and adaptation in ERP EEG signals** -> Stefan Martinovski (Sup: David Hübner)
z.B. Vidaurre, Carmen, et al. "Toward unsupervised adaptation of LDA for brain-computer interfaces." *Biomedical Engineering, IEEE Transactions on* 58.3 (2011): 587-597.

Applications

- **M9 Speech decoding with ECoG signals (Part 1)** -> Kangkan Jyoti Bharadwaj (Sup: Henrich Kolkhorst, Michael Tangermann)

e.g. Brain-to-text: decoding spoken phrases from phoneme representations in the brain C Herff, D Heger, A de Pesters, D Telaar, P Brunner, G Schalk, T Schultz, Frontiers in neuroscience 9

- **M10 Speech decoding with ECoG signals (Part 2)** -> Bandar Alsharif (Sup: Joos Behncke)
Decoding spectrotemporal features of overt and covert speech from the human cortex S Martin, P Brunner, C Holdgraf, HJ Heinze, NE Crone, J Rieger, G Schalk, RT Knight, BN Pasley, Frontiers in neuroengineering

- **M12 BCI controlled robots / wheelchairs / telepresence / shared control** -> Hassan Gamaleldin (Sup: Daniel Kuhner)

e.g. [<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7109829>]

- **M13 BCI-supported rehabilitation of hand motor deficits after stroke** → Ryan Davies Goga (Sup: Felix Burget)

Clinical study of neurorehabilitation in stroke using EEG-based motor imagery brain-computer interface with robotic feedback, <http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=5626782>

- **M14 Dynamic frequency feature selection based approach for classification of motor imageries**
-> Anup Kumar (Sup: Andreas Kuhner)

Wavelet packet decomposition for feature extraction of EEG signal of motor imagery, then selecting good features for later classification through a Random Forest

- **M15 Revolutionizing Prosthetics** -> Kay Hartmann (Sup: Martin Glasstetter)

<http://www.jhuapl.edu/prosthetics/scientists/default.asp>

<http://www.darpa.mil/program/revolutionizing-prosthetics>

http://www.hopkinsmedicine.org/news/media/releases/mind_controlled_prosthetic_arm_moves_individual_fingers

—
Individual finger control of a modular prosthetic limb using high-density electrocorticography in a human subject
[<http://iopscience.iop.org/article/10.1088/1741-2560/13/2/026017/meta>]

- **B2 Basic analysis techniques for ERP signals** -> Lukas Fiederer

description via peak latency, jitter, amplitude; visualization by stimulus alignment vs. response alignment; Meaning of ERP components; baselining of single epochs to improve SNR; Outlier removal to improve SNR; various visualization methods; Simple pre-processing via PCA or ICA; typical paradigms: oddball, BSR) - An introduction to the event-related potential technique. SJ Luck, MIT press, 2005

[\[http://mitpress.mit.edu/books/introduction-event-related-potential-technique\]](http://mitpress.mit.edu/books/introduction-event-related-potential-technique)

- **Robust estimation of covariance matrices** for LDA: (1) Shrinkage-regularization of LDA, (2) bootstrapping, (3) outlier removal, (4) short-time windowed covariance...

[\[http://www.sciencedirect.com/science/article/pii/S1053811910009067\]](http://www.sciencedirect.com/science/article/pii/S1053811910009067) [Short-time windowed covariance: A metric for identifying non-stationary, event-related covariant cortical sites]

- **Levels of Brain Signals: From single-unit activity to fMRT**

(z.B. welche Features werden genutzt, wofür welche Skala besonders geeignet, Informations Übertragung zwischen den Skalen,...)

- **B8 Workload detection with BCI** -> Henrich Kolkhorst

z.B. Mühl, Christian, Camille Jeunet, and Fabien Lotte. "EEG-Based Workload Estimation across Affective Contexts." *Neuroprosthetics* 8 (2014): 114. doi:10.3389/fnins.2014.00114.

<http://journal.frontiersin.org/article/10.3389/fnins.2014.00114/full>

- **B9 Dynamic stopping for ERP paradigms** -> David Hübner

Schreuder, Martijn, et al. "Optimizing event-related potential based brain-computer interfaces: a systematic evaluation of dynamic stopping methods." *Journal of Neural Engineering* 10.3 (2013): 036025.

<http://iopscience.iop.org/1741-2552/10/3/03602>

- Spontaneous Decoding of the Timing and Content of Human Object Perception from Cortical Surface Recordings Reveals Complementary Information in the Event-Related Potential and Broadband Spectral Change
KJ Miller, G Schalk, D Hermes, JG Ojemann, RPN Rao, PLoS Comput Biol 12 (1), e1004660

- **Mean-shift adaptation and covariance-shift adaptation**

- **Codebook / Dictionary approaches for EEG**

- **BCI scales: On the representation of kinematic parameters in brain signals.**

<http://cercor.oxfordjournals.org/content/early/2016/03/15/cercor.bhw033.full>

<http://iopscience.iop.org/article/10.1088/1741-2560/13/2/026021/meta>

- **Covariance space classification** / Riemannian distances (siehe letzte Runde)

- **M3 The LDA beamformer: Optimal estimation of ERP source time series using linear discriminant analysis** -> Tobias Schubert

- **Unsupervised classification of ERP signals**

<http://www.degruyter.com/view/j/bmte.2013.58.issue-s1-S/bmt-2013-4439/bmt-2013-4439.xml>

- Unsupervised classification of oscillatory signals (is Raj Rao's work published yet?)

- **SPoC for ERD/ERS signals**

- **Subclass shrinkage for ERP classification**

[\[http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6858523&tag=1\]](http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6858523&tag=1)

- Neurophysiological assessment of perceived image quality using steady-state visual evoked potentials S Bosse, L Acqualagna, AK Porbadnigk, G Curio, KR Müller, B Blankertz, ... SPIE Optical Engineering+ Applications, 959914-959914-12

- Neural indicators of the depth of cognitive processing for user-adaptive neurotechnological applications IE Nicolae, L Acqualagna, B Blankertz, Engineering in Medicine and Biology Society (EMBC), 2015 37th Annual ...

