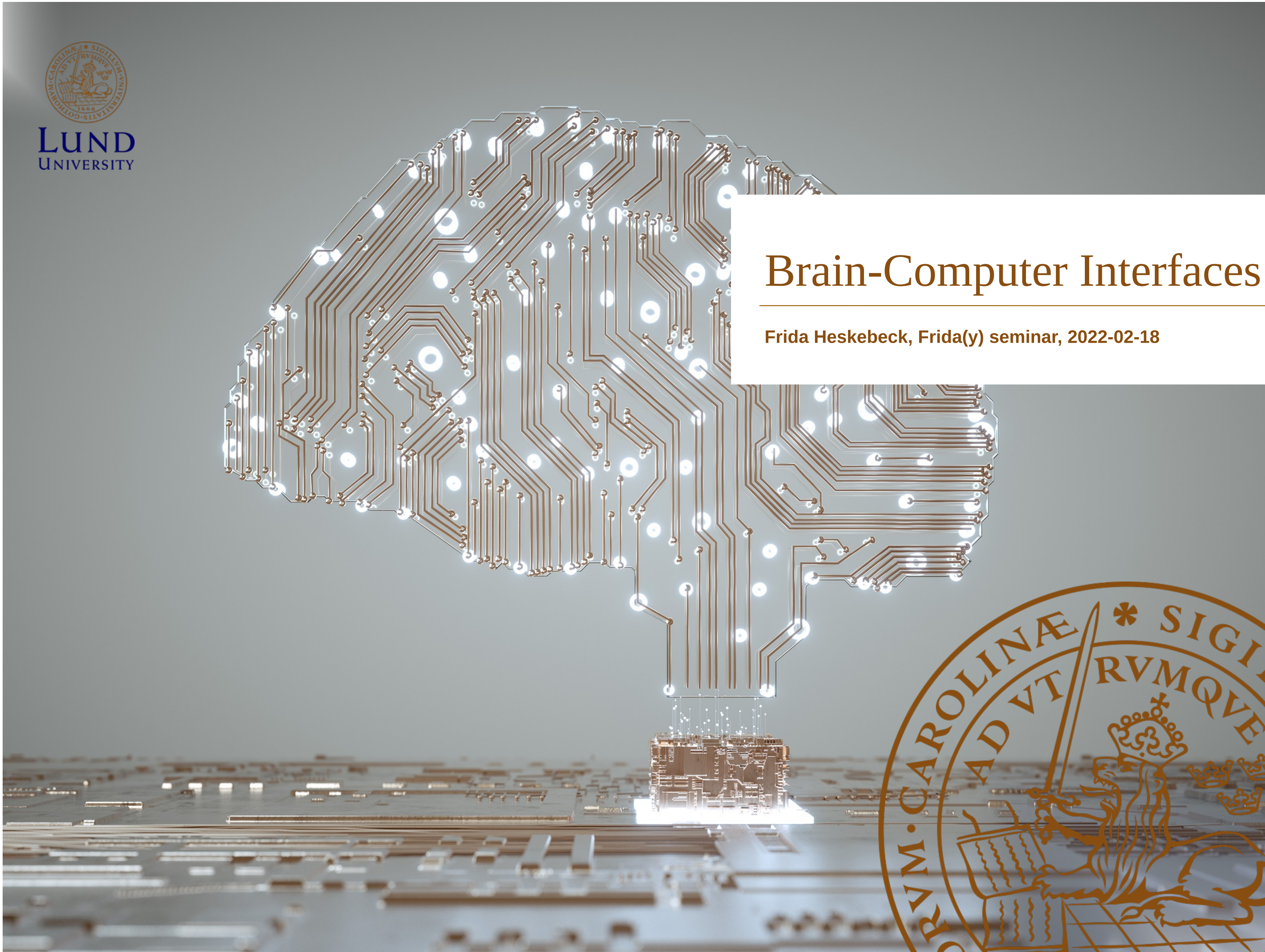


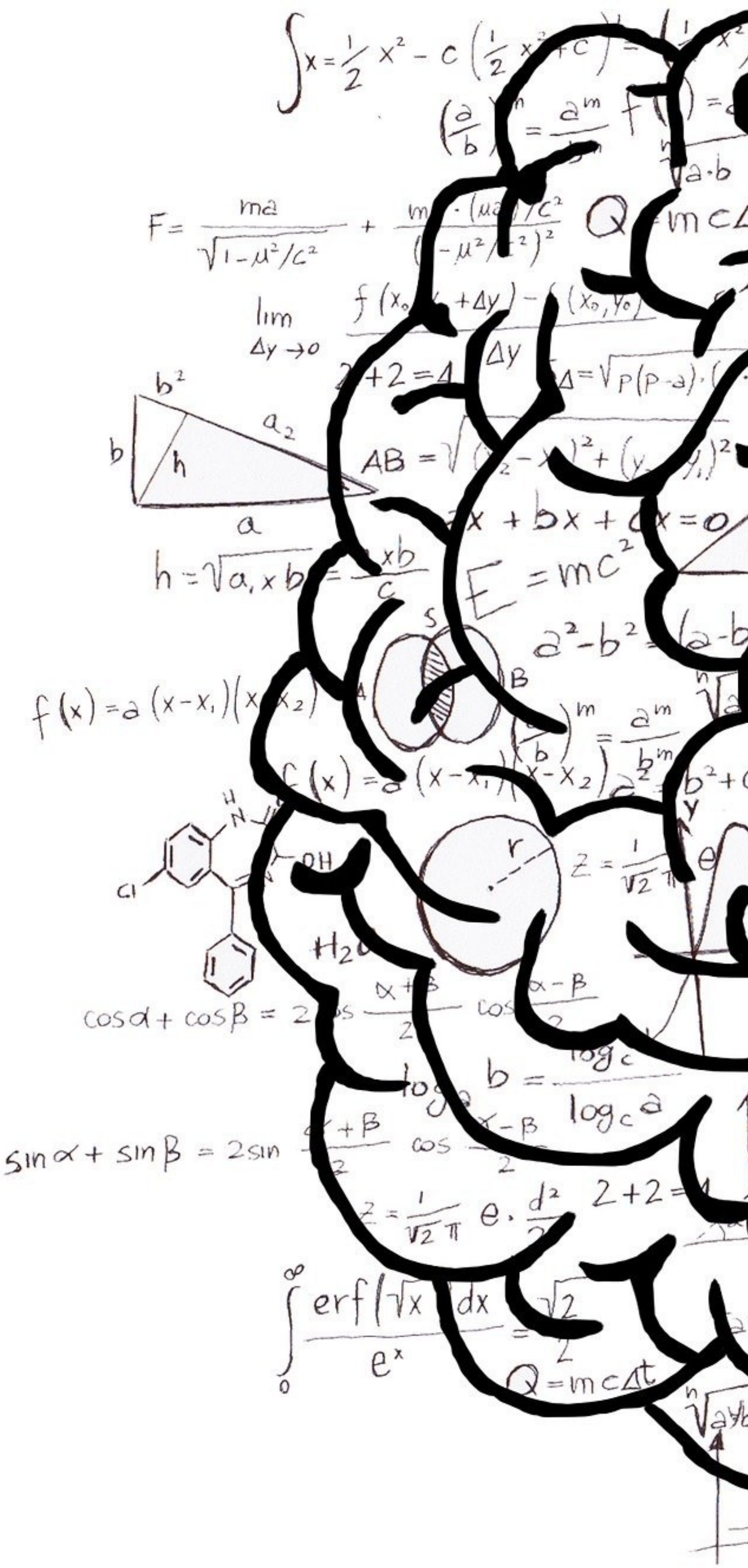
Lund University

Brain-Computer Interfaces

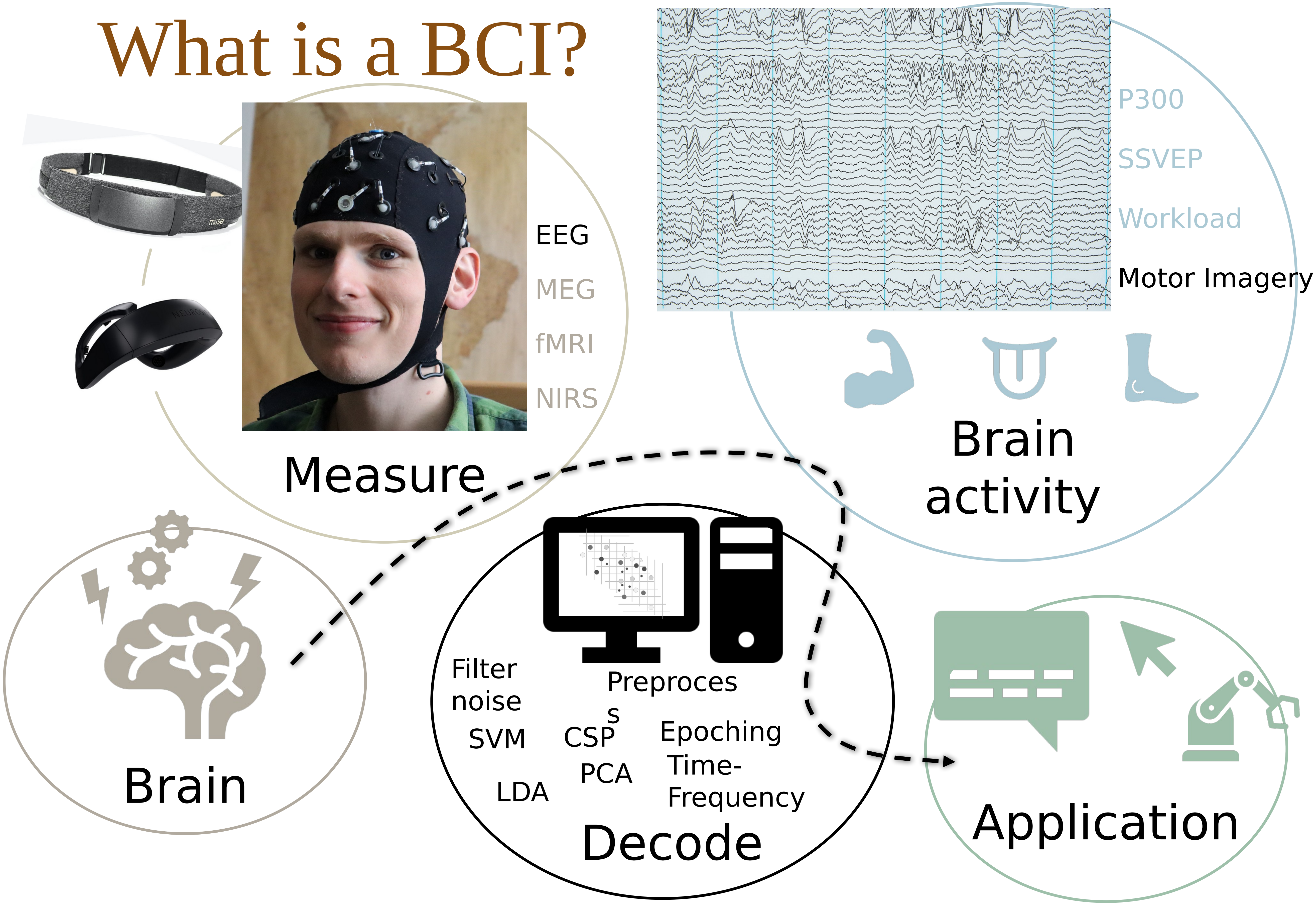
Frida Heskebeck, Frida(y) seminar, 2022-02-18

Outline

- Introduction to Brain-Computer Interfaces
- BCI @ Automatic control
- My research

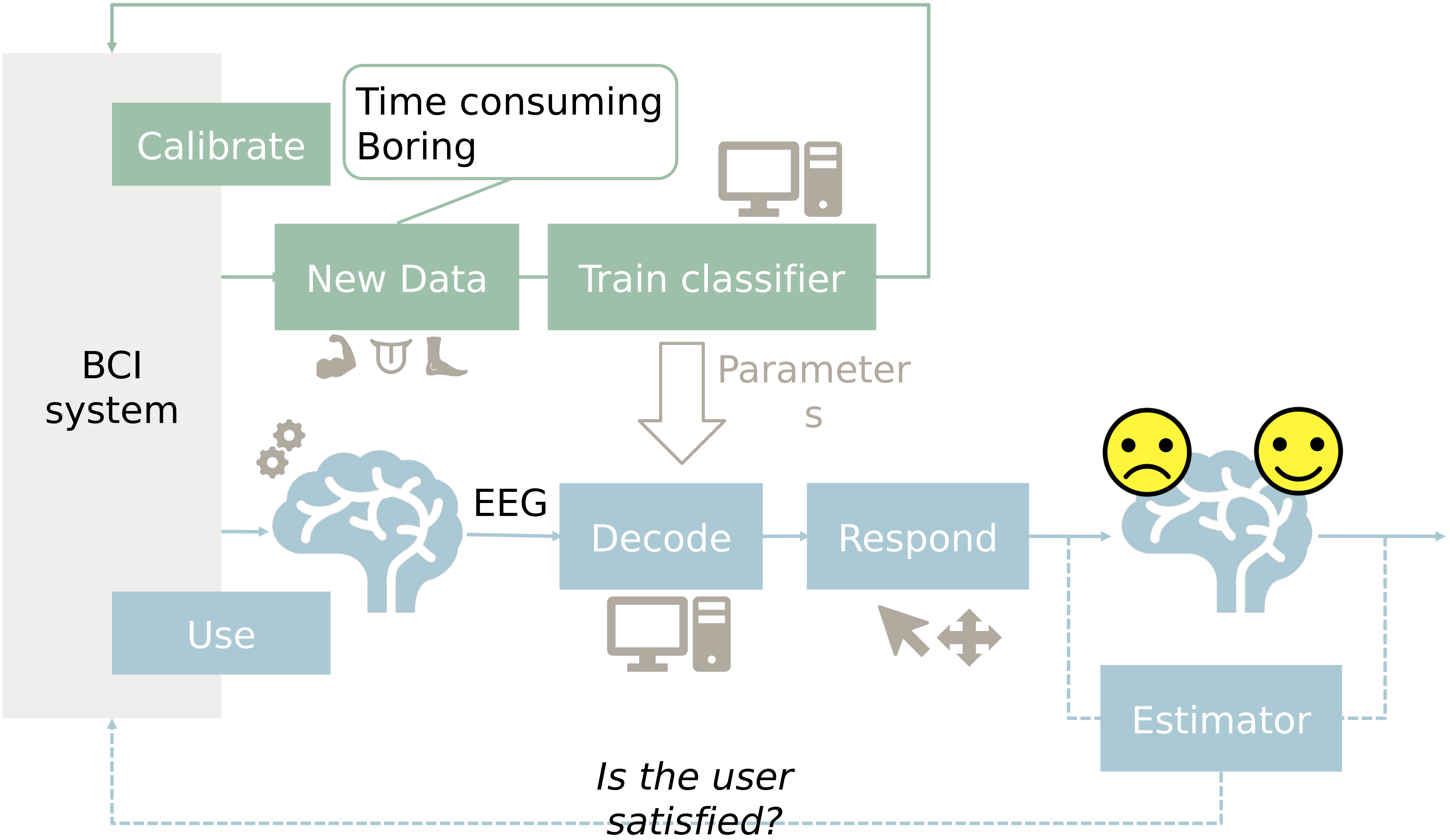


What is a BCI?



EEG
MEG
fMRI
NIRS
Measure
P300
SSVEP
Workload
Motor Imagery
Brain activity
Brain
Filter noise
Preprocess
SVM
CSP
Epoching
PCA
Time-Frequency
LDA
Decode
Application

Control loop



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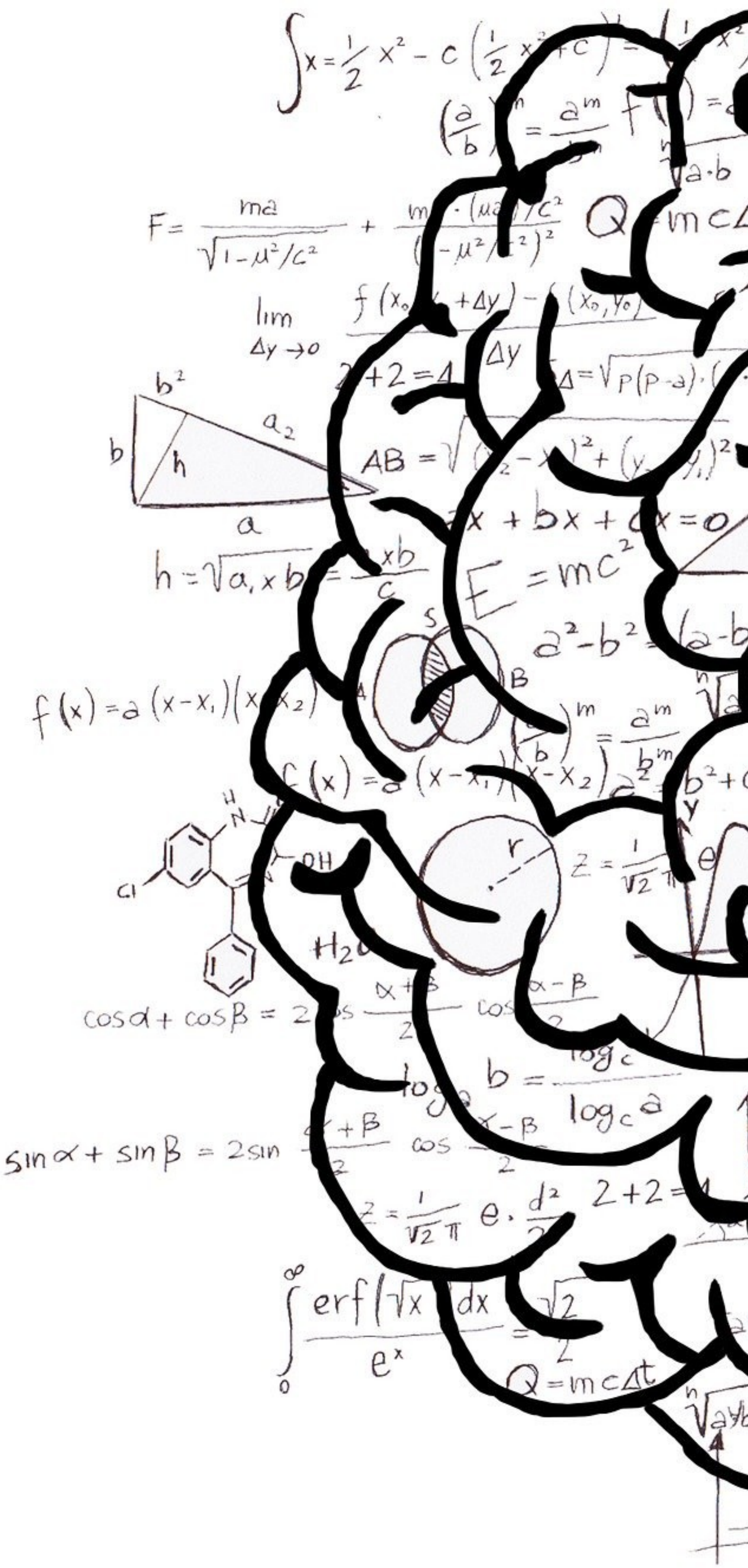


BCI @ LU

Bo Bernhardsson

Department of Automatic Control

Maria Sandsten

Department of Mathematical Statistics

Mikael Johansson

Department of Psychology

BCI @ Automatic control

Pex Tufvesson

ERICSSON

Carolina Bergeling (BTH)

Johan Eker

Bo Bernhardsso n

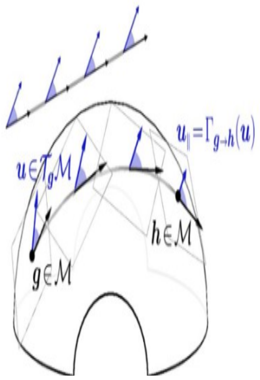
Frida Heskebeck

Martin Gemborn Nilsson

WASP WALLENBERG AI, AUTONOMOUS SYSTEMS AND SOFTWARE PROGRAM

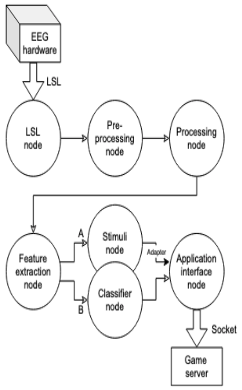
ELLIIT

BCI @ Automatic control



Domain Adaptation for Attention Steering

- Johanna Wilroth
- 2020

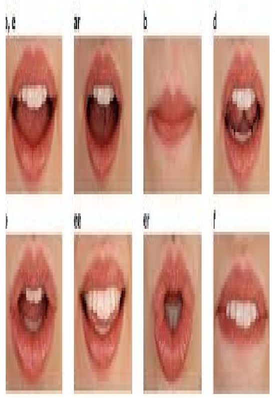


Implementation of a Simple Asynchronous Pipeline Framework (SAPF) for construction of real-time BCI systems

- Tom Andersen
- 2021

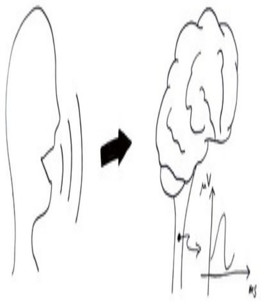
Audiovisual processing in the wild by using video-based lip reading software

- Louise Karsten & Sara Enander
- 2022



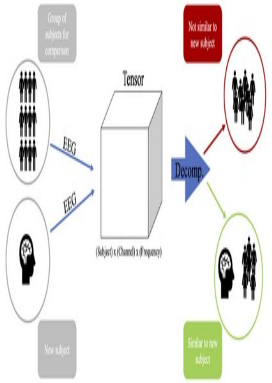
Audiovisual processing in the wild by using video-based lip reading software

- Nelly Ostreus & Viktor Andersson
- 2022



Optimal signal processing of brain signals used for automatic control of a hearing device

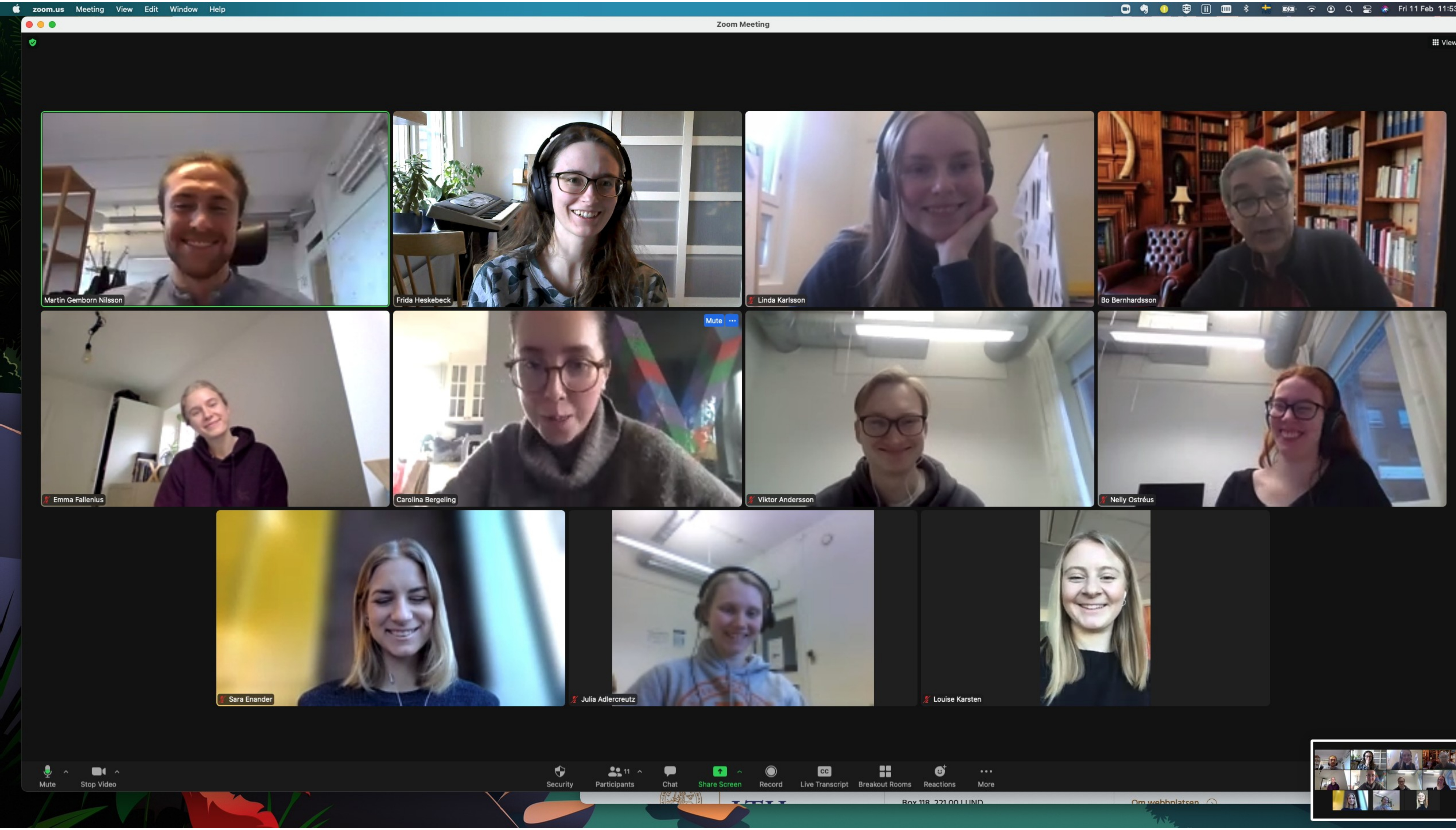
- Julia Adlercreutz
- 2022



Tensor Decomposition of EEG signals

- Emma Fallenius & Linda Karlsson
- 2022

BCI @ Automatic control



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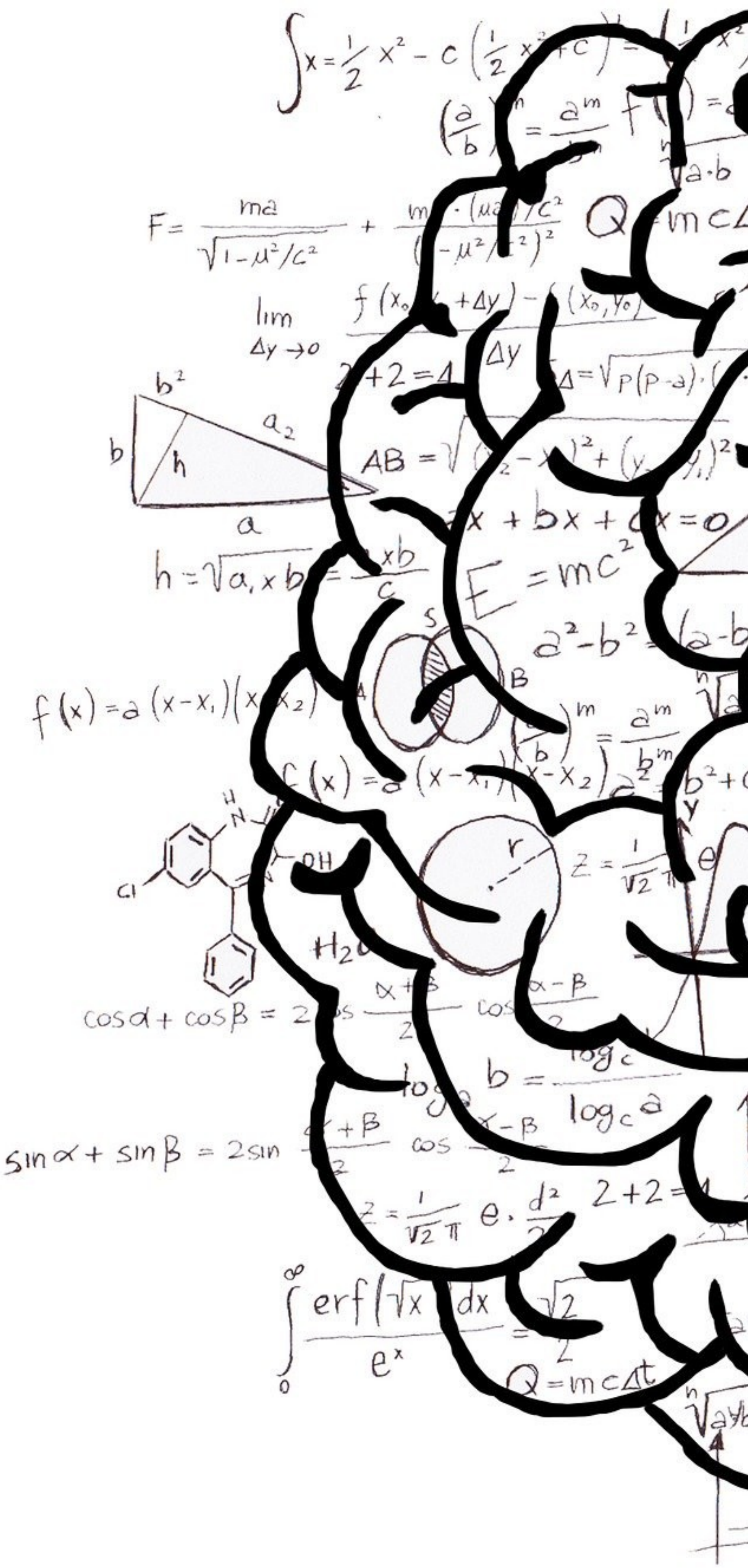
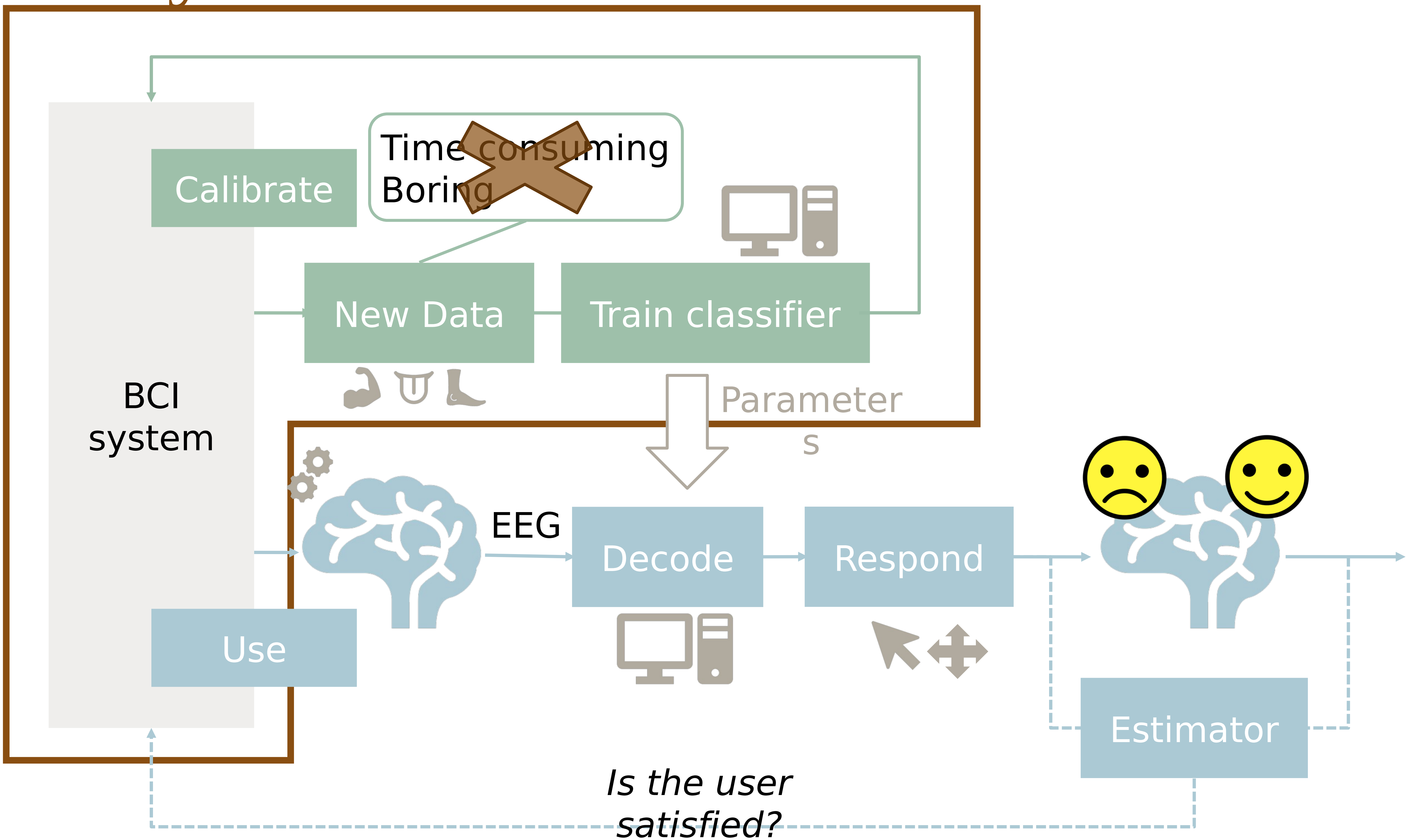


My focus


Calibrate
Time consuming
Boring
New Data
Train classifier
BCI
system
Parameter
s
EEG
Decode
Respond
Use
Estimator
Is the user satisfied?

Calibration reduction

- Gamification
- Transfer learning
- Artificial EEG data
- Online learning

Multi-Armed Bandits

- Stationary bandits
- Non-stationary bandits
- Mortal bandits
- Sleeping bandits
- ...

???

Exploration vs Exploitation

Multi-Armed Bandits in BCI

Keybord

- Which is the fastest way to find the correct key?

BCI button

- What is the best class to use to push the button?

Our thoughts

- Attention steering
- Transfer learning
- What new data to collect in calibration?

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References

- [gamification] Flatla, D. R., Gutwin, C., Nacke, L. E., Bateman, S., & Mandryk, R. L. (2011, October). Calibration games: making calibration tasks enjoyable by adding motivating game elements. In *Proceedings of the 24th annual ACM symposium on User interface software and technology* (pp. 403-412).
- [MAB, BCI-button] Fruitet, J., Carpentier, A., Munos, R., & Clerc, M. (2012). Bandit Algorithms boost Brain Computer Interfaces for motor-task selection of a brain-controlled button. In *Advances in Neural Information Processing Systems* (Vol. 25, pp. 458-466). Neural Information Processing Systems (NIPS) Foundation.
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- [MAB, keyborad] Ma, T., Huggins, J. E., & Kang, J. (2021, December). Adaptive Sequence-Based Stimulus Selection in an ERP-Based Brain-Computer Interface by Thompson Sampling in a Multi-Armed Bandit Problem. In *2021 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)* (pp. 3648-3655). IEEE.