UNIVERSITÄT BERN

Deep-learning Your Brain

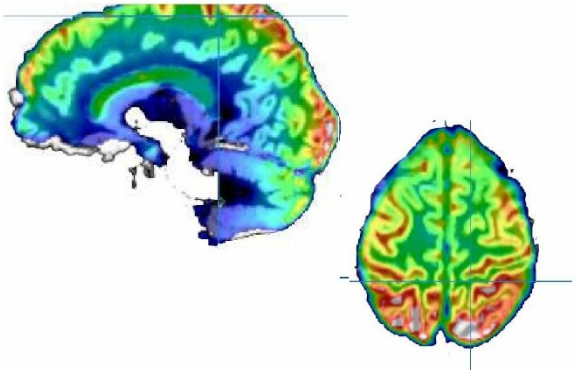
Classification of movement execution and imagination using EEG signals

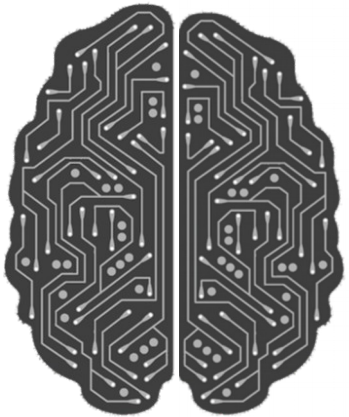
Tim Fischer, Özhan Özen, Joaquin Penalver-Andres

21st May 2019, University of Bern, Advanced Topics in Machine Learning

Learning your movement intention

What do we aim for?



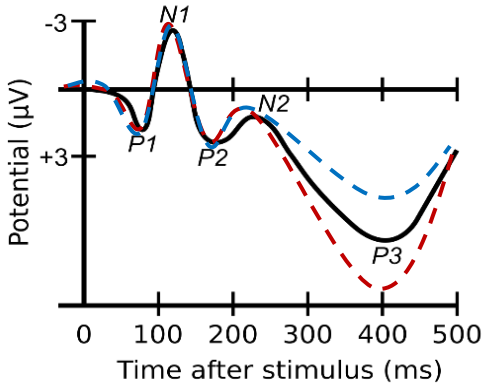


Why to read your mind?

Current and future applications

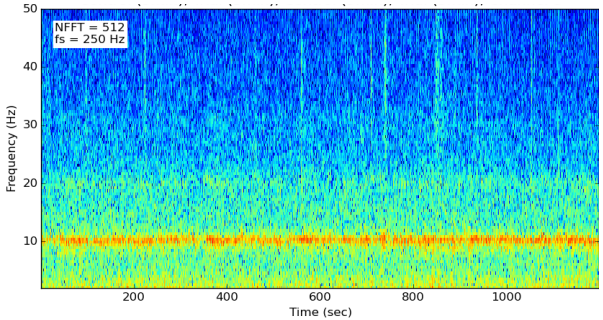
How to understand people's intention?

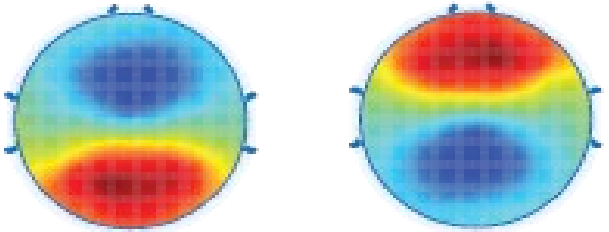
EEG Basics



Time Domain

Frequency Domain

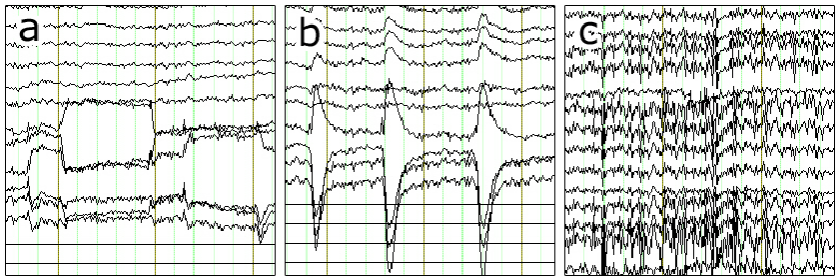


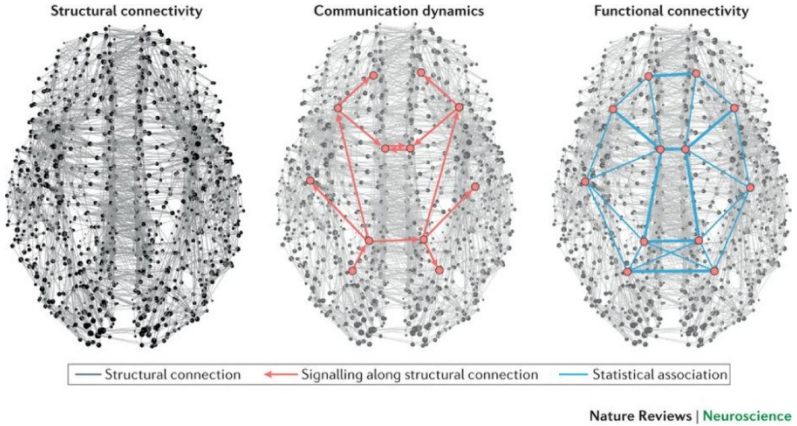


Spatial Domain

Each person, one world

Challenges in EEG analysis





Artefacts

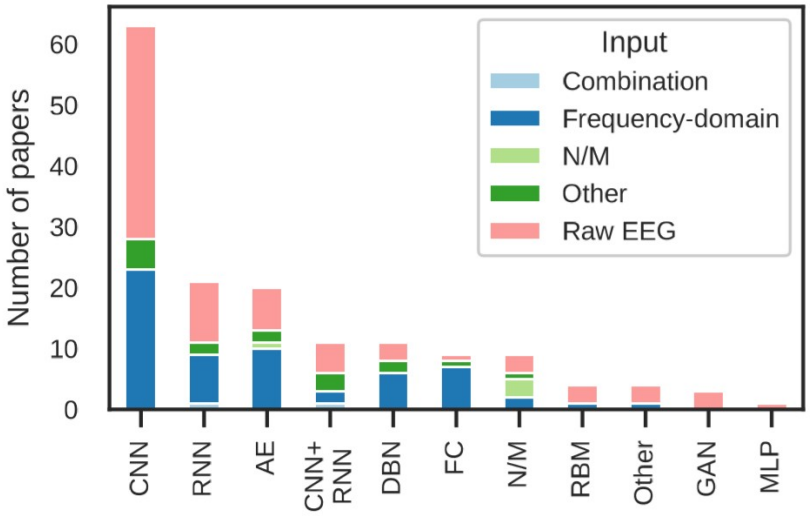
Complex neural processes

Biggest dataset EEG:
Physionet BCI 2000
109 subjects, 64 electrodes, 7 differe

Biggest dataset Images:
Imagenet
>14 mio. Images

Prior attempts

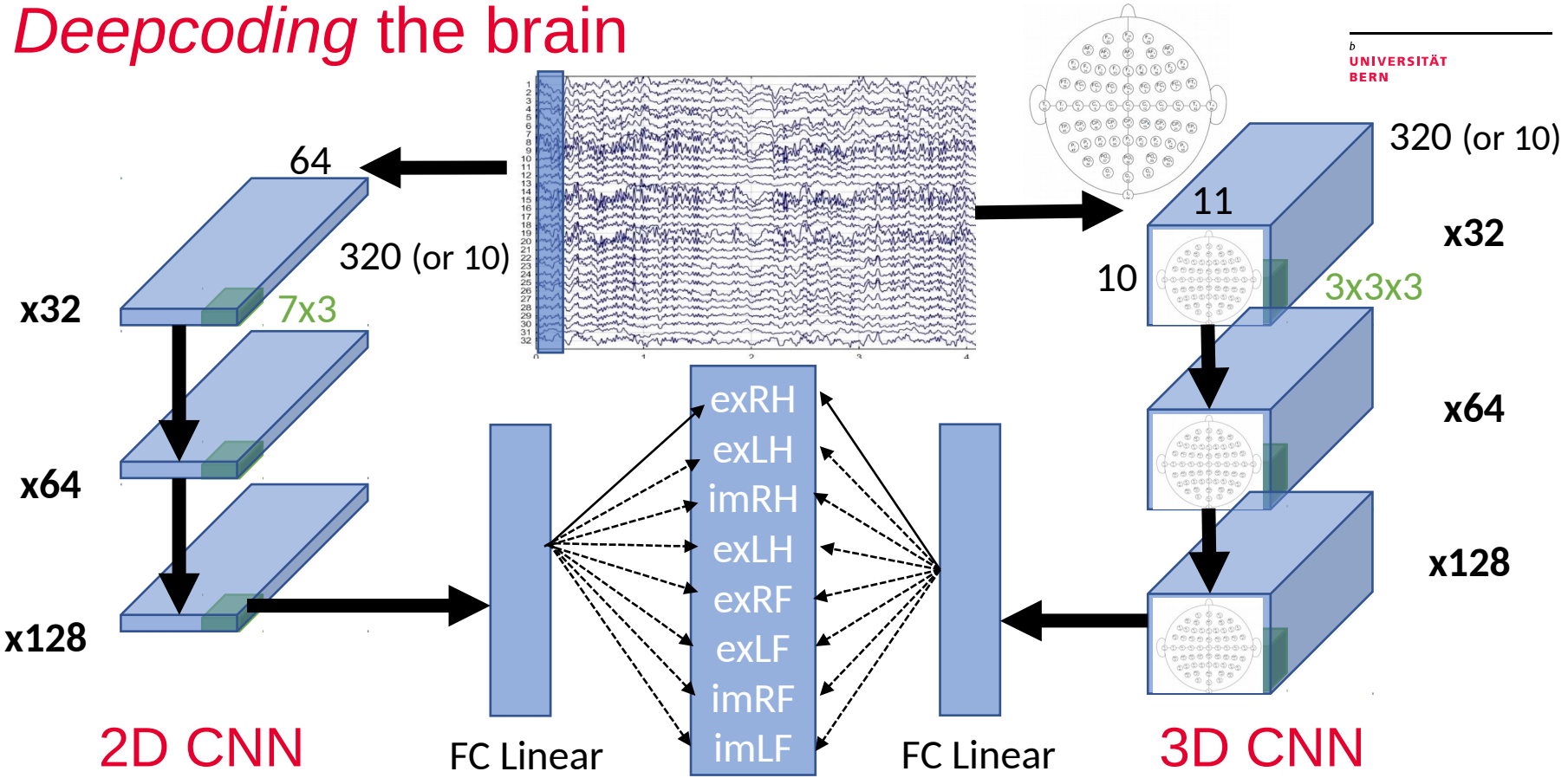
From Machine Learning to Deep Learning



Yannick et. al. (2019), arXiv:1901.05498

- Zhang et al. (2018), Advances in Knowledge Discovery and Data Mining
  - 20 subjects, 5 tasks
  - Sliding window (10 points, 50% overlap)
  - 3D-CNN + LSTM + RL
  - 93% accuracy
- Schirrmeister et al. (2017), Hum. Brain Mapp
  - Compared FBCSP, Deep and Shallow CNN in 5 task clasiffication
  - Best accuracy over datasets 93% in Shallow CNN

Deepcoding the brain



Adam optimizer

Results

Neural Network	Test Accuracy
3D-CNN cropped	76.5%
3D-CNN	26.94%
2D-CNN cropped	72.4%
2D-CNN	30.83%

Class	Test accuracy
Exec. Left Hand	75%
Exec. Right Hand	80%
Imag. Left Hand	77%
Imag. Right Hand	73%
Exec. Both Hand	79%
Exec. Both Feet	75%
Imag. Both Hand	74%
Imag. Both Feet	77%

Critical Appraisal and Future Works

- Time cropping is a good strategy. Better frequency information integration.
- 3D-CNN outperforms 2D-CNN. Better spatio-temporal information exploitation.

And what now … ?

- Integrate RNN to capture global temporal aspects.
- Using transfer learning to exploit big Phisionet datasets for motor learning experiments.

Thanks for your attention!

Questions…?