UNIVERSITÄT BERN

Deep-learning Your Brain

Classification of movement execution and imagination using EEG signals

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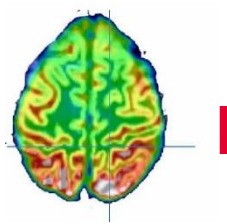
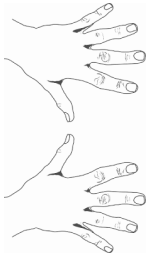
Classification of movement execution and imagination using EEG signals

What do we aim for?



OR



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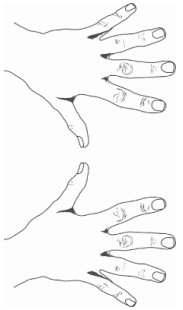
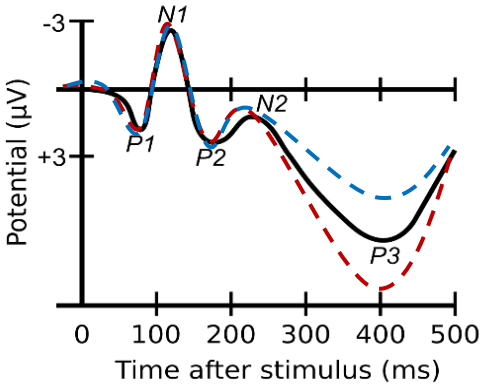


Why to read your mind?

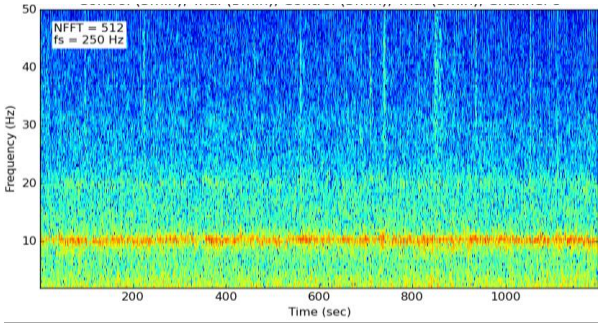
Current and future applications

How to understand people's intention?

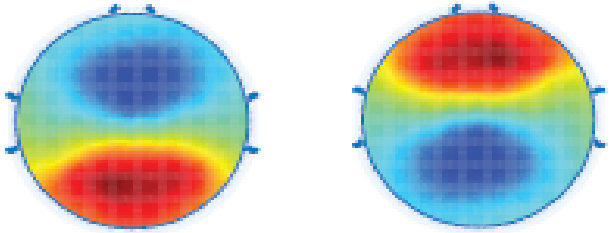
EEG Basics



Time Domain



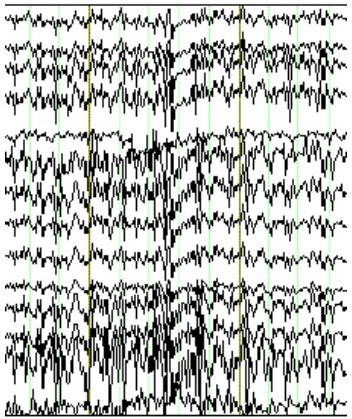
Frequency Domain

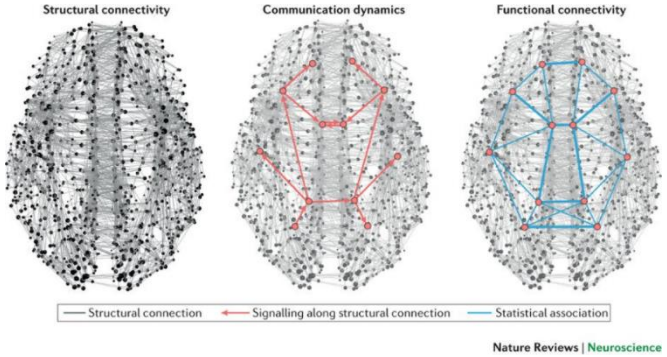


Spatial Domain

Each person, one world

Challenges in EEG analysis





Images:
Imagenet
>14 mio. Images

EEG:
Physionet BCI 2000
109 subjects, 64 electrodes,
7 different tasks

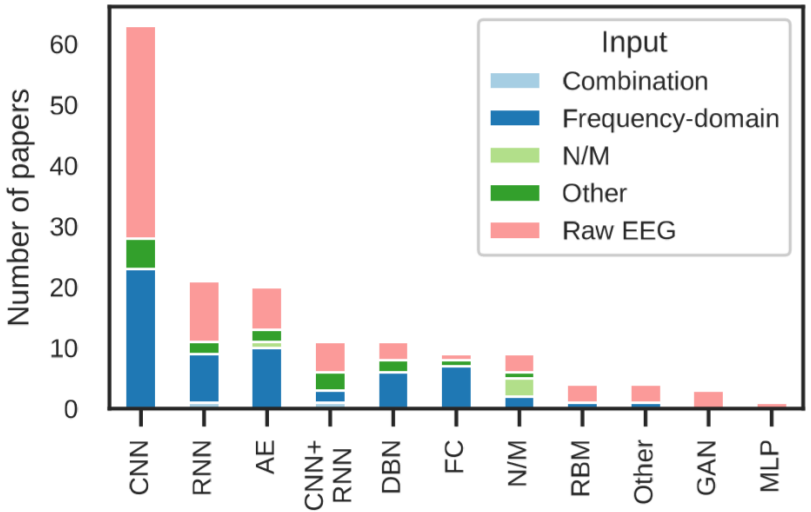
Artefacts

Complex neural processes

Limited Data

Prior attempts

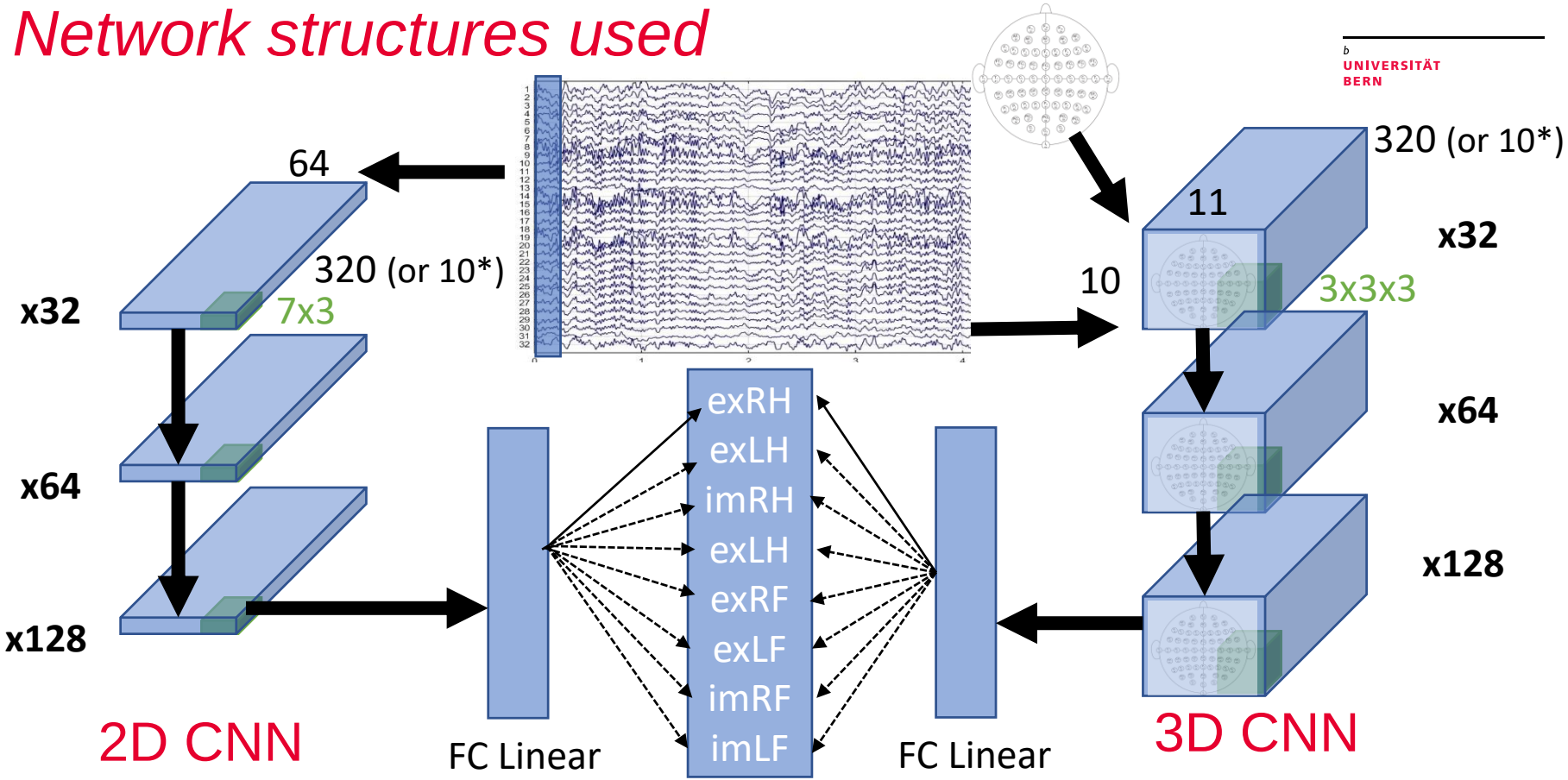
Classification on EEG Data



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

Network structures used



Adam optimizer, Cross Entropy Loss, *with Time Cropping, 20 Subj. (Zhang,2018)

Results

Neural Network	Test Accuracy
3D-CNN cropped	77.1%
3D-CNN	28.9%
2D-CNN cropped	73.1%
2D-CNN	32.2%

Class	Test accuracy
Exec. Left Hand	75%
Exec. Right Hand	78%
Imag. Left Hand	75%
Imag. Right Hand	76%
Exec. Both Hand	80%
Exec. Both Feet	76%
Imag. Both Hand	76%
Imag. Both Feet	77%

Discussion and Future Works

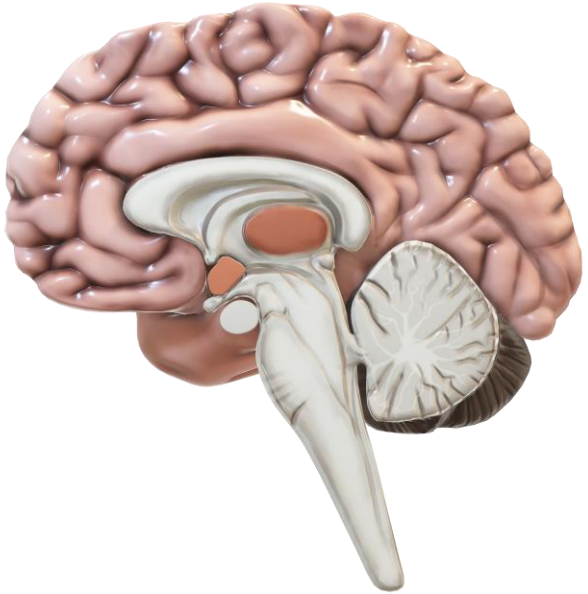
- Time cropping is improving performance. Better local temporal information (high frequency), in exchange of slowly changing global temporal change information.
- 3D-CNN outperforms 2D-CNN due to exploitation of spatial information.

Future Steps:

- Integrate RNN to capture global temporal aspects (Zhang, 2018).
- Using transfer learning to exploit big Phisionet dataset for motor learning experiments with robots.

Thanks for your attention!

Questions…?



Take part in our motor learning experiments ;)
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