Terabyte Scale Analysis of Neural Signals with MDCS

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Outline

• Measuring neural signals

• Big data neuroscience

• Results

• Why MATLAB
Measuring Neural Signals

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<th>LFP</th>
<th>ECoG</th>
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- SUA / MUA: size of neuronal cluster: high, >100,000
- LFP: spatial resolution: low
- ECoG: invasive: non-invasive
- MEG & EEG: non-invasive

Tangermann et al., Front. Neurosci., 2012
Measuring Neural Signals

Recording from single neurons fails in <6 months

Sexana et al., *Biomaterials*, 2013
Electrocorticography
Electrocorticography
Clinical Applications

Can record epileptic seizures with high spatial and temporal resolution
Clinical Applications

Can record voltage changes related to movement

NeuroVista Study

Cook et. al, *The Lancet*, 2013
15 Patients

16 Electrodes

400 Hz

0.5 – 3 years

Big Data Neuroscience
Big Data Neuroscience

• Usually analyse data ~1-2 weeks in duration
• How do we distribute/access 3 years of data?
• Managing international collaboration
• Big-data processing
Welcome!

IEEG.Org is a collaborative initiative funded by the National Institutes of Neurological Disorders and Stroke. This initiative seeks to advance research towards the understanding of epilepsy by providing a platform for sharing data, tools, and expertise between researchers. The portal includes a large database of scientific data and tools to analyze these datasets.

You can also:

- Sign up
- Download Toolbox
- Read Documentation

Highlighted Links

- Coregistration
- IEEG.org Tools on GitHub
iEEG.org

- Cloud-based platform for sharing EEG/ECOG data
- Fully integrated with MATLAB through downloadable toolbox
- No need for large scratch space
MATLAB Distributed Computing Server

- University of Melbourne has a 256 worker MDCS (most desktops have 4 workers)
- Can be used with most common schedulers
Parallel Computation

- Data takes form of:
  Patient (15) x electrode (16) x time (2min epochs)

```matlab
for iPatient = 1:NumPatients
  for iElecrode = 1:NumElectrodes
    parfor = 1:NumEpochs
      %Load required data
      %Take spectrogram
      %Save data
    end
  end
end
```
Results
Results
Clinical Significance

• Electrodes have stable recording characteristics

• Recordings have suitably high bandwidth for range of applications
Statistics in MATLAB

- Group level statistics done with Linear Mixed-Effects Model – `fitlme`

- Useful for linear regression of groups of data (patients x electrodes)

- Outputs linear fit \( y = mx+c \) with confidence interval
(and of course all the data figures where made with \texttt{plot} or \texttt{imagesc})
Why MATLAB for Big Neuroscience?

1. Load data segment from portal
   - IEEG.org cloud data storage

2. Process segment & save output
   - MDCS & Parallel Computing Toolbox

3. Statistics & Data Exploration
   - Statistics & Machine Learning Toolbox

4. Visualisation
   - Plot, image etc

5. Reporting
Thanks for listening!

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Links

- https://www.ieeg.org/
- https://bitbucket.org/ieeg/