

Grid Computing for Electrophysiology

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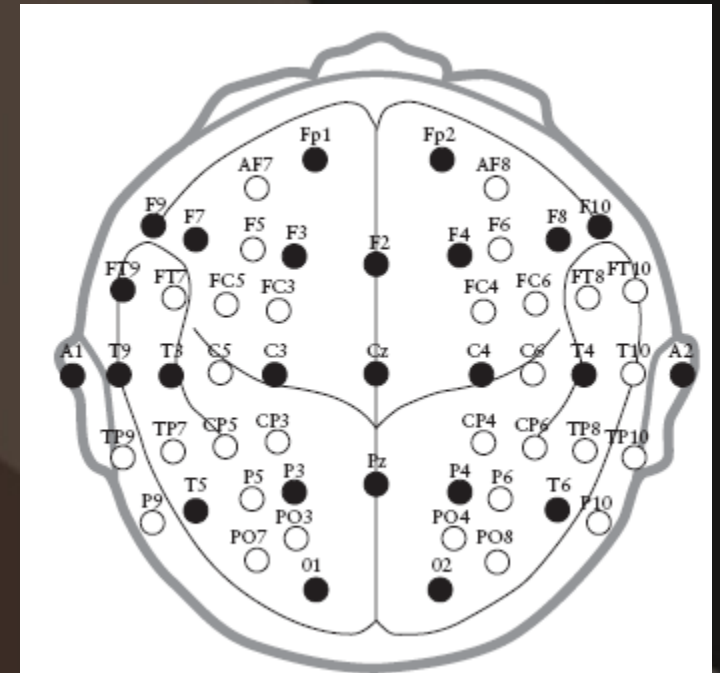
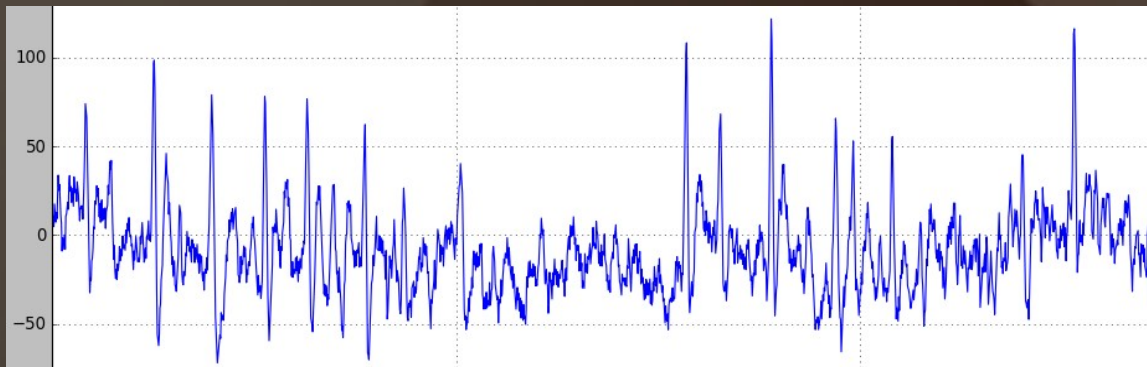
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Introduction

- Electroencephalogram analysis for Epilepsy diagnosis and treatment
- Outline
 - Electroencephalography
 - Epilepsy
 - Centrottemporal spikes
 - Problem
 - Solution using Grid

Electroencephalography

- EEG is the recording of electrical activity along the scalp produced by the firing of neurons within the brain
- Electrodes record activity of neuron regions
- Multiple channels (10 – 128)
- May last hours
- Artifacts
- Epilepsy diagnosis and treatment

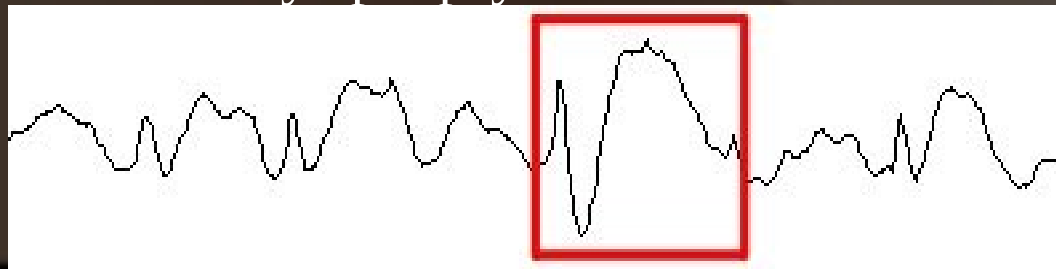


Epilepsy

- Epilepsy is the tendency to experience repeated seizures, which stem from activity originating in the brain
- Over 40 different kinds
- Criteria for diagnosis:
 - Seizures
 - Spike activity in EEG
- EEG analysis is the cornerstone of epilepsy diagnosis!

Centrotemporal spikes

- Main criteria in epilepsy diagnosis
- High-voltage (100-microvolts to 300-microvolts) discharges
- Usually sharp spikes are followed by slow wave complexes
- May appear isolated or in clusters
- Interesting spike characteristics:
 - Sharpness
 - Duration (spike and slow wave)
 - Amplitude
- Not all spike are caused by epilepsy



Other EEG characteristics

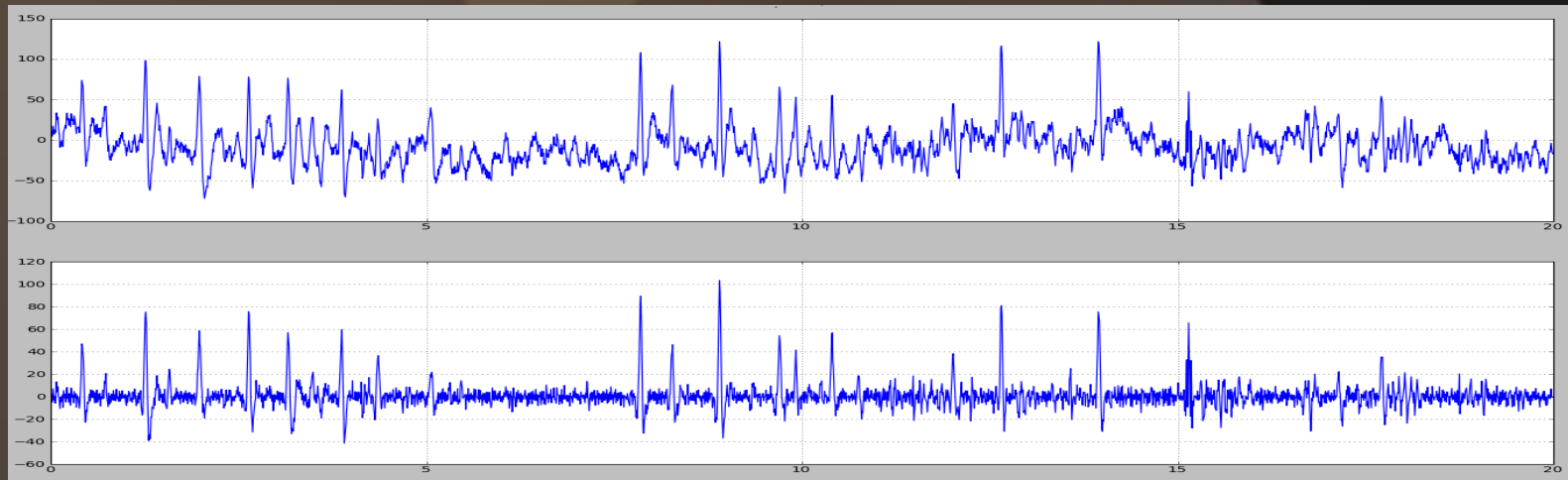
- Karolinska drowsiness score
 - How sleepy is the patient?
- Brain rhythms (alpha, beta, gamma, delta, theta) and their ratios
 - Brain wave classification based on frequency
 - Different patient states
- Spikes appear in different patient states (e.g. sleepy)
- All these calculations are done by hand!
- Takes a lot work and time!

Further investigation of EEG data

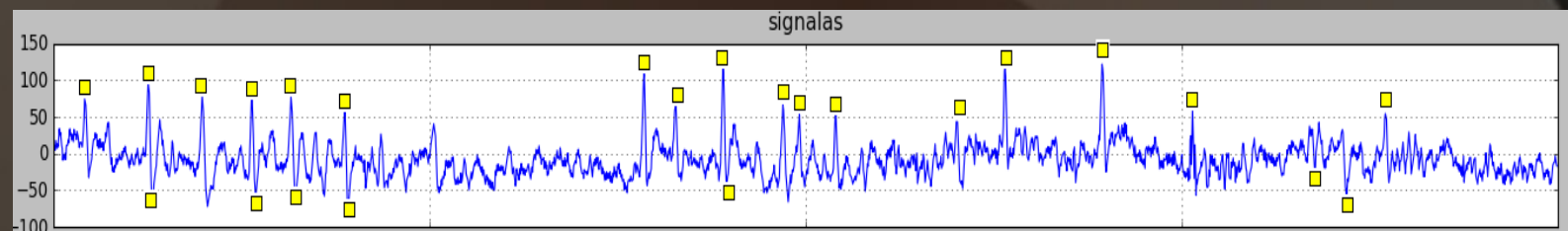
- A new score for drowsiness/sleepiness evaluation
- Correlation between spike activity and different brain waves
- Brain rhythm and spike morphology correlation to epilepsy type
- And much more...
- Requires a lot of computing power as well as large amounts of collected data

Automatic Spike detection

- Uses morphological filter proposed by Guanghua Xu and Jing Wang
- Signal is separated to transient and background activity



- Threshold is applied to determine spikes



Problem

- Calculations take a lot of time!

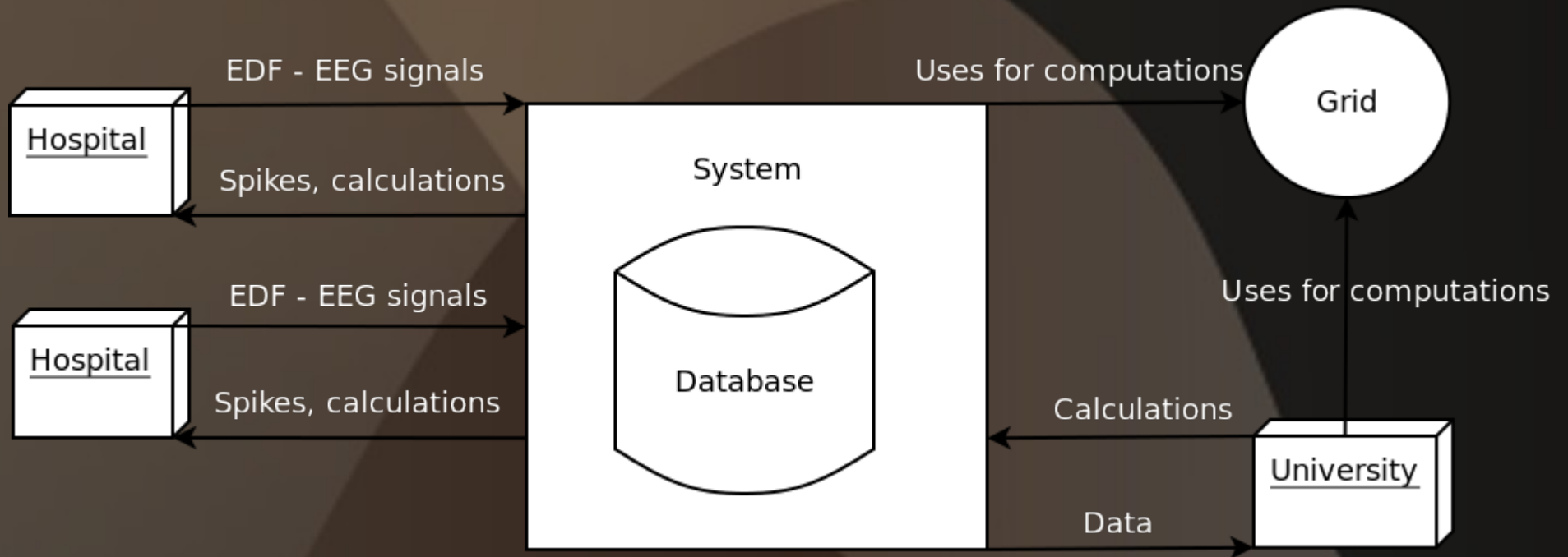
Processing 1 minute of one EEG channel takes around 30 seconds

- Average EEG recording duration > 1 hour
- Each recording ~ 20 channels

Hundreds of patients data to process.

- Artifact processing
- Additional investigation of EEG data using data mining methods requires large amounts of data as well as processing power!

The solution



Workflow

- Doctor submits EDF file to system
- EDF file is split into 20 s chunks and stored in the Database
- Grid is used to find Spikes, KDS, brain rhythms, ...
- Calculation results are stored in the database
- Researchers use this data and the computing resources of the grid to analyze data further (data mining algorithms)

Database design

- MongoDB[©] - document based DB
- EEG recording is split into 20s intervals for easier processing.
- Each document stores:
 - EEG signal
 - Tags
 - Derived data (spikes, KDS, brain rhythms, ...)
- Tags describe what derived data can be found in this document.
- Flexible design allows for addition of future data

Conclusions

- EEG processing requires a lot of processor power
Use the Grid!
- EEG database allows future research (using data mining algorithms)
Again the Grid is used for calculations
- Current work can be used in more general EEG analysis than epilepsy diagnosis and treatment

Questions?

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