Electrophysiological Signal Analysis and Visualization using Cloudwave for Epilepsy Data Research

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Outline of the talk

- Background: Electrophysiological Data Management
- Challenges: Big Data, Multicenter studies
- Cloudwave Framework: Features, Components
- Current Results
- Future Directions
Background

- What is Epilepsy?
  - Most common neurological disorder affecting 60 million worldwide

- How is Epilepsy detected?
  - Multi-modal Electrophysiological evaluations like EEG, EKG, BP, O₂ and CO₂, Sleep data, video
  - Electroencephalogram (EEG) is the gold standard for diagnosis and pre-surgical evaluation
Multi-center Clinical Study for Prevention and Identification of Risks in SUDEP Patients

Key Components
- MEDCIS
  Multimodality Epilepsy Data Capture and Integration System
- OPIC
  Online Patient Information Capture
- EpiDEA
  Epilepsy Data Extraction and Annotation
- Cloudwave
  Electrophysiological Signal “Big Data” on the Cloud
Cloudwave Features

- **Ontology-driven Web-based** Electrophysiological Epilepsy Signal Query, Visualization and Analysis Framework
- Provides **High Performance Cloud Computing** Infrastructure for handling Electrophysiological “Big Data”
Cloudwave Components

- Patients Cohorts are selected using the MEDCIS Query Builder
- Patient ID is linked to Cloudwave Signal Viewer

All studies and the related seizure events for the patient can be viewed using Cloudwave interface.
Components (contd.)

- Selection of Patient Study, Montage, Signal/Channels for display
- Facilitate creation of new montages (referential and bipolar)
Components (contd.)

- **Selection of Seizure Events/Annotations**
  - Mouse zooming to time-range of interest
  - Exporting as image and printing

![Diagram showing selection of seizure events and annotations.](image)

- a) Event drop down menu, user can select multiple.
- b) Events denoted on the signals. User can also highlight areas of the signals to zoom in.

Visually navigate using scroll to select time-range.
Components (contd.)

- Selection of Filters – Sensitivity, HF Filter and Time Constant

- **Sensitivity**
  - Available Filters: 1 uV, 5 uV, 10 uV, 20 uV, 40 uV, 60 uV, 120 uV

- **Time Constant**
  - Options: 0.1 s

- **High Frequency Cutoff**
  - Option: 70 Hz

- **Before Filter**
  - Sample signal before the selection in b) was made.

- **After Filter**
  - Sample signal after the selection in b) was made.
Future Directions

- Electrophysiological “Big” Signal Data Storage on HDFS by collecting similar signals for correlation and quantitative signal analysis using MapReduce distributed processing
  - *Cloudwave*: Distributed Processing of “Big Data” from Electrophysiological Recordings for Epilepsy Clinical Research Using Hadoop, AMIA 2013 (accepted)

- Computation of complex Signal Processing algorithms – Cardiac Arrhythmia, Respiratory Arrhythmia and related measurements for real-time rendering on Cloudwave web interface (work in progress)
Take home points

- PRISM is **NIH funded, multi-disciplinary and multi-center** (4 participating centers) – recruiting 1200 patients
- Cloudwave **establishes the capability for comprehensive comparative studies** of SUDEP and near-SUDEP cases vs. cohort survivors
- Cloudwave is a key component of PRISM project–facilitate the **management of Electrophysiological “Big” Data and Real Time Web Rendering of Multimodal signals**
- For more details, please visit: [http://prism.case.edu](http://prism.case.edu)
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