AI in Epilepsy: 2024
Source Localization

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Role of Epilepsy Surgery

• 1/900 kids have medically refractory epilepsy; they wait until Adult epilepsy conference to be presented?

• Goals of presurgical evaluation:
  • Is patient a “good candidate” for resection?
  • localize or at least lateralize the Epileptogenic Zone (EZ)
  • Identify functional areas and proximity to EZ
  • determine need/location of invasive monitoring (iEEG, SEEG)

• Goals of resection:
  • Seizure freedom or reduction in seizure burden
  • Spare eloquent cortex as much as possible
  • Disrupt/reverse developmental arrest or regression, to improve long-term developmental outcome
Pediatric Epileptologists

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Epilepsy is a disorder of Brain Networks

Resting state signal latency predicts laterality in pediatric medically refractory temporal lobe epilepsy

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Role of Resting State MRI Temporal Latency in Refractory Pediatric Extratemporal Epilepsy Lateralization

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FIGURE 1: Two exemplary lesionectomy case preoperative latency analysis images qualitatively compared with postoperative structural MRI. Patient #8 underwent a left superior frontal lesion resection. Patient #31 underwent a left frontal polar resection. Type I error $\alpha_c = 0.001$ cutoff was used in both patient latency images. Blue voxels are significantly early and red voxels are significantly late.
A comparison of machine learning classifiers for pediatric epilepsy using resting-state functional MRI latency data

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Receiver operating characteristic curves

- XGBoost: AUC: 0.79
- SVM: AUC: 0.66
- Random forest: AUC: 0.73
GIGO (XKCD)

This is your machine learning system?

Yup! You pour the data into this big pile of linear algebra, then collect the answers on the other side.

What if the answers are wrong?

Just stir the pile until they start looking right.
Source Localization with Brainstorm
Analysis Overview

**Data Importing**
1) Import subject anatomy
2) Align MEG data with anatomy
3) Extract epileptic MEG activity

**Source Localization**
1) Generate head model from subject anatomy
2) Compute sources
3) Model sources as dipoles
Data Import: *Subject Anatomy*

- Load Freesurfer segmentations into Brainstorm.
Data Import: *MEG Data*

- Import & anatomically co-register MEG data.
  - *Sensor position (A)*
  - *Recordings (B)*
  - *Epileptic spike annotations (C)*
  - *Use first 10s for noise estimation (D)*
Source Localization: *Head Modeling*

- Approximate brain, skull, and scalp as series of overlapping spheres. *(A)*

- Approximate source space as 3D grid of vectors dispersed throughout brain *(B)*
Source Localization: *Source Computation & Dipole Production*

- Evaluate source space for activity during epileptic events.
- Estimate dipoles that best fit the source space during epileptic events.
Final Product (spatial and temporal clustering)
Future Directions

• More Sophisticated Clustering
  • AI
• More Data
• More Outcomes
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