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# Automated Classification of Epileptogenic Zone

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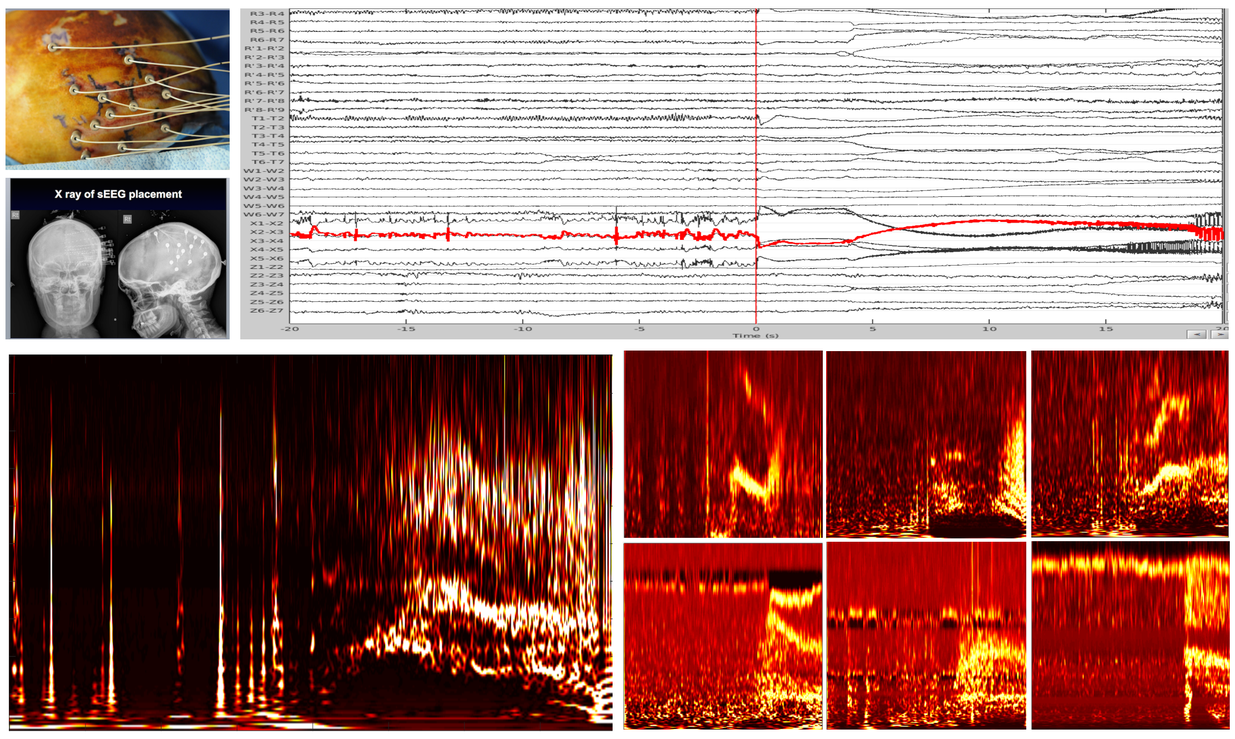
## Motivation & Introduction

- Epilepsy is a neurological disorder of the brain that affects approximately 50 million people around the world
- More than 30% of those patients suffer from refractory focal epilepsy where regular anti-epileptic drugs fail to take effects
- Surgical resection of the epileptogenic zone (EZ) can be an effective treatment for curing refractory focal epilepsy but 50% are not seizure free after surgery
- Successful post-operative outcomes strongly rely on an accurate localization of the EZ
- Time-frequency decomposition from SEEG recordings provides a unique insight into the characteristics of EZ
- An automated classification of EZ from non-EZ regions is highly desired and could have a significant impact on success rate of surgical resection for epilepsy



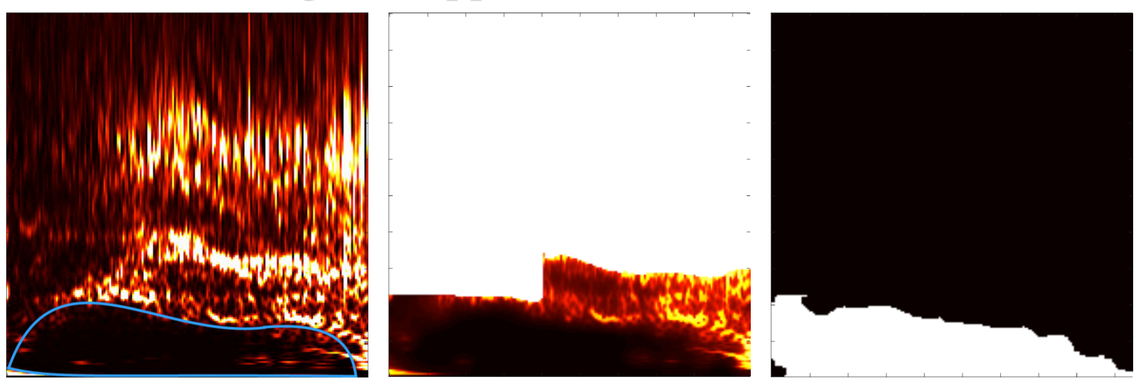

## Data & Subject Profiles

| Subject # | Age (years) | History (years) | # of Seizures | MRI Result | Follow up (months) | Engel Outcome |
|---|---|---|---|---|---|---|
| 1 | 43 | 37 | 3 | FCD | 13 | 1A |
| 2 | 29 | 22 | 3 | N | 36 | 1A |
| 3 | 33 | 17 | 3 | Hippocampus | 7 | 1A |
| 4 | 17 | 8 | 3 | N | 16 | 1A |
| 5 | 16 | 1 | 3 | Benign PPG | 26 | 1A |
| 6 | 46 | 41 | 3 | FCD | 29 | 1A |
| 7 | 5 | 1 | 3 | N | 21 | 1A |
| 8 | 63 | 14 | 3 | N | 38 | reoccur 2ys |
| 9 | 33 | 19 | 3 | Gliotic | 12 | 1A |
| 10 | 21 | 11 | 3 | N | 9 | 1A |
| 11 | 32 | 27 | 3 | FCD | 64 | 1A |
| 12 | 22 | 3 | 3 | FCD | 30 | 1A |
| 13 | 19 | 18 | 3 | N | 48 | 1A |
| 14 | 30 | 18 | 3 | N | 47 | 1A |
| 15 | 20 | 11 | 3 | N | 58 | 1A |
| 16 | 65 | 25 | 3 | N | 27 | 1A |
| 17 | 65 | 9 | 3 | N | 18 | 1A |

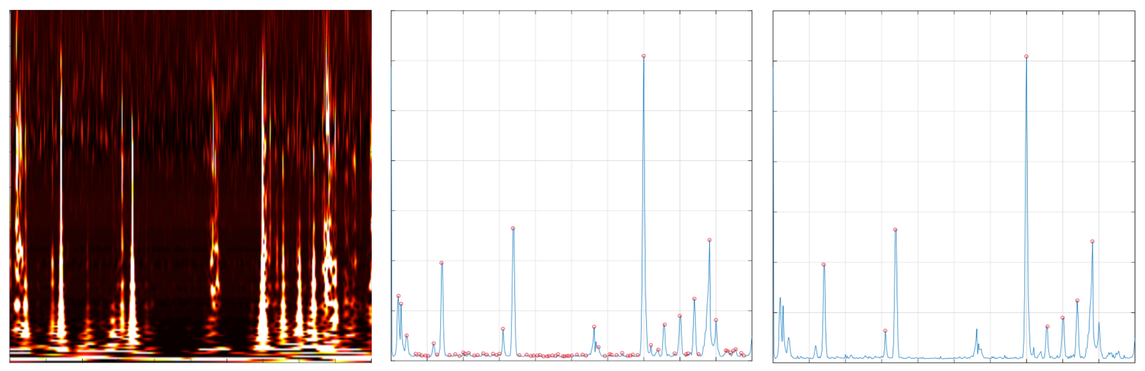
## Method & Pipeline

- SEEG recordings are transformed into time-frequency (TF) plots using Morlet wavelet
- Artifacts are identified and removed via complex Independent Component Analysis (cICA)
- Feature Extraction:
  - Fast Activity: A novel multiscale Frangi filter is proposed for extracting the fast activity mask

  - Suppression: TF plot is smoothed using the guided filter and a bounded thresholding is applied for extracting the suppression mask



  - Pre-ictal Spiking: candidate spikes are found by extracting local maxima of median (in frequency) of time-frequency data at each sample point



- Numerical descriptors are extracted based on the candidates found for each of the three features
- Unsupervised clustering is applied towards those descriptors in order to identify real EZ contacts so that the uncertainty of the resection labels can be handled properly
- A Support Vector Machine (SVM) is trained given those descriptors and labels on the selected channels
- A leave-one-out cross validation is used to avoid overfitting and obtain the prediction for each contacts
- A voting mechanism is utilized across 3 seizures for the final prediction for each subject

## Result & Discussion

| | Labelled EZ | Labelled not EZ | |
|---|---|---|---|
| Within Resect | 58 | 322 | |
| Outside Resect | 6 | 827 | 0.7% (FPR) |
| | 90.6% (PPV) | | |

- In this retrospective study, more than 90% of putative EZ contacts were within resected region for patients with successful (no seizures) surgical outcomes.
- Potential for use as tool for identifying potential resection targets based on invasive SEEG monitoring.

**USC Biomedical Imaging Group**
http://neuroimage.usc.edu/neuro

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