SEECOG: An Offline and Browser-based Tool for Visualizing Intracranial Electrodes and Multi-Modal Imaging Data

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Background

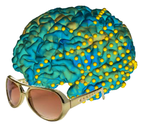
Viewing and interaction with multimodal data from intracranial EEG patients is challenging. We are developing a viewer that:

- Has an intuitive interface to visualize intracranial electrodes and multimodal data
- Runs on a web browser (no installation of additional software is needed)
- Has dynamic 3D rendering for easy adjustments of views
- Runs locally (no need for internet, no need to upload sensitive data to a server)
- Works on every operating system
- Does not require technical knowledge

Workflow

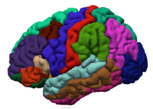
Data inputs:

Electrode localization



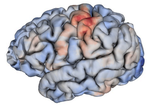
iELVis

Cortical reconstruction and parcellation



Freesurfer

Functional and anatomical overlays



fMRI, PET, Cortical Thickness etc.

Electrode attributes

ID	SOZ	Spike	Expressive Language	Receptive Language
LFp1	1	0	0	
LFp2	0	1	0	
LTx1	0	0	1	
LTx2	0	1	0	
LTx3	0	1	0	
LFa1	0	0	0	
LFa2	0	0	1	
LFa3	1	0	1	

Labels based on functional and clinical criteria

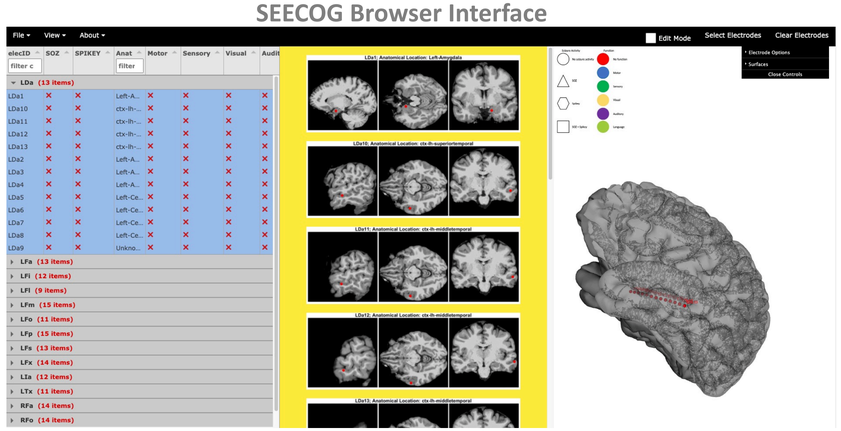
Javascript toolboxes

ami Medical Imaging Javascript Toolkit

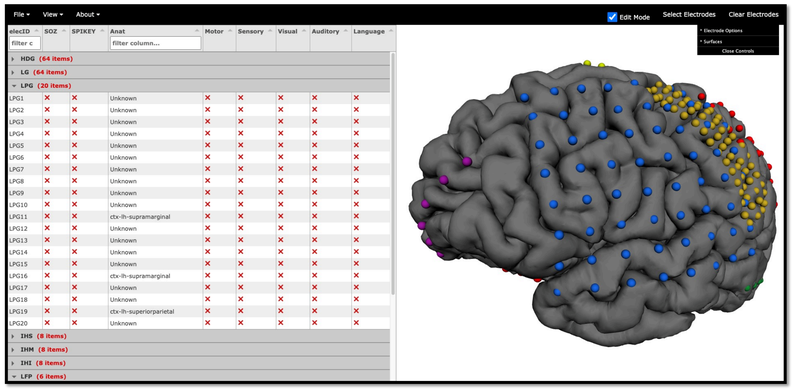
jsabulator

three.js

SEECOG Browser Interface

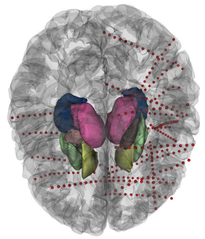


SEECOG Interface

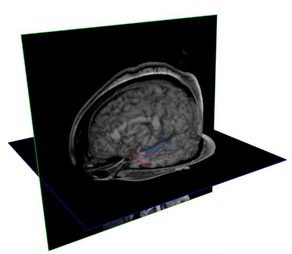


- Easy interactive, 3D display of both depths and subdural electrodes on the cortical surface and 2D-slices (see below)
- The electrode table allows to define multiple attributes to each contact

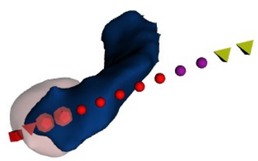
Render in 3D



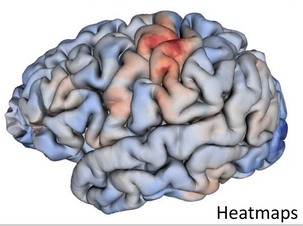
Glass brain



Oblique and planar 2D viewing



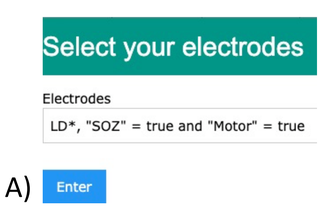
Display subcortical structures and adjust electrode colors and shapes



Heatmaps

- View volumetric images as well as Freesurfer reconstructed meshes
- Oblique and planar 2D viewing
- Enable viewing of subcortical structures
- Add heatmap overlays of functional and anatomical data (fMRI, PET, cortical thickness, atlas parcellations etc.)
- Change electrode features (colors and shapes) based on functional and clinical data (below)

Electrode Search bar and Selector



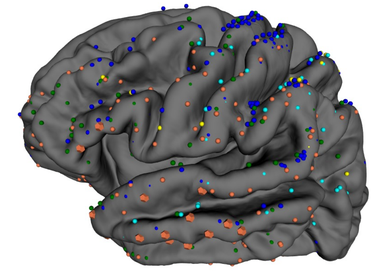
A)

SEECOG → X

B)

- Simple shorthand for querying and selecting contacts based on labels of annotations (A)
- Electrode Data can be exported for use in other programs (B)

Multi-Subject Plotting



Plot multiple patients on an average brain

Electrode Table

elecID	SOZ	SPIKEY	Anat	Motor	Sensory	Visual	Auditory	Language
LDa (13 items)								
LDa1	✓	✗	Left-A...	✗	✗	✗	✗	✗
LDa10	✗	✗	ctx-lh-...	✗	✗	✗	✗	✗
LDa11	✗	✗	ctx-lh-...	✗	✗	✗	✗	✓
LDa12	✗	✗	ctx-lh-...	✗	✗	✗	✓	✗
LDa13	✗	✗	ctx-lh-...	✗	✗	✗	✓	✗
LDa2	✓	✓	Left-A...	✗	✗	✗	✗	✗
LDa3	✗	✓	Left-A...	✗	✗	✗	✗	✗
LDa4	✗	✓	Left-A...	✗	✗	✗	✗	✗
LDa5	✗	✗	Left-Ce...	✗	✗	✗	✗	✗
LDa6	✗	✗	Left-Ce...	✗	✗	✗	✗	✗
LDa7	✗	✗	Left-Ce...	✗	✗	✗	✗	✗
LDa8	✗	✗	Left-Ce...	✗	✗	✗	✗	✗
LDa9	✗	✗	Unkno...	✗	✗	✗	✗	✗
LFa (13 items)								
LFi (12 items)								
LFl (9 items)								
LFm (15 items)								
LFo (11 items)								
LFp (15 items)								
LFs (13 items)								

Electrode Table with properties. Each property of an electrode can be edited.
Query electrodes across patients.

Summary

This intuitive browser-based tool to visualize multimodal data from iEEG patients can help groups to interactively visualize and discuss results of single patients we well as across a group of patients. Links to SEECOG and subject associated data can be created to compliment publications

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References:
[1] Fischl, B. (2012). FreeSurfer. Neuroimage.
[2] Groppe, D. M., Bickel, S.,... & Honey, C. J. (2017). iELVis: An open source MATLAB toolbox for localizing and visualizing human intracranial electrode data. Journal of NSc Methods.
[3] Bernal-Rusiel,... & Pienaar, R. (2017). Reusable client-side javascript modules for immersive web-based real-time collaborative neuroimage visualization. Frontiers in Neuroinformatics.