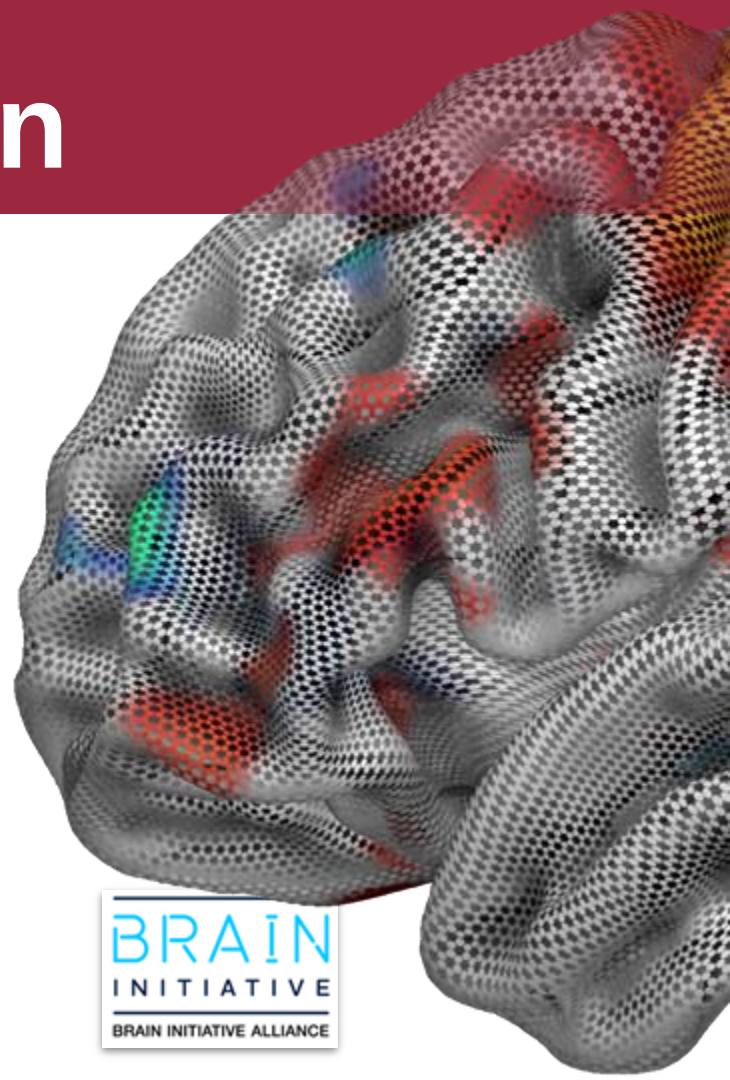
NiiVue Visualization

Chris Rorden
dcm2niix, MRIcro, MRIcron, MRIcroGL & Surfice creator

Chris Drake, Taylor Hanayik
niiVue Lead developers

Franco Pestilli, Dan Levitas
ezBIDS & brainlife.io developers

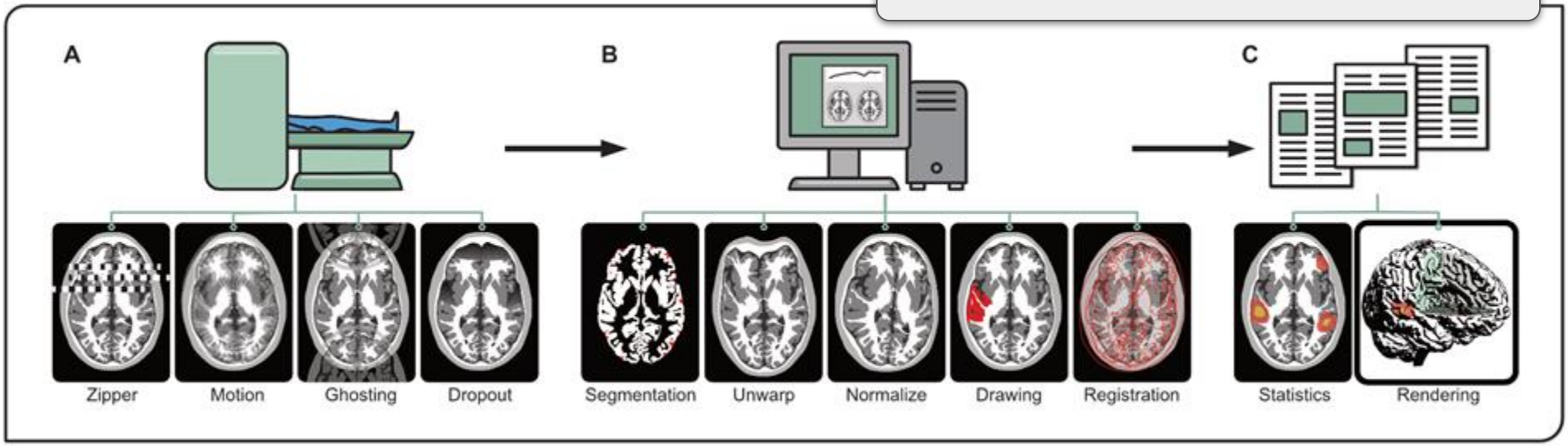


University of South Carolina
Center for the Study of Aphasia Recovery
NIH RF1-MH133701, P50-DC014664

Motivation

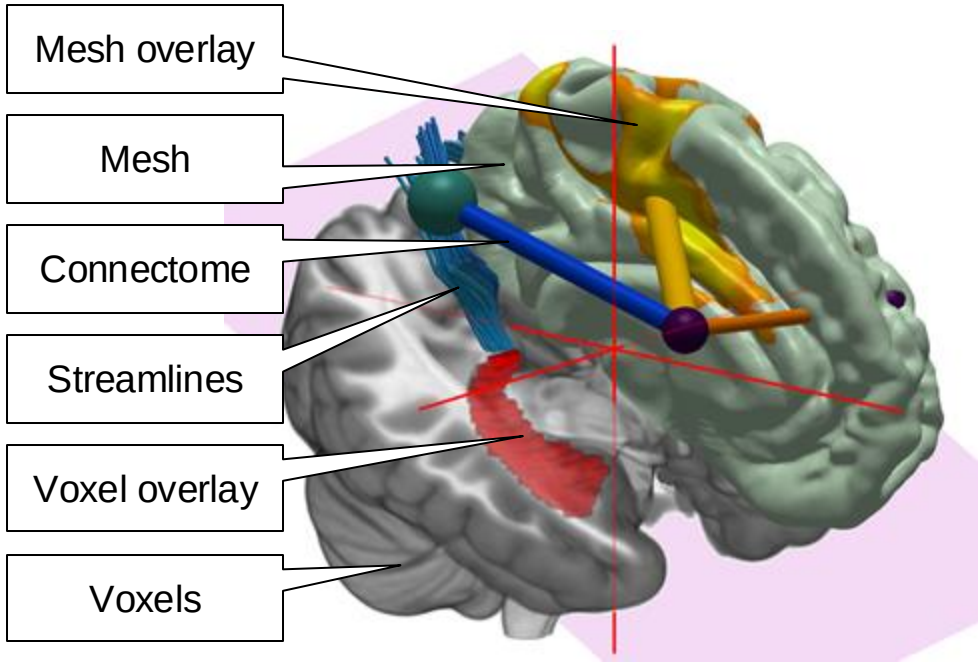
- Visualization crucial for all stages (acquisition, processing, inference and dissemination) of neuroimaging.
- Popular tools not web-capable and incompatible with each other.

MRI pipelines as self driving cars: generally robust but require human intervention to avoid catastrophic errors.



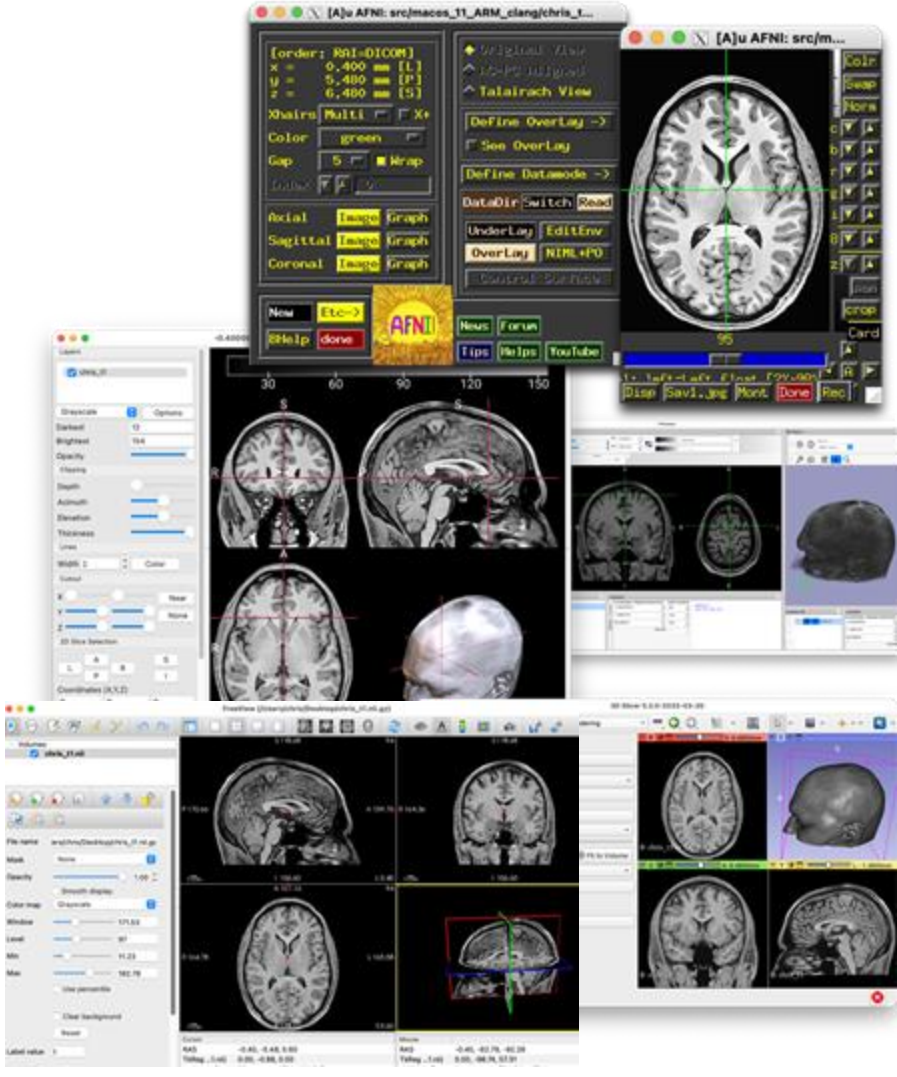
Need for Domain Specific Visualization

- Neuroimaging has (unique) formats.
- Voxels, meshes, gantry tilt, atlases, statistical maps, diffusion streamlines, connectomes.
- While most tools support some common formats (DICOM, NIfTI, GIFTI, TRX), most tools use proprietary formats.



Limitation of popular solutions

- Desktop-based:
  - Unsuitable for cloud or edge deployment.
- Complicated:
  - Overwhelming user interfaces.
- Inconsistent:
  - Different formats.
  - Skills don’t transfer easily.
  - Redundant maintenance efforts.



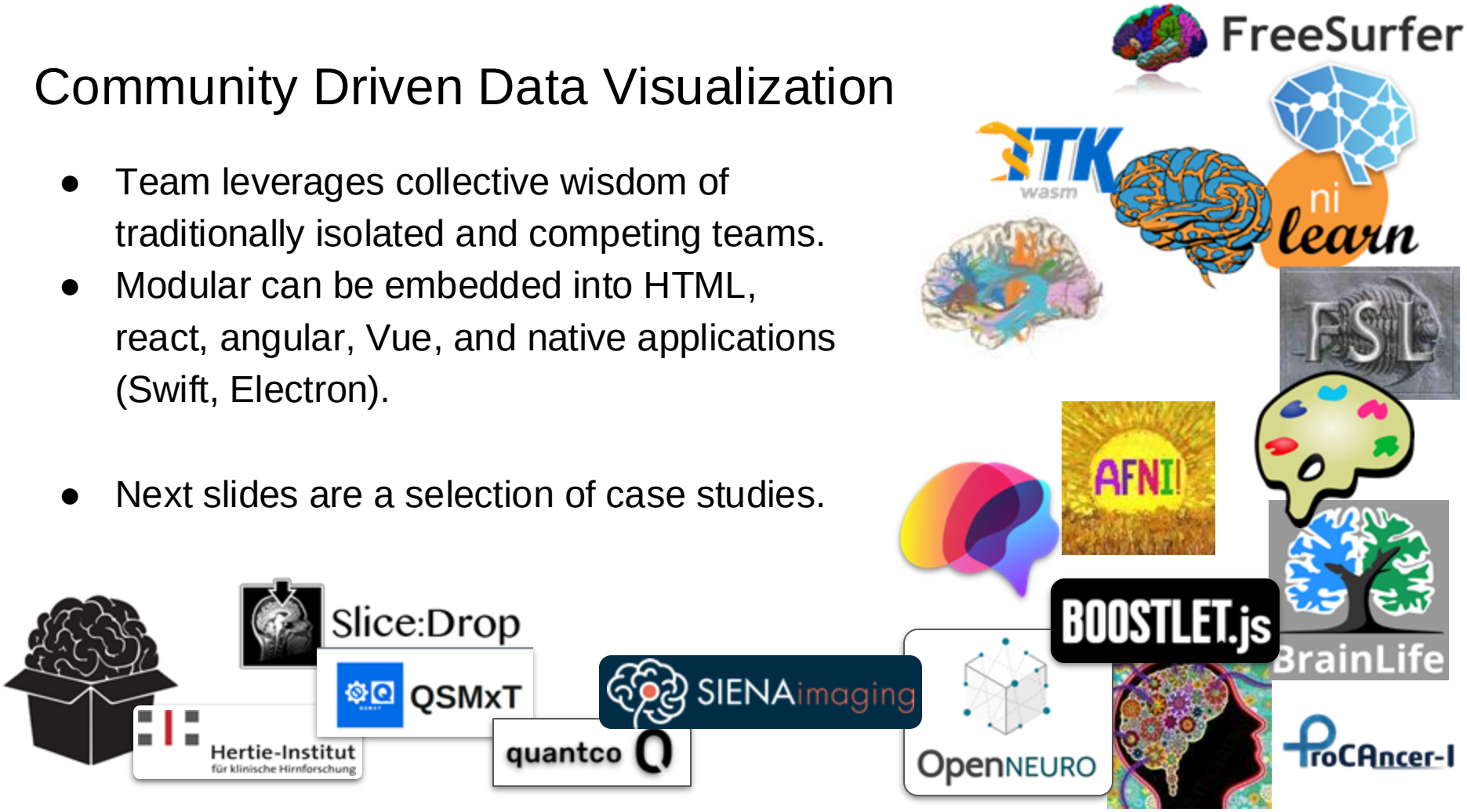
Vision: web-based neuroimaging visualization

- Zero footprint neuroimaging can democratize science, scale on demand.
- Support any devices:
  - Computer: General purpose.
  - Tablet: Drawing lesions.
  - Phone: QA for cloud processing.

Community Driven Data Visualization

- Team leverages collective wisdom of traditionally isolated and competing teams.
- Modular can be embedded into HTML, react, angular, Vue, and native applications (Swift, Electron).

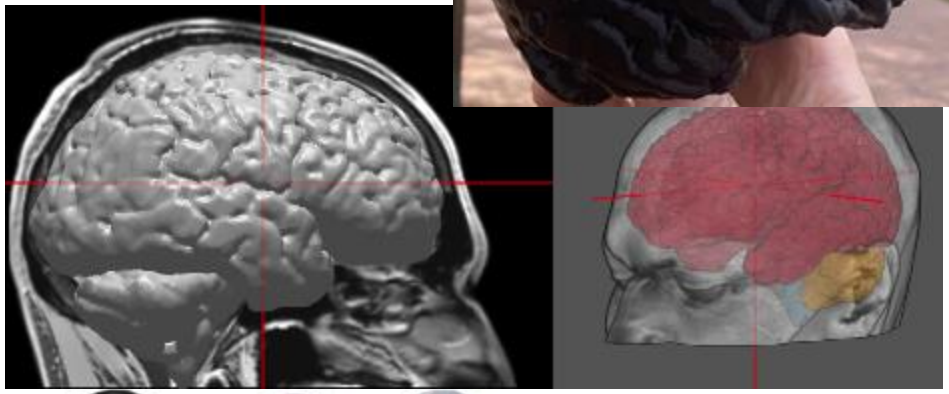
- Next slides are a selection of case studies.

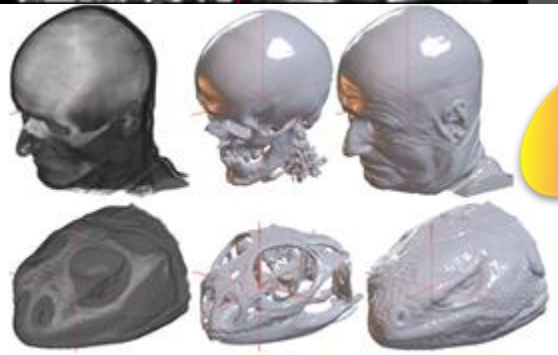


NiiVue in the wild 1 • brain2print.org

A tool to automatically segment MRI and send them to 3D printers

- brainchop models can segment the brain in seconds.
- our nii2mesh and niimath tools can be compiled to web assembly.
- Combine these for a drag-and-drop zero footprint solution to convert MRI scans to printable models in seconds.





PMID: 39301517

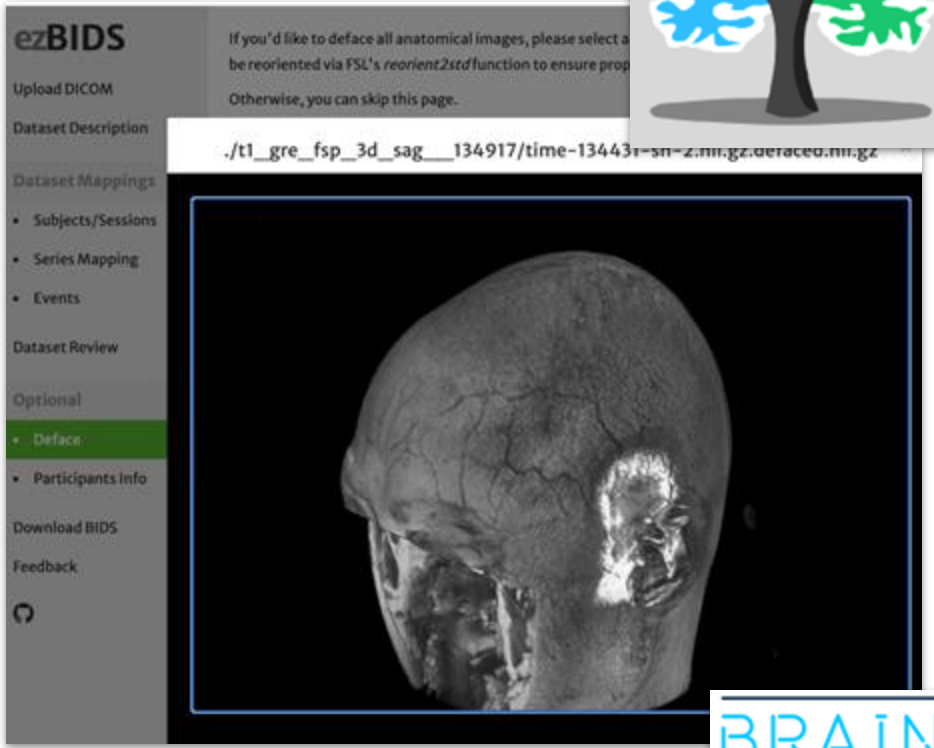
BRAIN INITIATIVE

BRAIN INITIATIVE ALLIANCE

NiiVue in the wild 2 • brainlife ezBIDS

A tool to guide users to standardize brain data

- Aid creation of BIDS datasets.
- Integrates our dcm2niix.
- Easy import to cloud processing (soon on edge).
- NiiVue volume rendering provides QA for defacing.



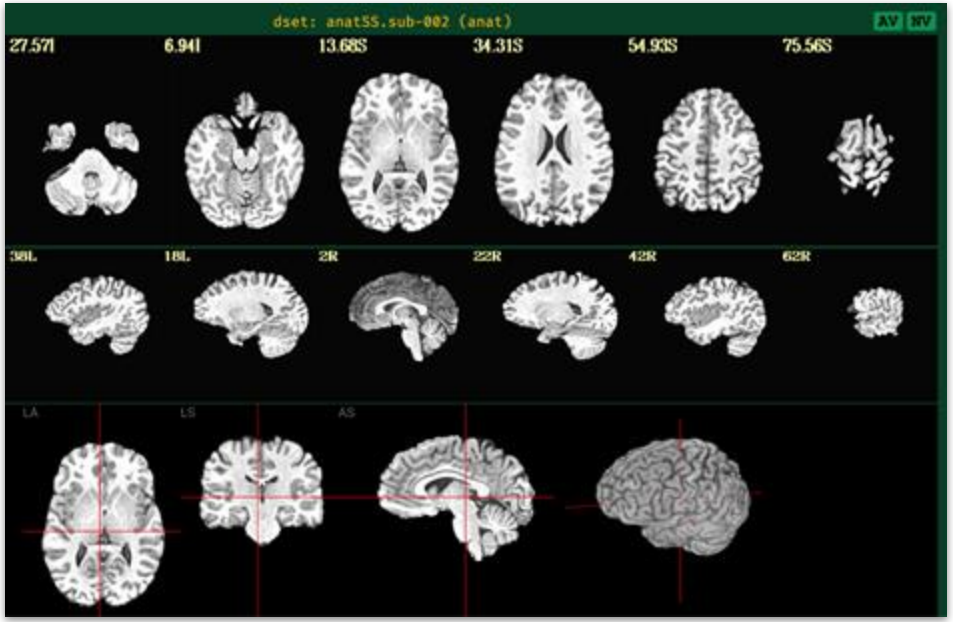
PMID: 3860511

NiiVue in the wild 3 • AFNI QC

Quality Control and Annotation

- Quality control (QC) integrated with AFNI framework.
- Live demo

  https://afni.github.io/qc-demo-repo/



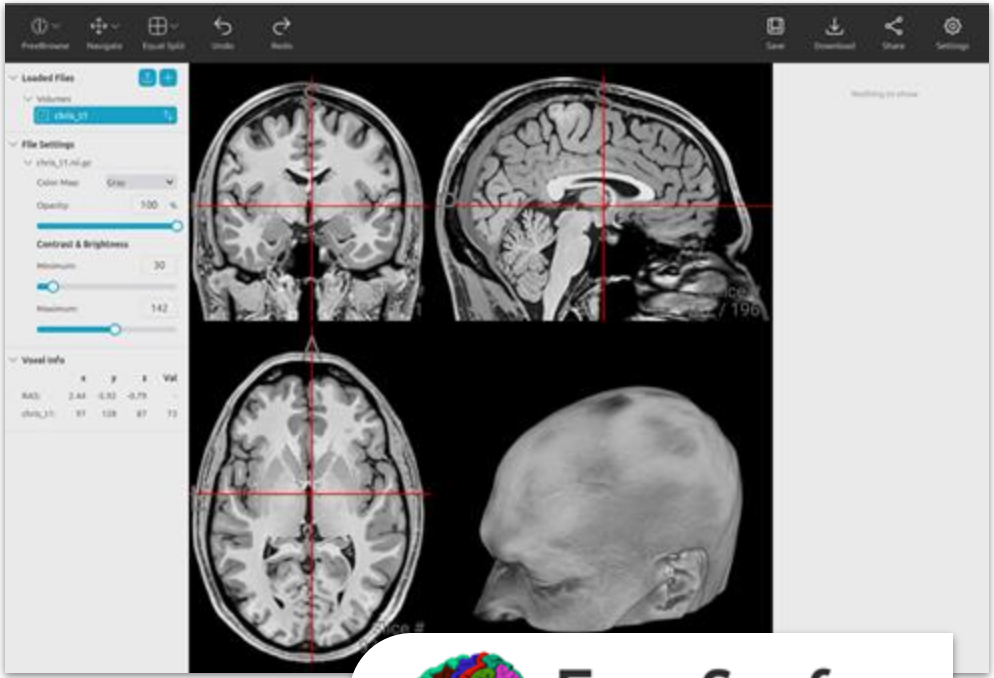
PMID: 39257641

NiiVue in the wild 4 • FreeSurfer FreeBrowse

View and edit FreeSurfer meshes and images

- Browser-based version of FreeSurfer's Freeview.
- Cloud capable, allowing integration with large and distributed backends.

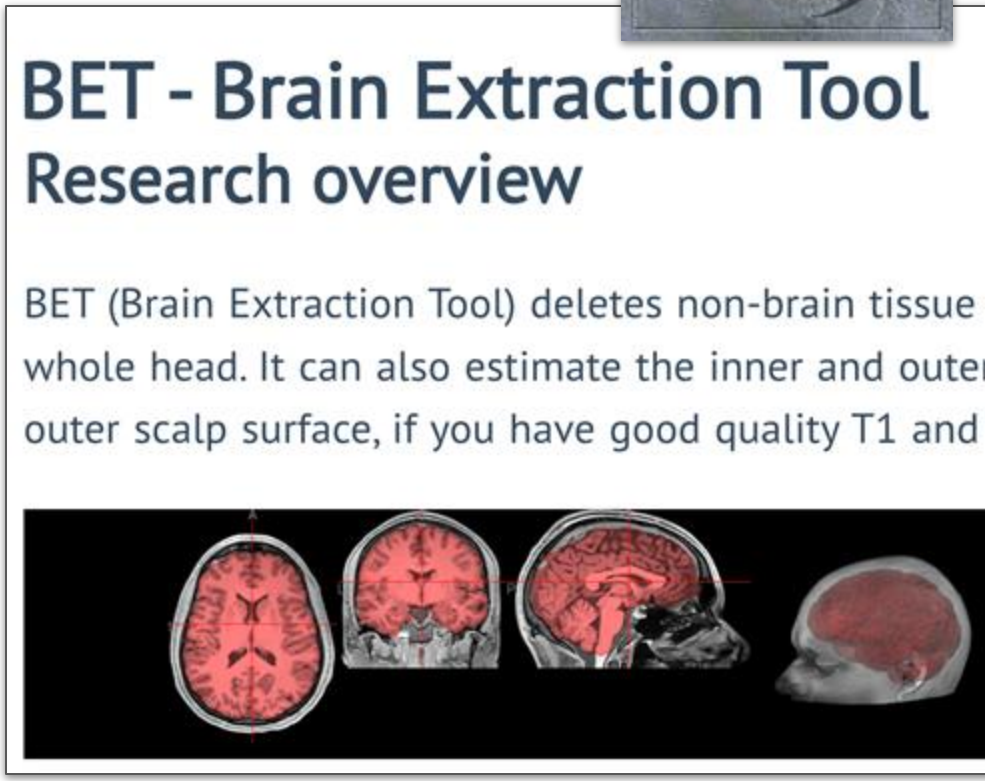
https://github.com/freesurfer/freebrowse



NiiVue in the wild 5 • FSL docs, FSL-UI

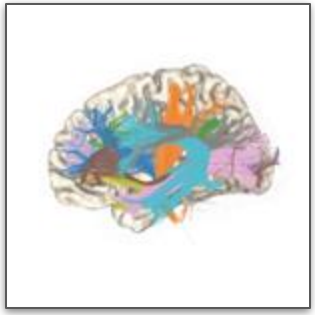
Interactive Documentation

- Interactive documentation.
- fslmaths, flirt, bet to WASM
- Replace proven but aging FSL TCL FEAT interface with interactive, high-DPI and web capable user interface.
    - Replaces bash scripting with modern Python scripts.



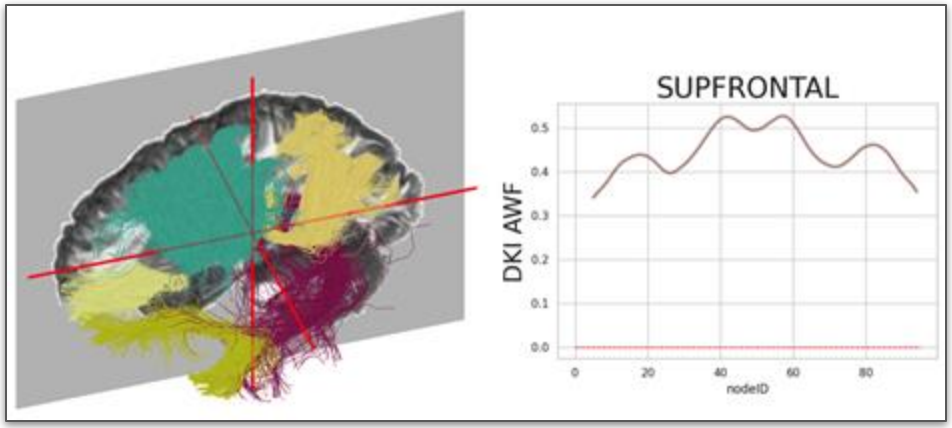
NiiVue in the wild 6 • nrdg tractoscope

A tool to explore preprocess white matter data



- browser-based visualization tool for qsiprep and pyAFQ datasets.
- Easy access to processed Healthy Brain Network and Human Connectome Project datasets.

- Live deployment: https://nrdg.github.io/tractoscope/



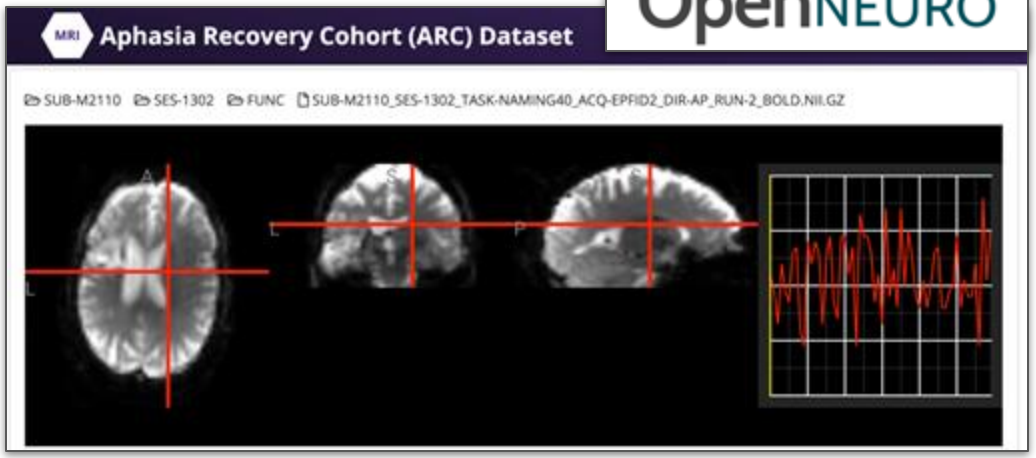
PMID: 38933816

BRAIN INITIATIVE
BRAIN INITIATIVE ALLIANCE

NiiVue in the wild 7 • OpenNeuro Viewer

A tool to visualize individual data files on OpenNeiro.org

- Integrated NiiVue allows users to interactively inspect each dataset.
- Live deployment
  https://openneuro.org/

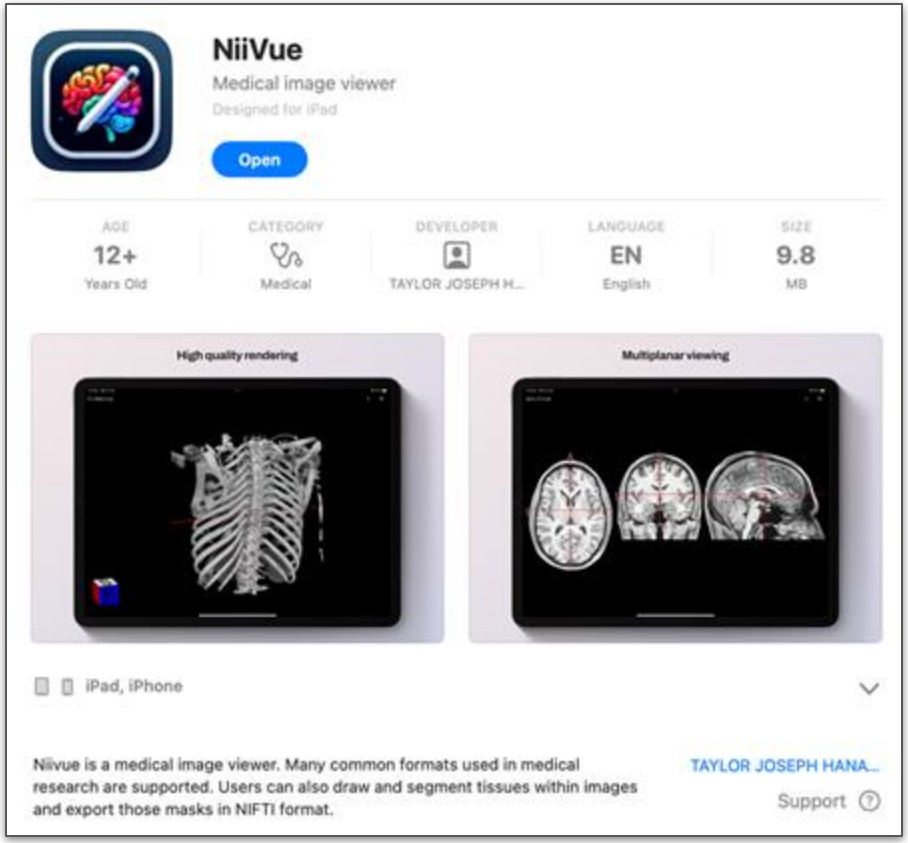


doi.org/10.1162/imag_a_00103

NiiVue in the wild 8 • iOS and MacOS app store

A desktop tool for viewing and editing neuroimaging data

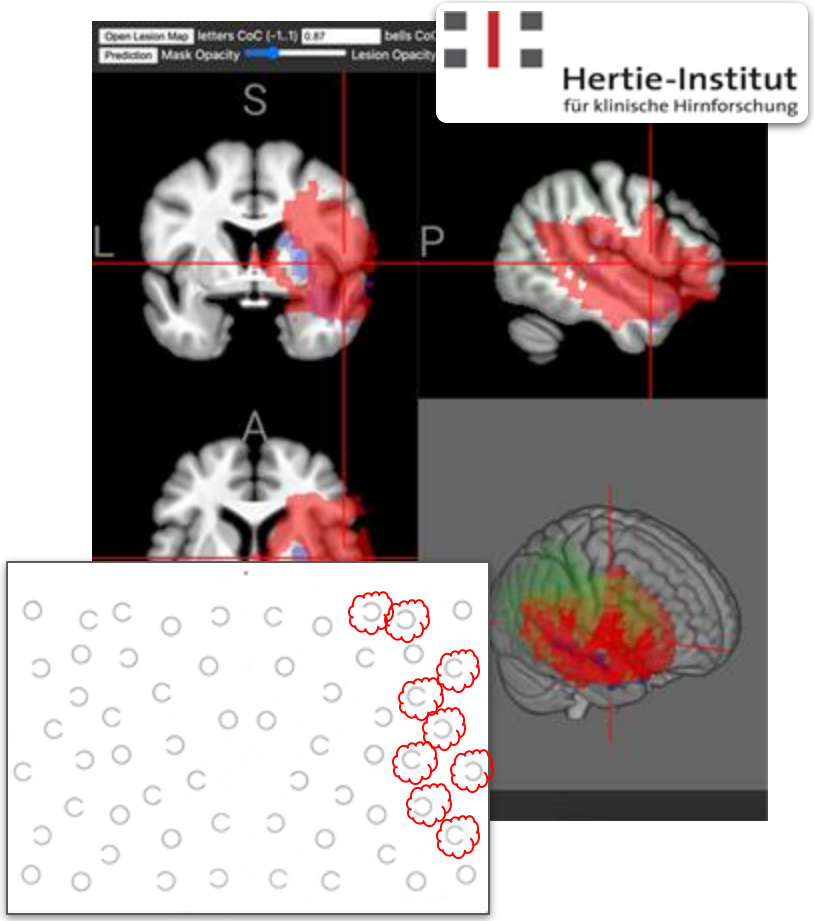
- Offline NiiVue with native user interface controls.
- Swift wrapper for webkit.



NiiVue in the wild 9 • Computer Aided Prognosis

A weblet to predict neglect recovery

- Stroke leading cause of disability.
- ~50% of right hemisphere strokes results in spatial neglect.
- While many recover, others left with long term disability.
- Stroke location and acute impairment can be used synergistically to predict outcome.
- Edge based solution allows clinical prediction without sharing data.

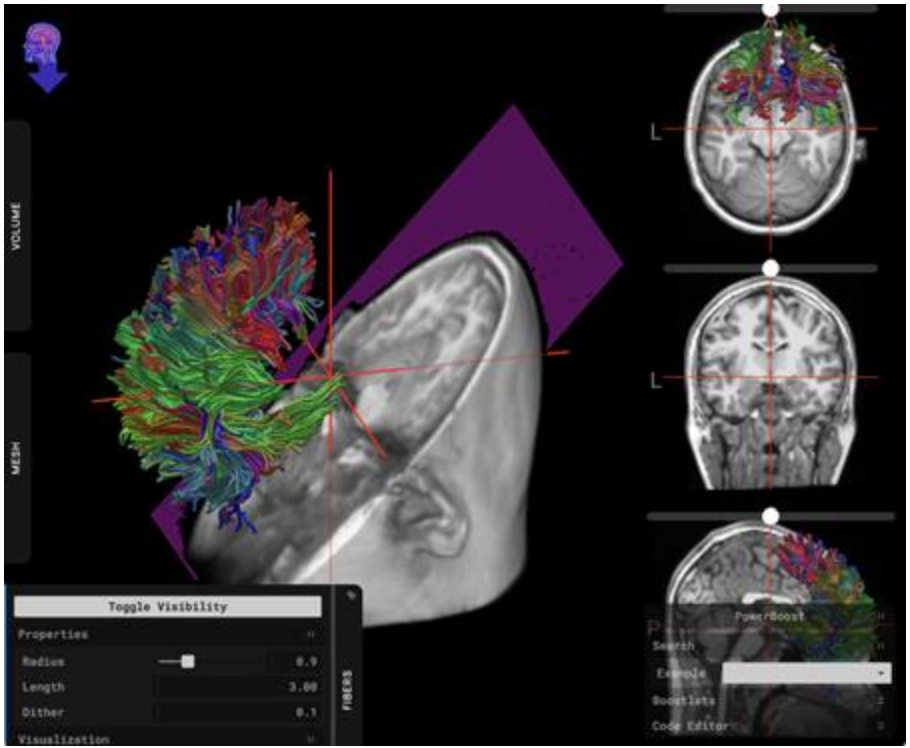


NiiVue in the wild 10 • Slice:Drop

Intuitive Medical Image Viewer

Slice:Drop

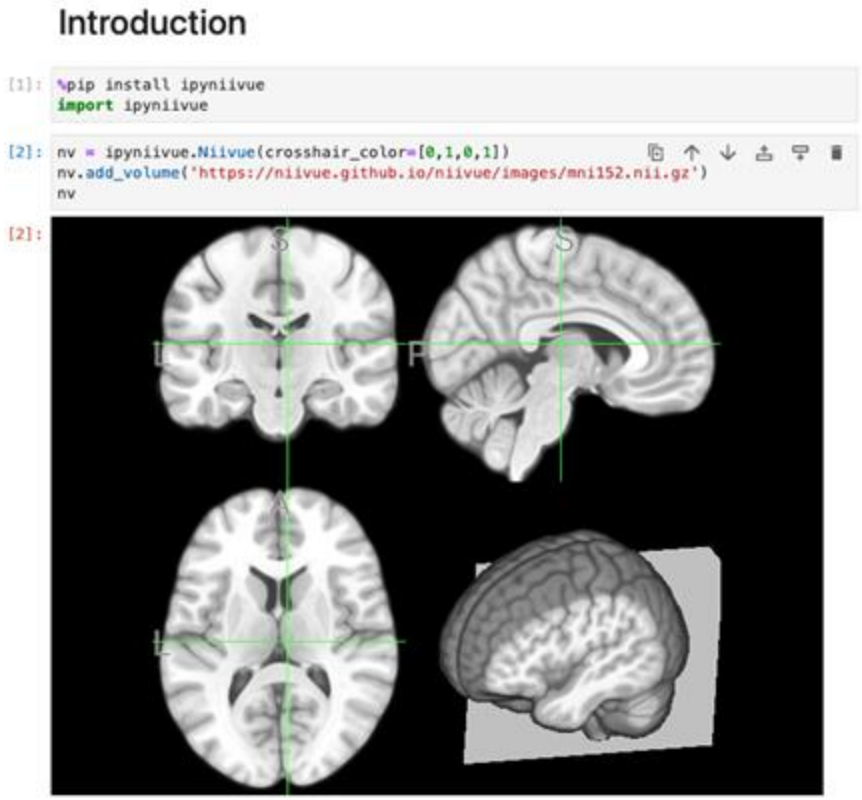
- 2013’s ‘Slice:Drop’ and its XTK library were seminal WebGL1 medical imaging tools.
- NiiVue-based ‘Slice:Drop reloaded’ unleashes WebGL2 capabilities with same intuitive interface.



NiiVue in the wild 11 • ipyniivue

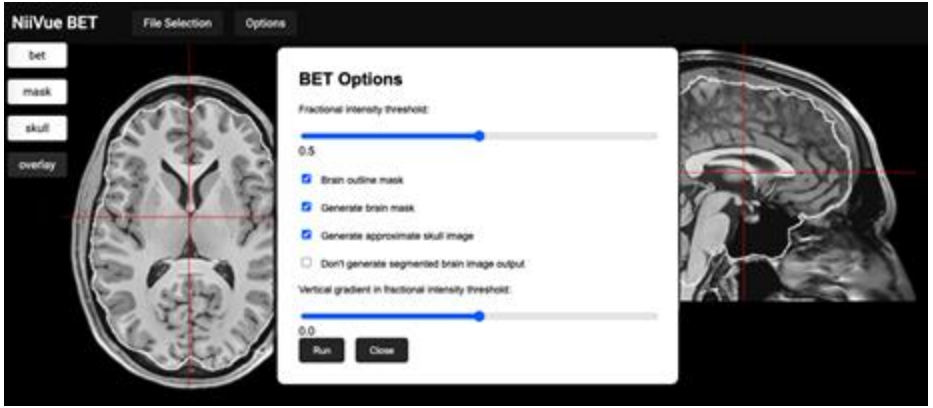
Neuroimaging visualization for jupyter notebooks

- Python notebooks empower scientists.
- Jupyter graphics must use web technologies.
- Vision: pythonic interface for NiiVue.
- Work In Progress. Actively seeking developers.



Feature plugins: proven modules to extend capabilities

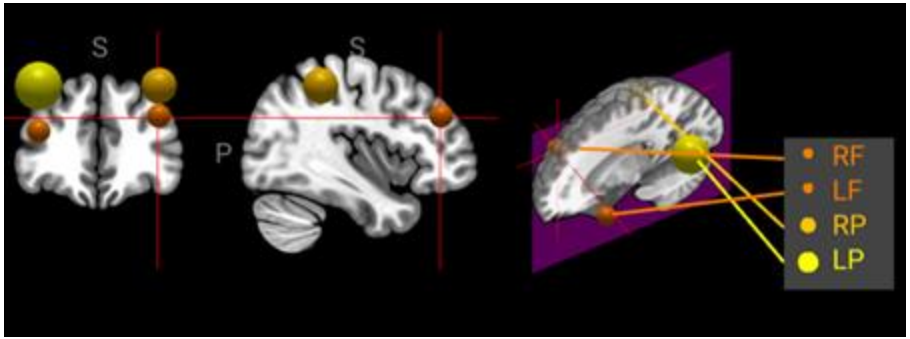
- WebAssembly for access to proven tools: bet, dcm2niix, fslmaths, flirt.
- Supports itk-wasm packages for image processing including elastix and ants.
- TensorflowJS, tinygrad and ONNX provide zero footprint AI model deployment regardless of users hardware or software.
    - AI for segmentation, parcelation, brain extraction, lesion identification and prognosis.



NiiVue can provide a visualization wrapper for proven and emerging tools.

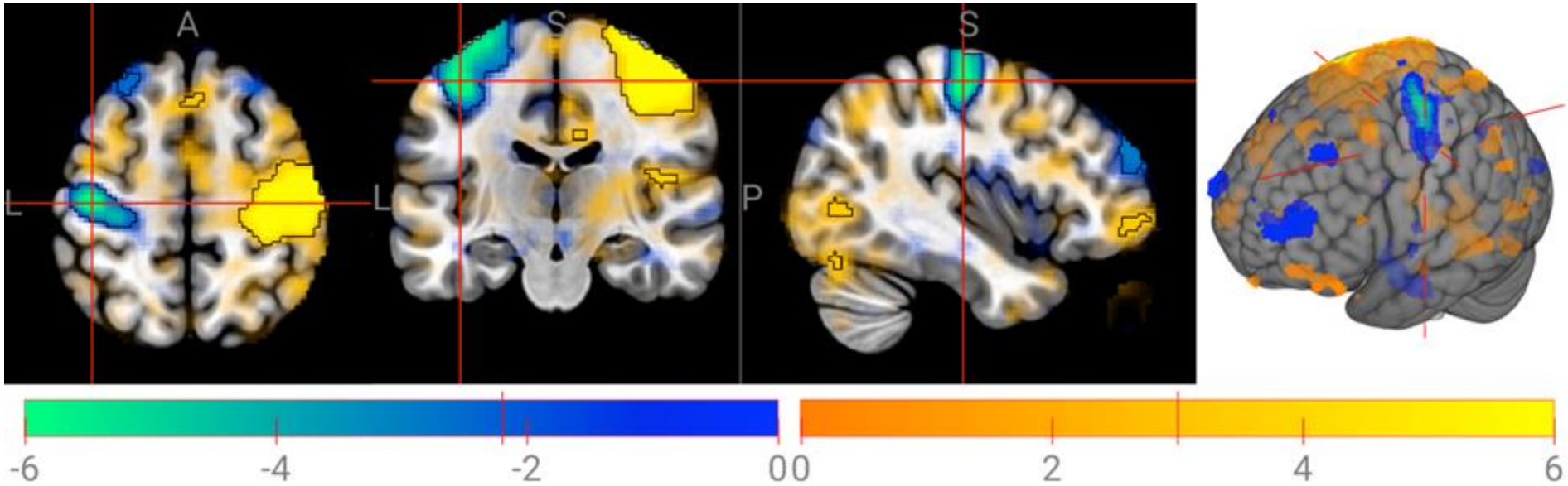
Feature documents: sharing scenes

- NiiVue can save entire scene (voxels, meshes, contrast, landmarks, drawings) as a document or self-loading interactive web page.
- Instead of sharing files, one have share the entire scene:
  - Correct AI failures.
  - Annotate images.
  - Homework tutorials.
  - Ask expert to describe anomaly.



Feature statistics: highlight results, don't hide them

- Accurate clinical familywise error correction with FDR and permutation will typically result in asymmetric thresholds.
- Alpha-blending to show trends.

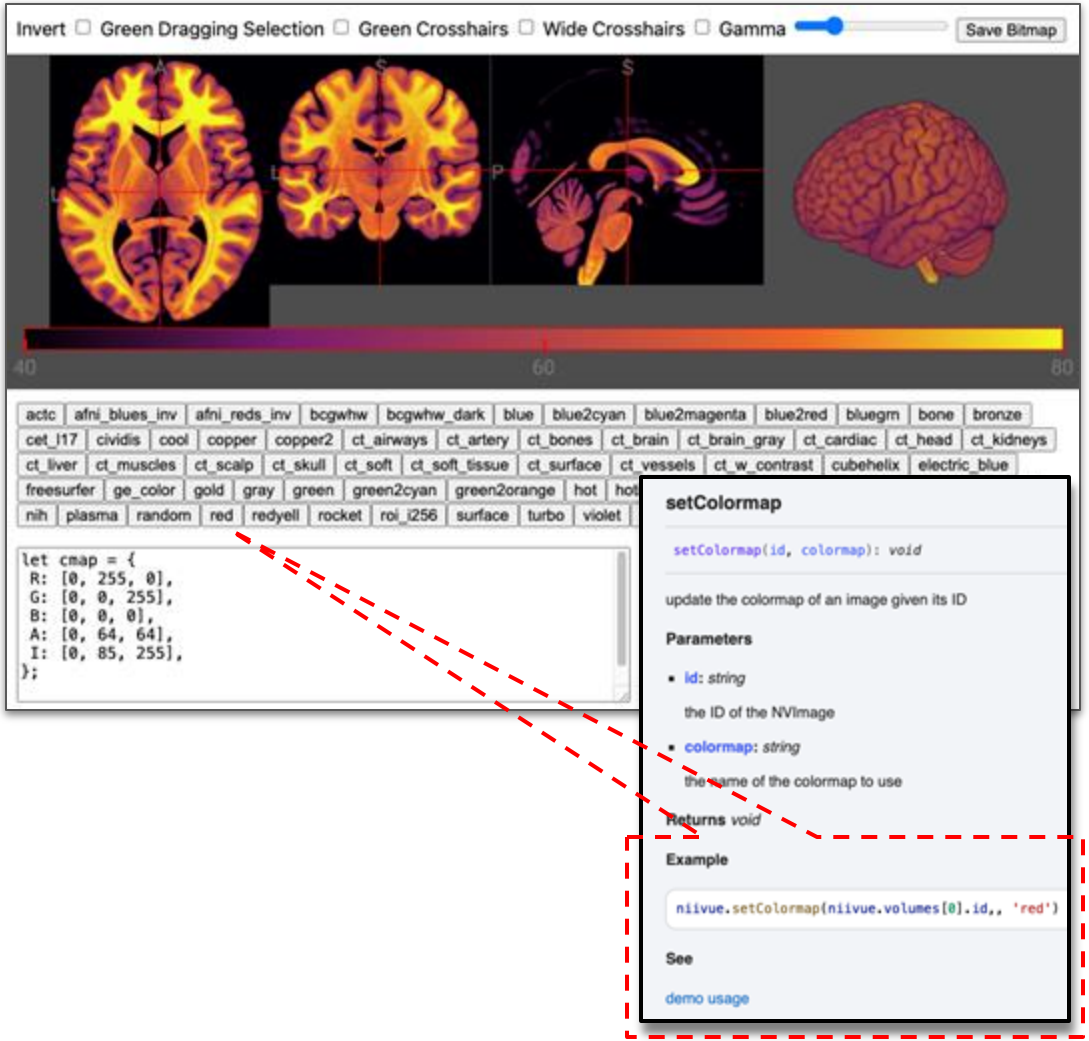


Why join the effort?

Developer Benefits:

- JavaScript is a scripting language, so you can interactively write code.
- Documentation links to minimal live demos.

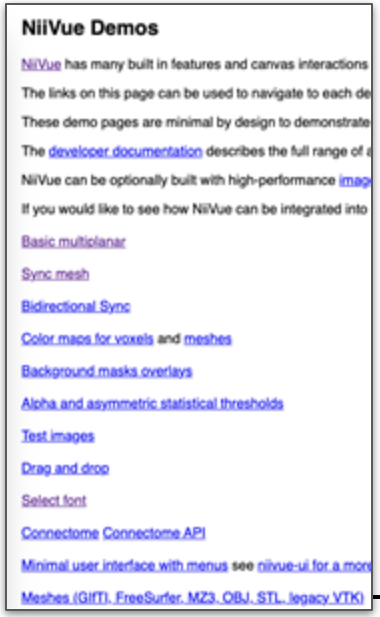
https://niivue.github.io/niivue/devdocs/

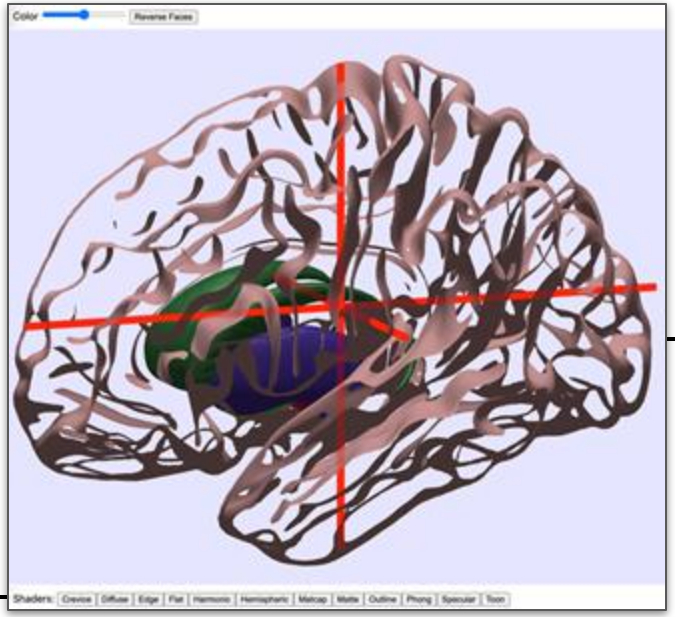


Collaborate 1: Explore Recipes

niivue.github.io/niivue/

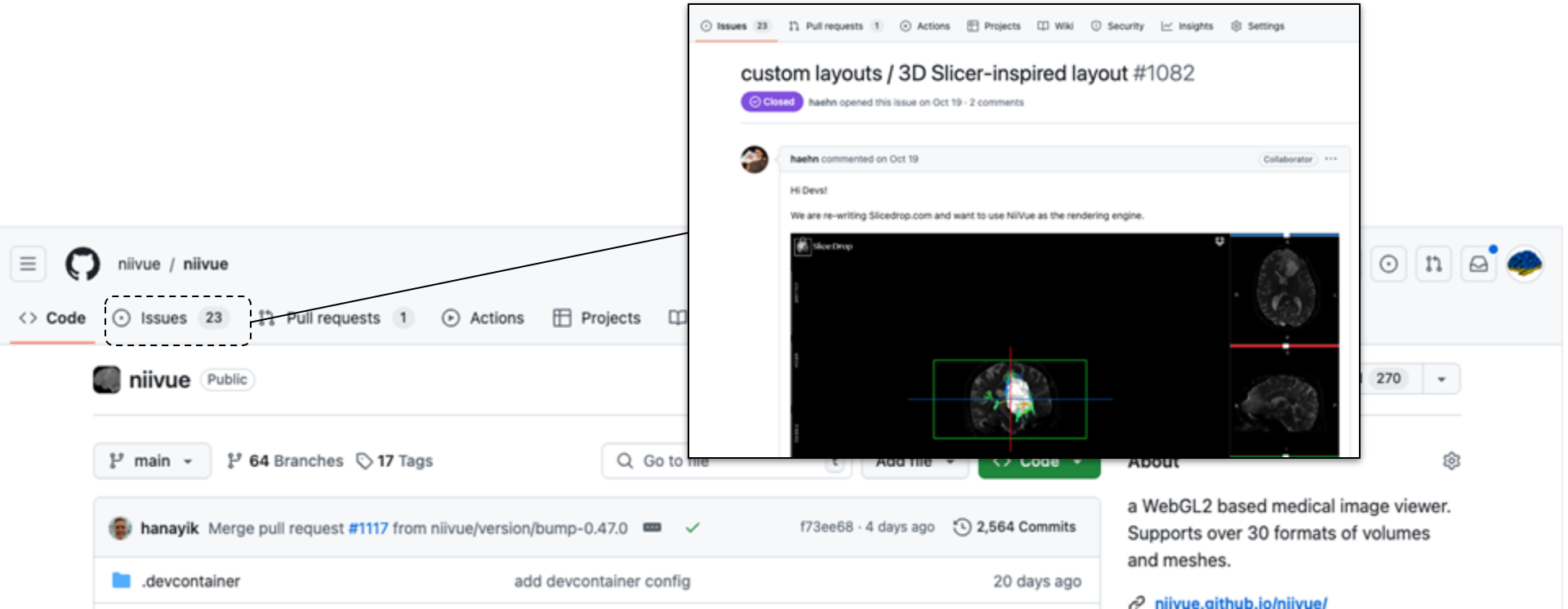
- Existing live demos provide minimal examples of features.
- View the web page source to duplicate features in your own projects.
- Demos use pure HTML, so agnostic to framework (Angular, React, Vue).
- Permissive license allows anyone to adopt NiiVue.





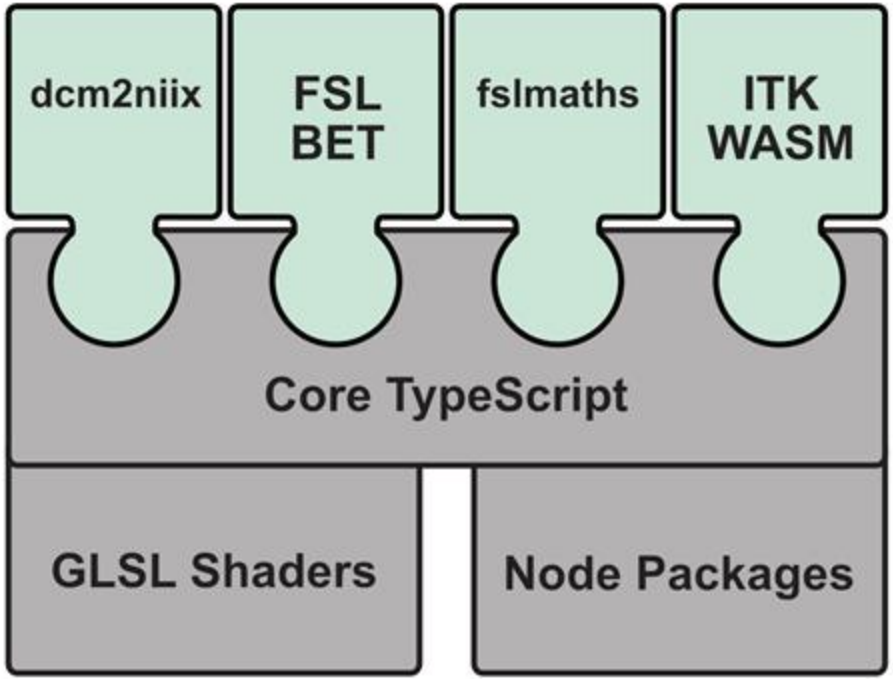
Collaborate 2: Communicate

- Create a new issue for bug reports, feature requests, and advice.



Collaborate 3: Embed

- Insert NiiVue into your own project.
- NiiVue has minimal dependencies.
- NiiVue can be extended with plugins.
- Minimal demos provided
  - React, Angular, Vue frameworks.
  - ONNX and TensorflowJS AI models.
  - bet, flirt, dcm2niix, nii2mesh, itk-wasm web-assembly plug ins.
  - Extend supported formats, TRAKO, CBOR file loading plugins.

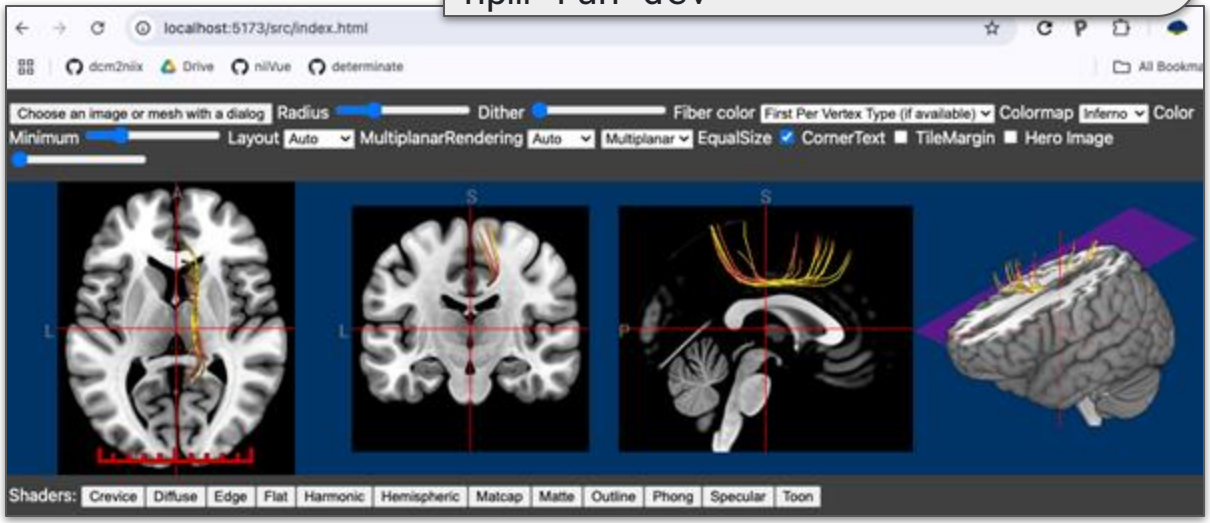


Collaborate 4: Develop

Hot reloadable development

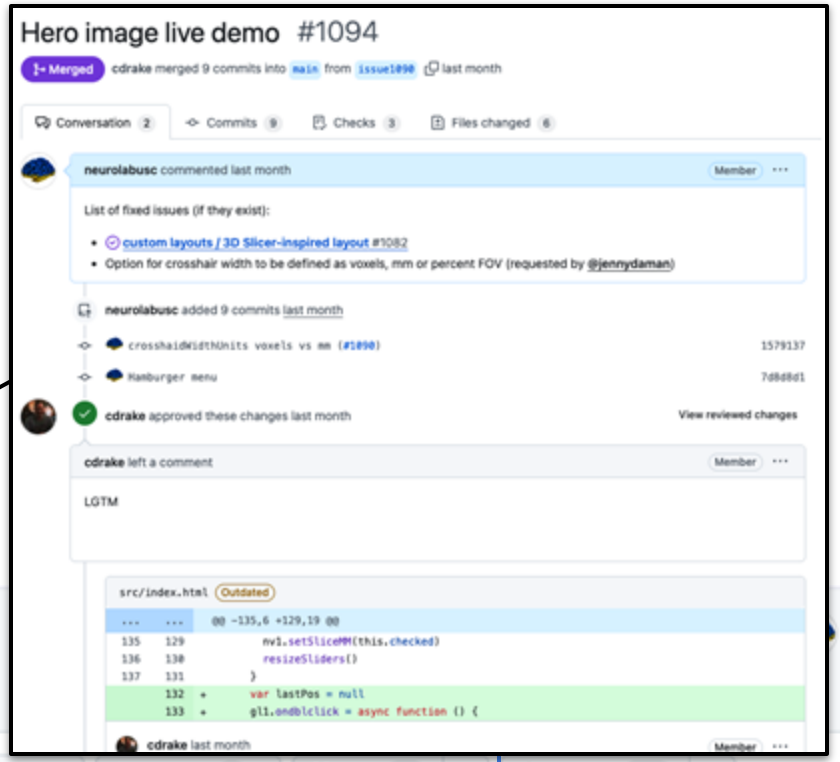
- Make sure git and node.js/npm installed.
- Download, install and run NiiVue locally.
- Saved edits instantly reflected in browser.

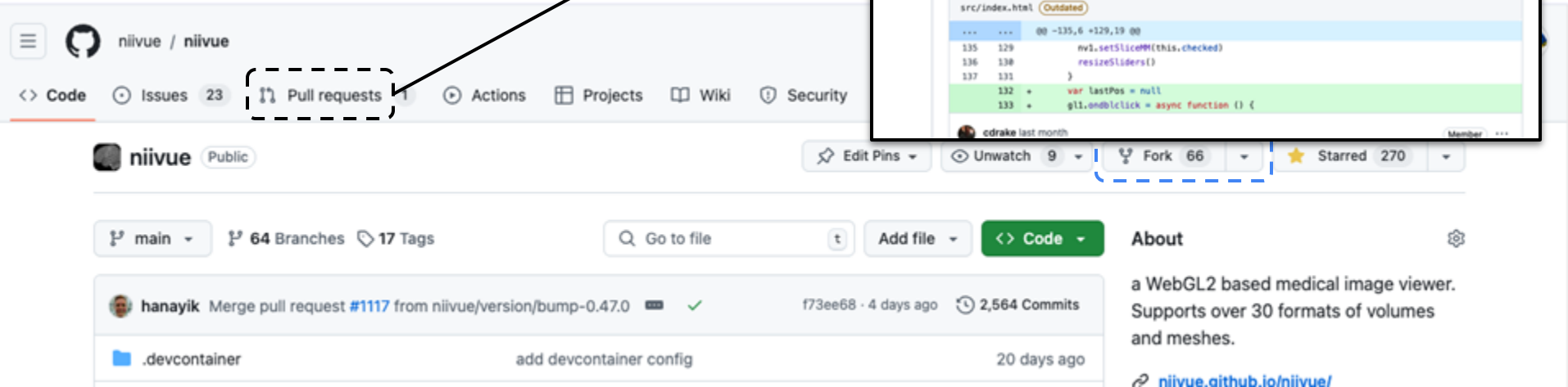
```
git clone
git@github.com:niivue/niivue.git
cd niivue
npm install
npm run dev
```



Collaborate 5: Contribute

- Fork the project to create your own branch.
- You can share improvements to the main branch with a pull request.





Roadmap • Annual Themes • Questions