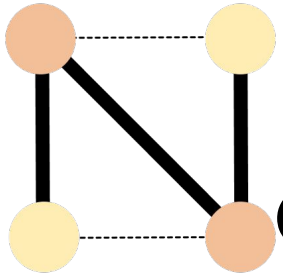


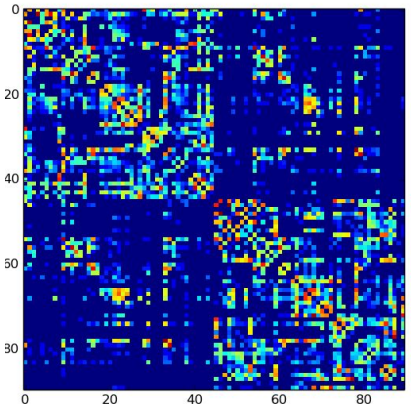
NeuroConnect

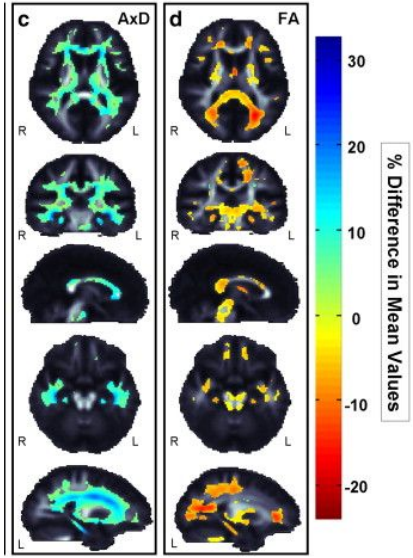
Interactive 3D visualization of structural brain connectivity

Tina Zhao, Kenny Yi, Carlos Pineda, Hongyu Mu

Rohlfing et al., 2010
Nir et al., 2013
O'Donnel & Westin, 2007

Background





NeuroConnect

✓ data precision
✗ spatial information

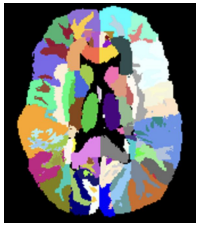
✓ group differences
✗ no 3D
✗ how tracts connect

✓ anatomically accurate
✗ can't compare groups
✗ too complex

✓ data encoded visually
✓ group comparison
✓ 3D spatial display
✓ accessible

Data Used

ADNI Alzheimer's Disease Neuroimaging Initiative



- **Diagnosis**.csv
  - Categorical labels per subject (CN vs AD)
- **DTI metrics**.csv
  - FA per tract per subject

Diagnosis	FA_CST_L	FA_CST_R	FA_CGC_L
CN	0.52	0.51	0.48
AD	0.44	0.43	0.41

JHU ICBM-DTI-81 White Matter Atlas.nii.gz

- Extracted MNI coordinates (start, end, centroid) per tract using PCA
- jhu_coordinates.csv

ROI	start_x	start_y	start_z
CST_L	20	21	24
CST_R	17	-30	36
CGC_L	30	-57	9

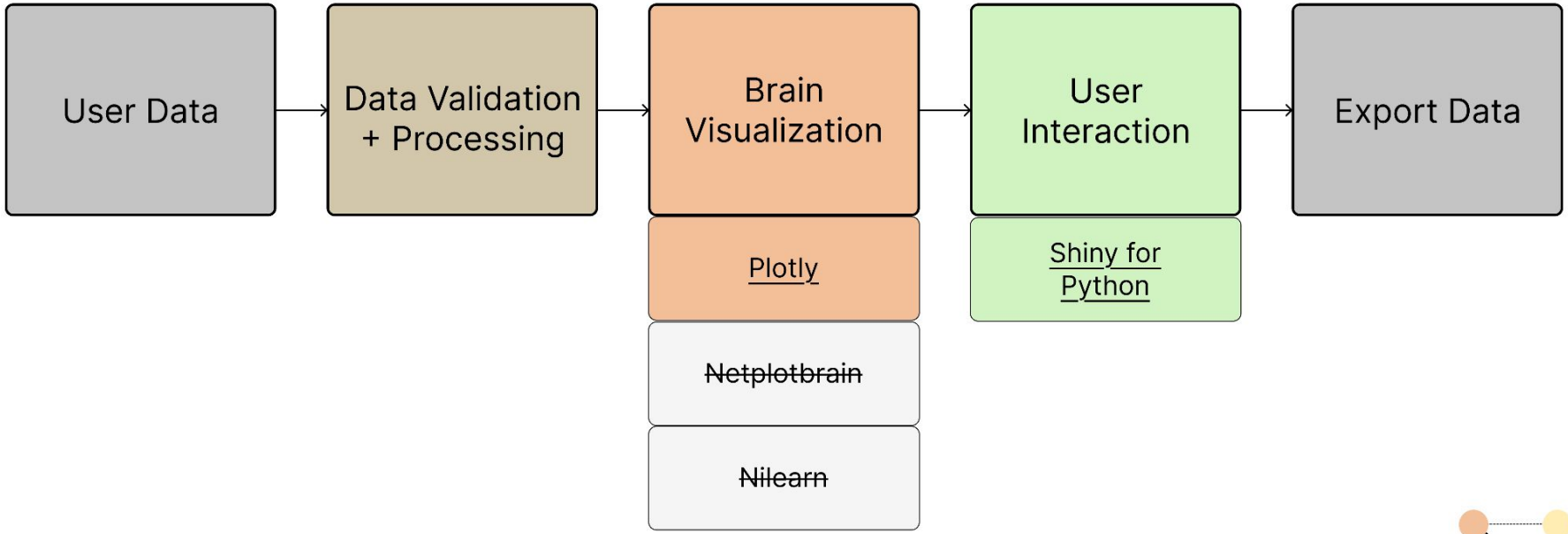
Limitations

- Individual variability within diagnosis group
- Single time point for subject
- Coordinate simplification
- Summary statistics

Use Cases

1. View brain connectivity
2. Compare brains (CN vs. AD)
3. **Upload and visualize data**
4. Export brain images
5. Validate Data Quality

NeuroConnect



= Incomplete

= Finished w/ No Test

= Finished w/ Test

Data Validation + Processing

1. Data Preparation

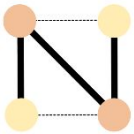
- 1.1 Data Loading
- 1.2 Data Cleaning
- 1.3 Summary Statistics Calculator
- 1.4 Summary Data Output
- 1.5 Group Difference Calculator

2. Tract Coordinate Extraction

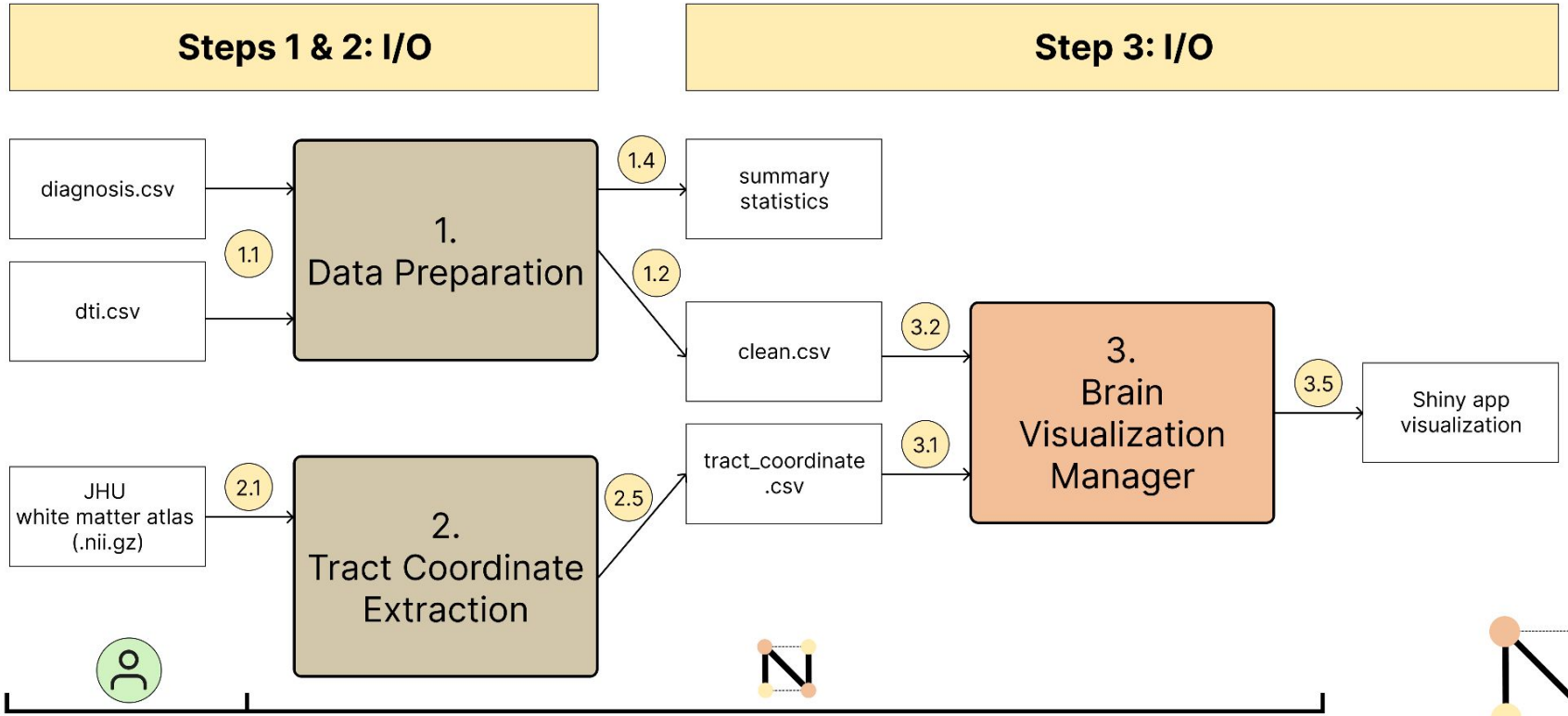
- 2.1 Atlas File Locator
- 2.2 Single Tract Coordinate Extractor
- 2.3 Base Tract Loop
- 2.4 Additional Tract Calculator
- 2.5 Coordinate File Writer

3. Brain Visualization Manager

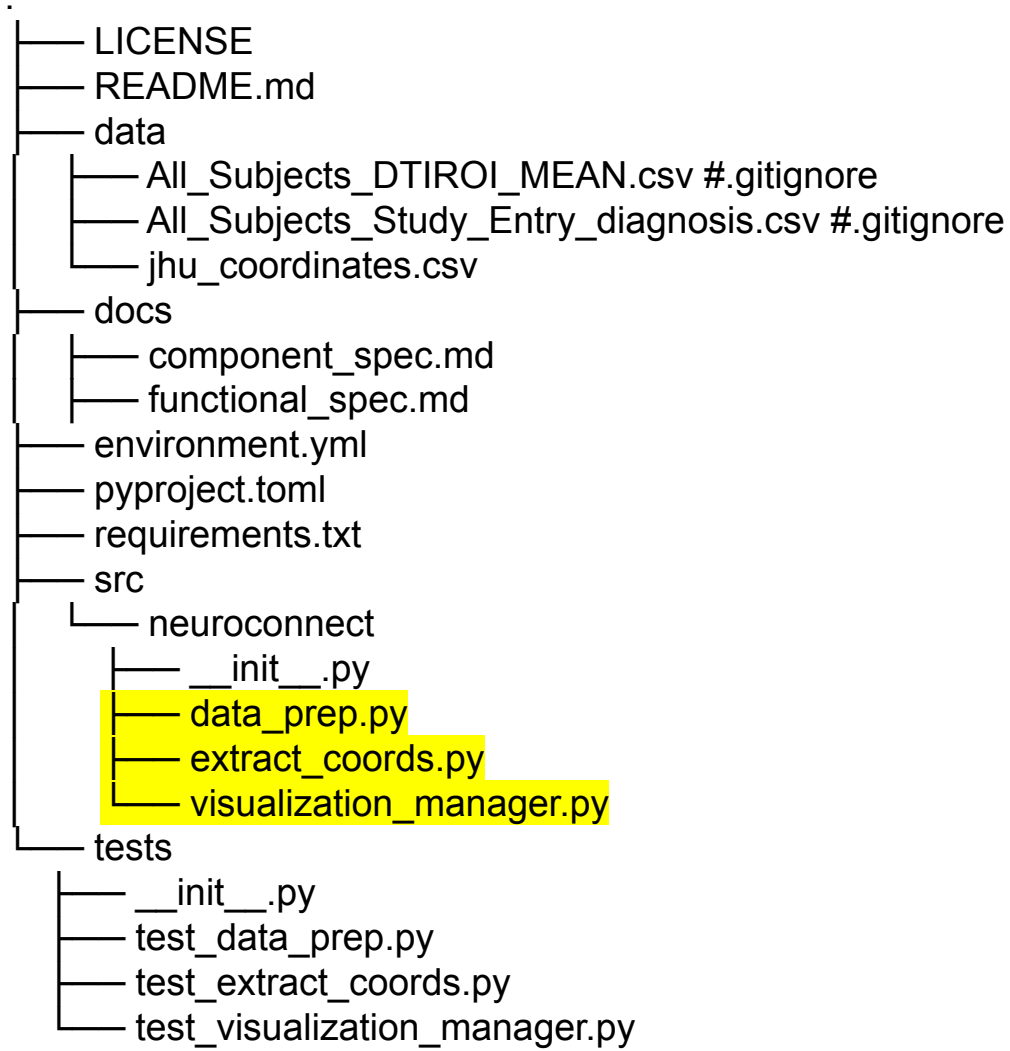
- 3.1 Coordinate File Loader
- 3.2 DTI Metrics Loader
- 3.3 Node-Edge Mapper
- 3.4 Edge Value Scaler
- 3.5 Visualization Renderer
- 3.6 Comparison Overlay Visualizer



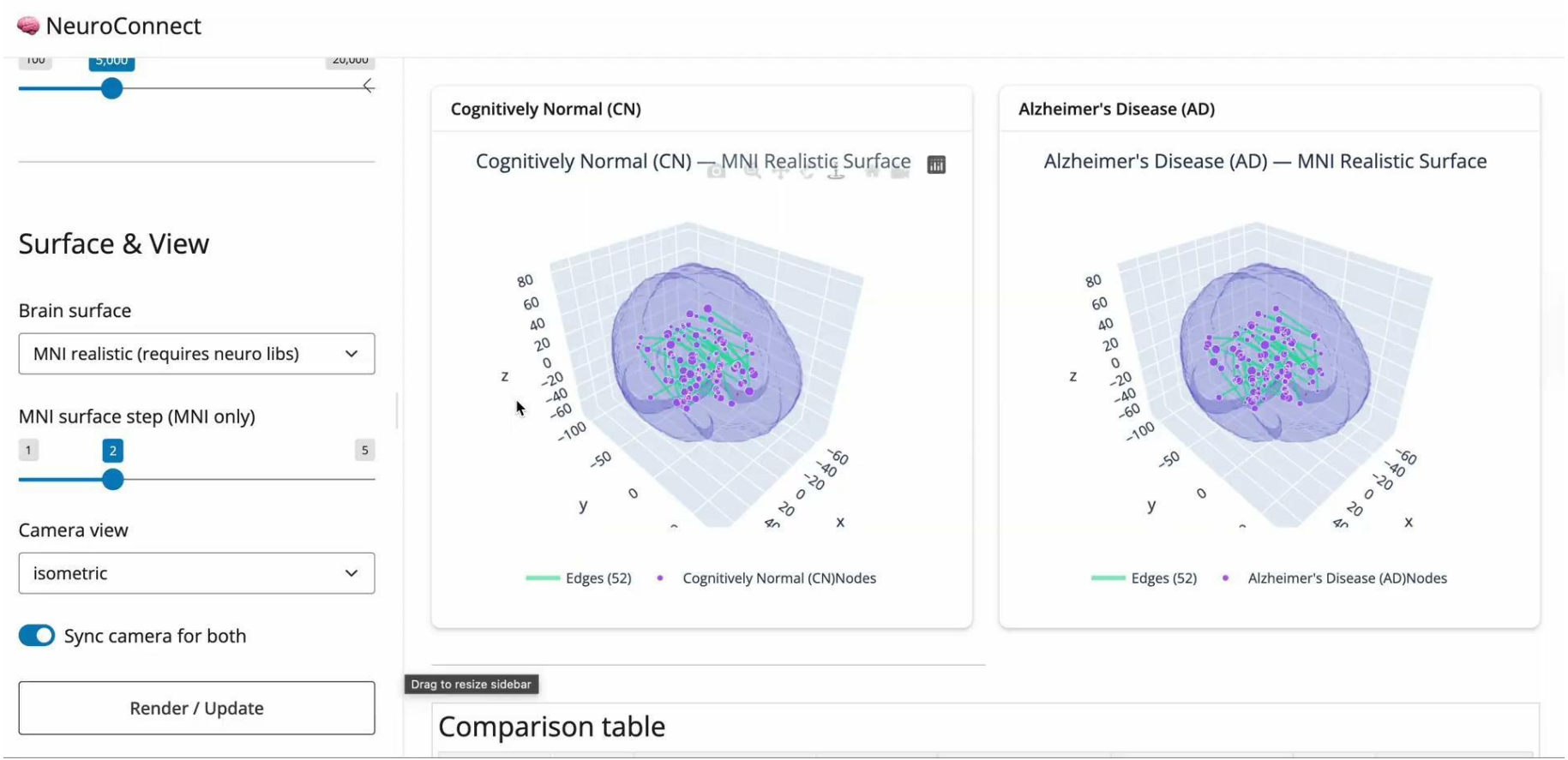
USE CASE: Upload and Visualize Data



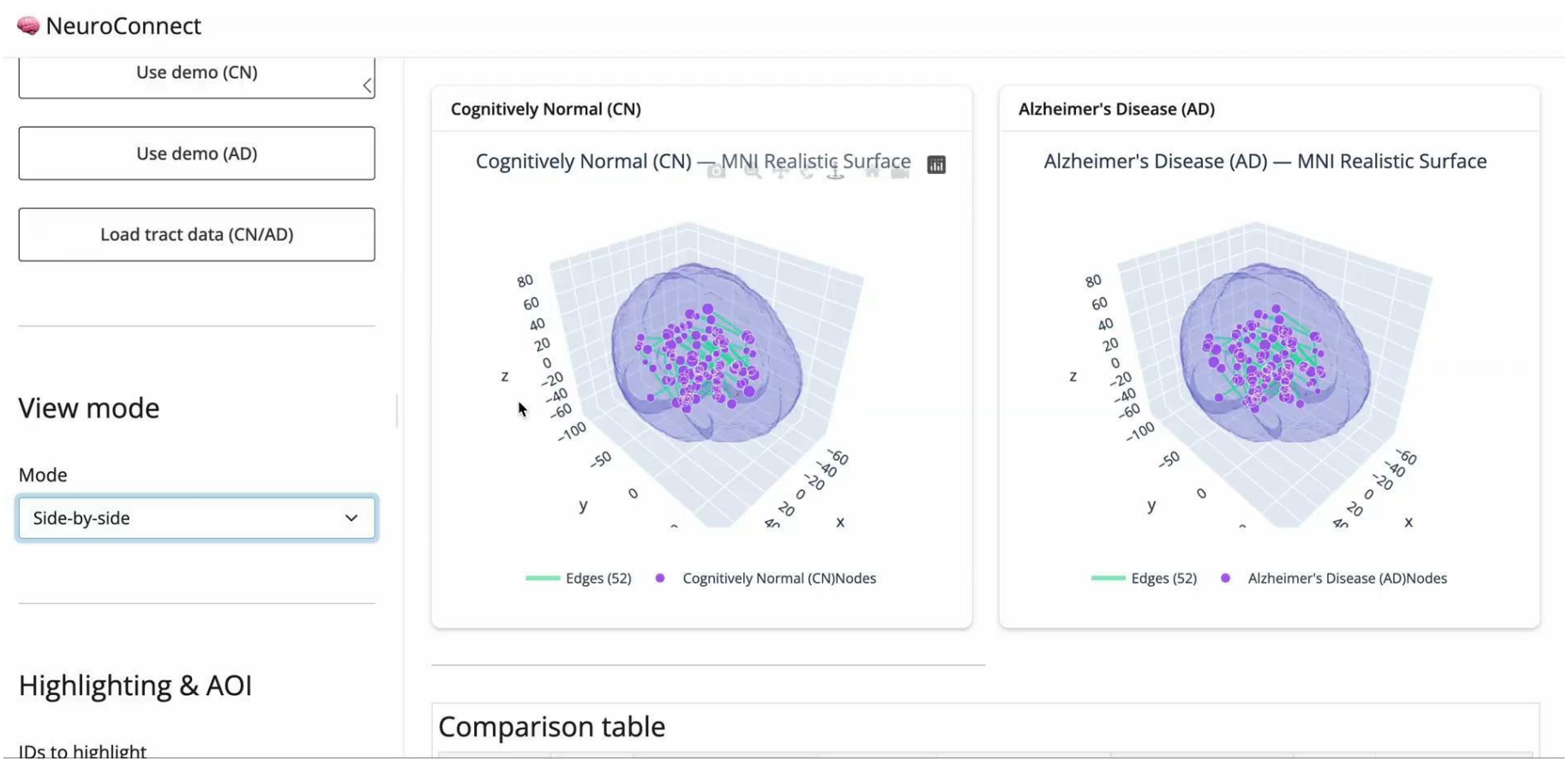
Project Structure



Final product visualization (side by side comparison)



Final product visualization (Differential visualization)



Lessons learned

- **More lenient lint/format, focus on actual tests first.** Import order and line-length churn burned time; auto-format + pre-commit saves reviews for logic
- **Continuous Integration Automation.** So that the configurations are not only “working on my machine” but tested in a neutral environment
- **Single, atomic units of pull requests.** Reducing load on reviewers
- **Define interfaces and inputs/outputs early on.** Prevent potential front-end UI and backend data mismatch
- **Testing early will save time late.** We don’t write test for today, we write tests so in the future we can refactor without fear.
- **Thinking in terms of user stories.** It centers the user experience and forces clarity on the problem we are solving.

Future Work

- Integration with standard neuroimaging formats (NIfTI, GIFTI, CIFTI)
- Add statistical comparison tools
- Work on continuous integration for catching breaking changes early
- Ensures consistency behavior across machines, OS, and environments
- Finalize the complete work pipeline (i.e connecting data prep, tract coordinate extraction and visualization modules)