

tedana Multi-echo fMRI noise removal software and resources

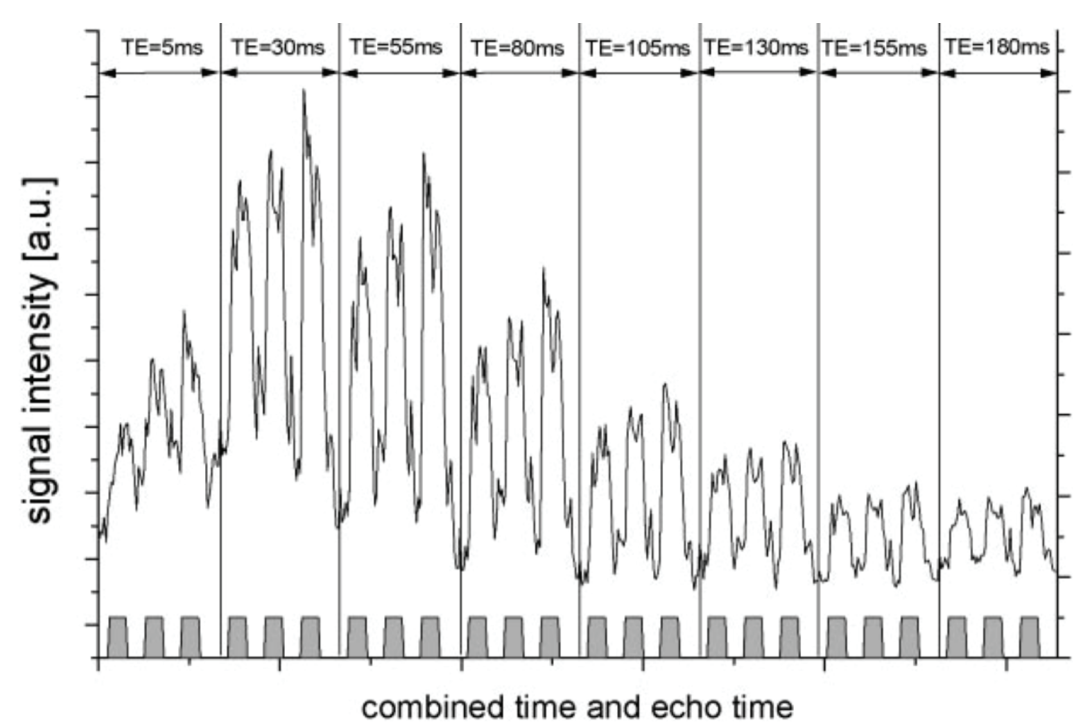
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tedana.readthedocs.io



MULTI-ECHO FMRI

Multi-echo fMRI involves collecting data at several echo times (TEs) during one acquisition. T_2^* signal, like the fMRI BOLD response, scales across echoes. Multi-echo information can be used to better isolate T_2^* signal changes.^{1,2}



For the same finger tapping task, the response magnitude varies with echo time in a predictable manner. Image from Barth et al NMR Biomed 2001

tedana is

1. Open software to test and improve multi-echo methods with an emphasis on an ICA-based denoising method⁴⁻⁶. Currently built into AFNI and fMRIPrep pipelines.

2. Tools to make ICA-based denoising methods adaptable & understandable.

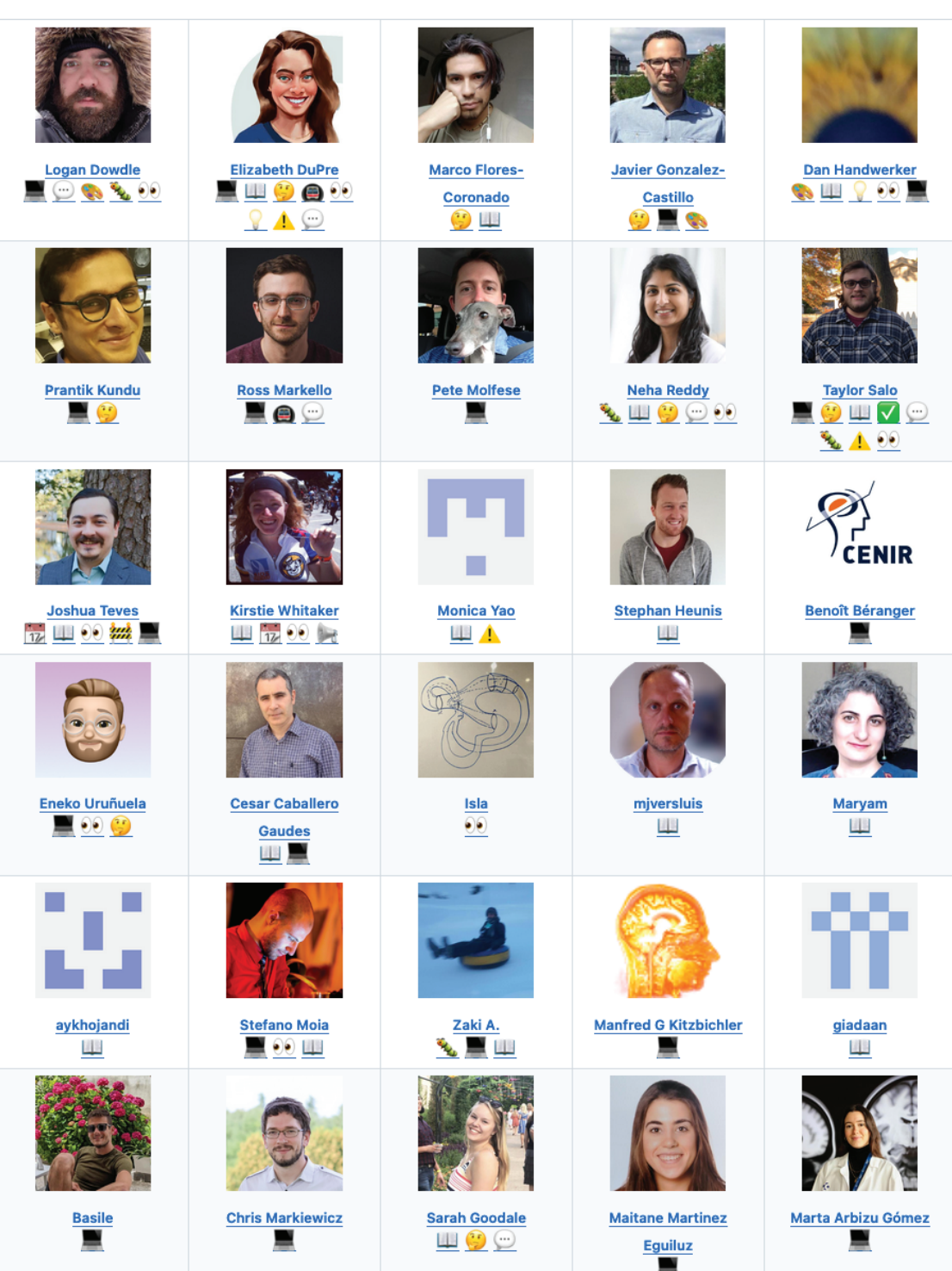
3. A community and resources for people interested in multi-echo fMRI whether or not they use tedana software

WAYS TO CONNECT

Multi-echo questions: <https://neurostars.org> with 'multi-echo' or 'tedana' tags
 Subscribe to the tedana (low volume) newsletter: <https://groups.google.com/g/tedana-newsletter>
 Join the conversation: mattermost.brainhack.org/brainhack/channels/tedana
 Code and resources are open source. Contribute at: <https://github.com/ME-ICA/tedana>

A list of multi-echo content at OHBM: github.com/ME-ICA/ohbm-2024-multiecho

CONTRIBUTORS



you can be here too!

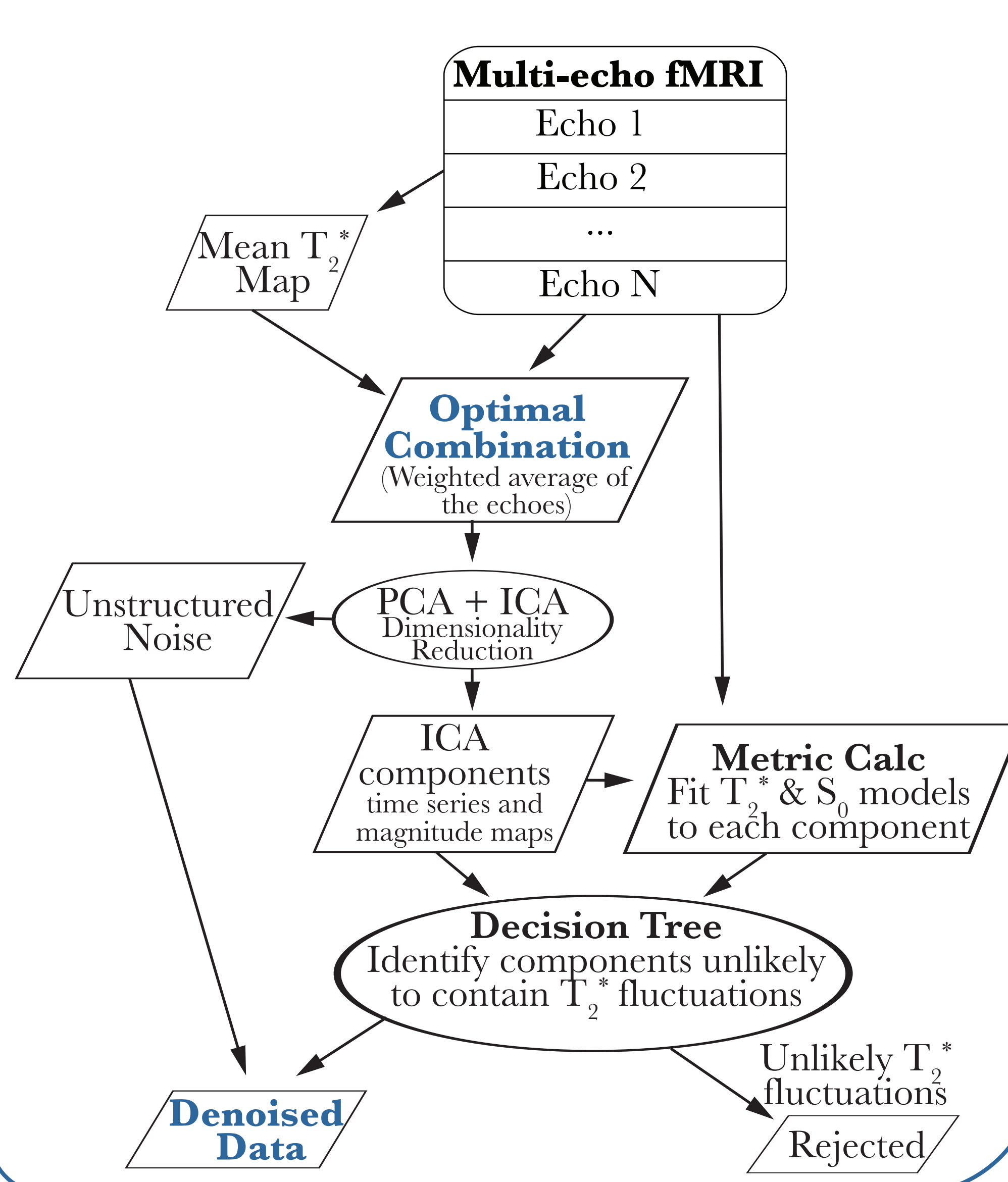
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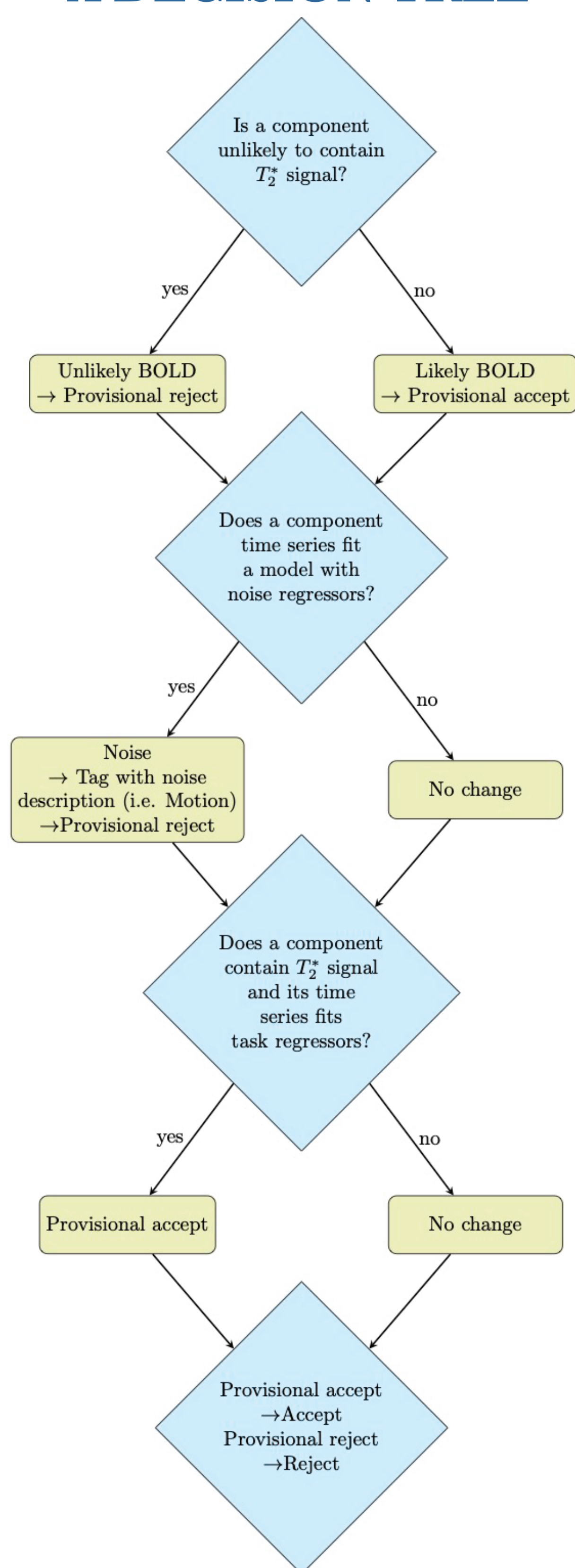
ACKNOWLEDGEMENTS

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TEDANA ALGORITHM



EXAMPLE OF USING EXTERNAL METRICS IN A DECISION TREE



IMPROVEMENTS DURING THE PAST YEAR

Continued improvements to multi-echo fMRI educational materials and documentation.

Logging of data processing information including, hardware, OS version, Python module versions, & a permanent citation for the executed version of the decision tree. <https://doi.org/10.6084/m9.figshare.25251433.v2>

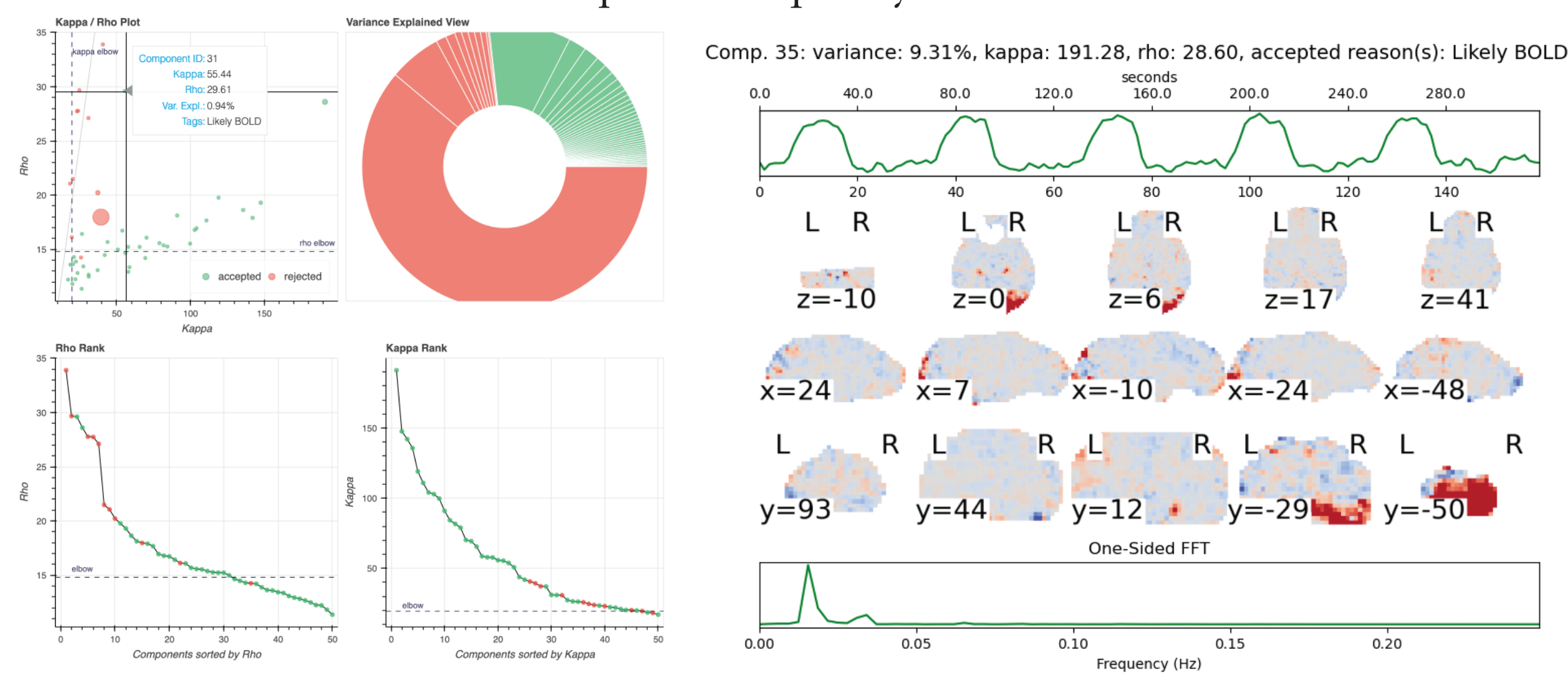
New decision tree that fully aligns with the older MEICA^{4,5} software.

Improvements & fixes to methods for calculating the number of usable echoes at each voxel.

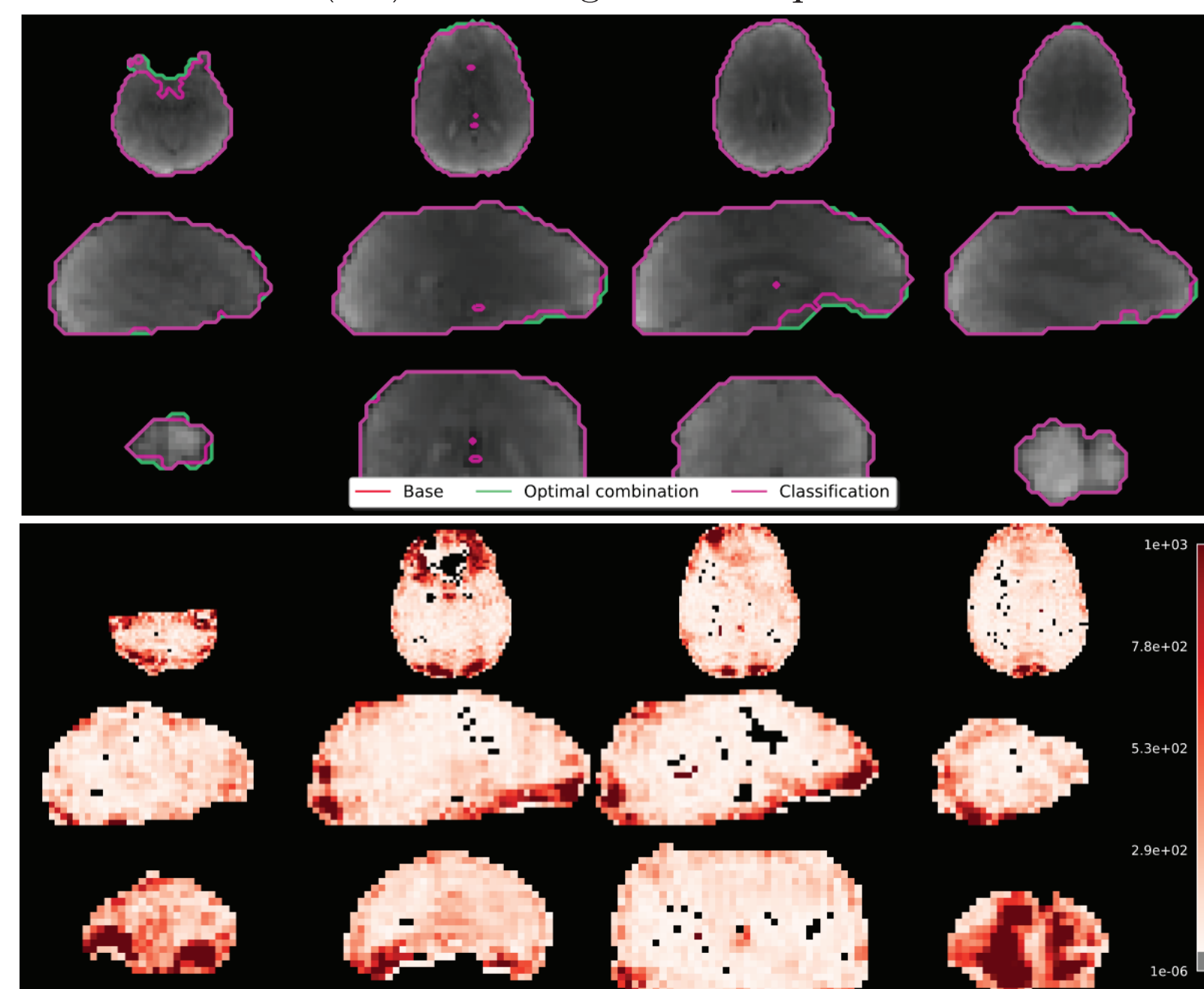
Fitting ICA components to external time series (similar to AROMA⁷) to include non- T_2^* reasons for component classifications, like head motion, CSF signal, and respiratory noise, in an integrated decision tree. (very soon to be added to tedana)

IMPROVED RESULTS REPORT

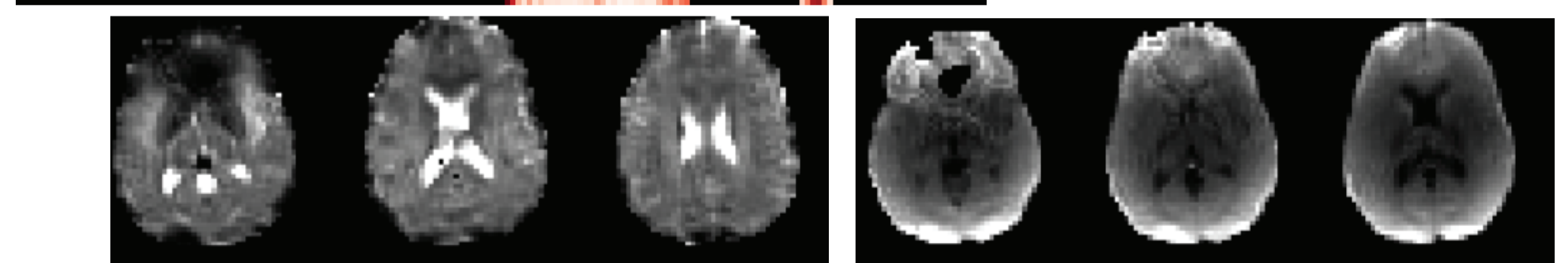
Tedana outputs an interactive report to help users understand their results and perform quality assurance.



Interactive result reports shows kappa (T_2^* -weighting) and rho (S_0 -weighting) values, and explained variance for each component. Hovering over a component shows additional information (left). Clicking on a component shows the time series and spatial map (right).



tedana outputs time series for voxels with at least one good echo, but needs three good echoes to calculate T_2^* & S_0 fits for classifications. These two masks are newly added to the report.



The quality of the fit to a T_2^* & S_0 model (Root mean squared error) is useful for characterizing dropout and identifying potential limits of data (newly added).

Images of the mean T_2^* (left) and S_0 (right) across time are newly added. More detailed explanations of all images in the report are added to: <https://tedana.readthedocs.io/en/stable/outputs.html#ica-components-report>

FUTURE PLANS

Work-in-progress to add RobustICA⁸ into tedana which will give more stable component estimations by identifying components that cluster across many iterations of ICA

Design and validate component selection processes that take advantage of the added external regressor functionality

Continue to improve documentation with a focus on educational materials & tools using openly available multi-echo fMRI data

A researcher can create a file of "nuisance" time series, like head motion, CSF signal, or respiratory and cardiac signals. These can be fit to components and decisions to keep or reject can be made based on the fits. This was designed to be highly flexible to allow a wide range of possible integrations. For example, the above method removes components that fit noise, but retains components with T_2^* signal that fits the task design.