# Neuroconductor: An R Platform for Medical Imaging Analysis

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## What is Neuroconductor?

Neuroconductor (`https://neuroconductor.org/`) is a a centralized repository of R software dedicated to medical image analysis.

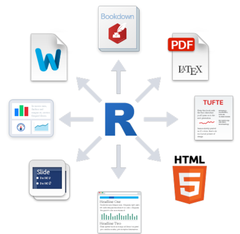
### *Goals of Neuroconductor*

- Disseminate quickly software updates
- Educate a large, diverse community of scientists using detailed tutorials and short courses
- Ensure quality via automatic and manual quality controls
- Promote the reproducibility of image data analysis

### *Benefits of Imaging in R*

Allow medical imaging to use all R has to offer:

- Statistics and Machine Learning
- Package versioning, testing, and distribution
- Reproducibile reports and analyses (knitr and rmarkdown)
- Shiny applications for the web




(Image from http://rmarkdown.rstudio.com/images/RMarkdownOutputFormats.png)

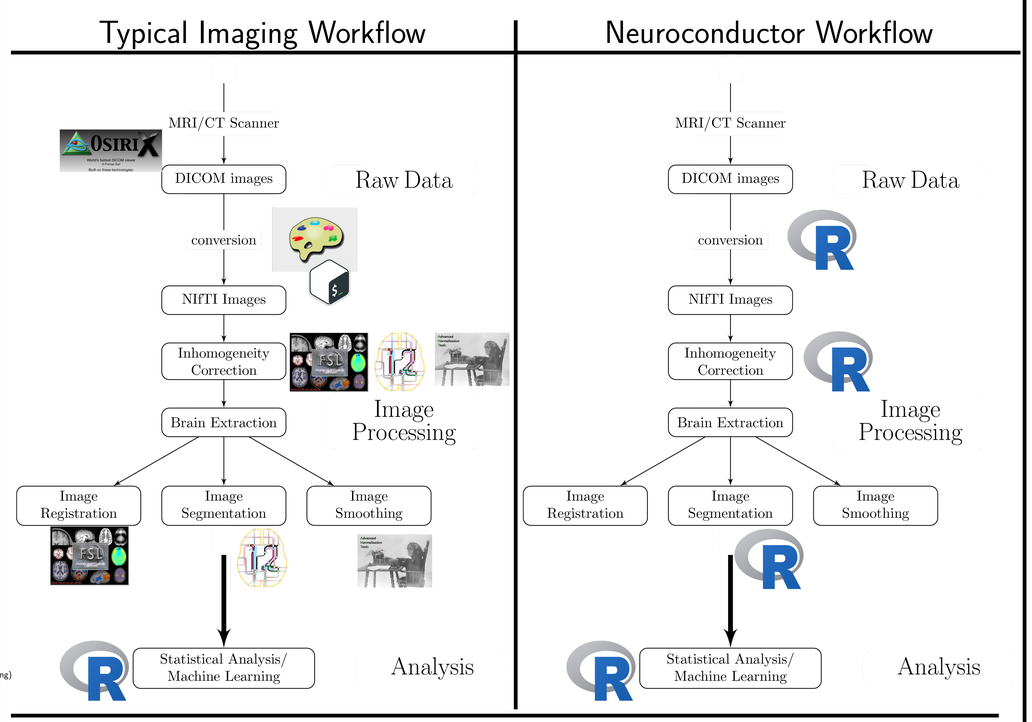
## Current Neuroconductor Capabilities

| Capabilities | Packages |
|---|---|
| DICOM Images | oro.dicom, dcm2niir, divest, ANTsR |
| NIfTI Images | oro.nifti, RNifti, ANTsR |
| Image Registration | spm12r, fslr, ANTsR, freesurfer |
| Inhomogeneity Correction | spm12r, fslr, ANTsR |
| Brain Extraction | spm12r, fslr, ANTsR, extrantsr |
| Structure Segmentation | spm12r, fslr, ANTsR, extrantsr, freesurfer |
| Intensity Normalization | WhiteStripe, neurobase, ANTsR |
| 3D Smoothing | ANTsR, spm12r, fslr |
| Temporal Filtering | spm12r, fslr, ANTsR |
| Slice-timing correction | spm12r, fslr |
| DTI models | rcamino, oro.dti, fslr |

## References

[1] Bennett A Landman et al. "Multi-parametric neuroimaging reproducibility: a 3-T resource study". In: *Neuroimage* 54.4 (2011), pp. 2854–2866.
[2] Kenichi Oishi et al. "Atlas-based whole brain white matter analysis using large deformation diffeomorphic metric mapping: application to normal elderly and Alzheimer's disease participants". In: *Neuroimage* 46.2 (2009), pp. 486–499.
[3] Vladimir Fonov et al. "Unbiased average age-appropriate atlases for pediatric studies". In: *NeuroImage* 54.1 (2011), pp. 313–327.
[4] Vladimir S Fonov et al. "Unbiased nonlinear average age-appropriate brain templates from birth to adulthood". In: *NeuroImage* 47 (2009), S102.
[5] Bennett Allan Landman et al. *MICCAI 2012 Workshop on Multi-Atlas Labeling*. CreateSpace Independent Publishing Platform, 2012.
[6] David C Van Essen et al. "The WU-Minn human connectome project: an overview". In: *Neuroimage* 80 (2013), pp. 62–79.

## Example Imaging Workflow




bash - shell scripting is usually required for command-line tools or pipelining

FSL (FMRIB Software Library) - suite of neuroimaging analysis tools

ANTs (Advanced Normalization Tools) - state-of-the-art tools for neuroimaging analysis

MRIcroGL - imaging analysis suite, with dcm2nii - DICOM to NIfTI software

OsiriX - standalone DICOM viewer

SPM 12 - statistical parametric mapping, requires MATLAB (Mathworks, Natick, Massachusetts, USA) - analysis tools for PET/SPECT/fMRI

## Data Packages

| Package | Description |
|---|---|
| kirby21 | Scan-rescan data for 42 subjects with structural and functional MRI and diffusion data [1] |
| EveTemplate, MNITemplate | Templates for population-level analyses [2, 3, 4] |
| malf.templates | Templates [5] for Multi-Atlas Label Fusion (MALF) and Skull Stripping |
| hcp | Download data from the Human Connectome Project [6] |

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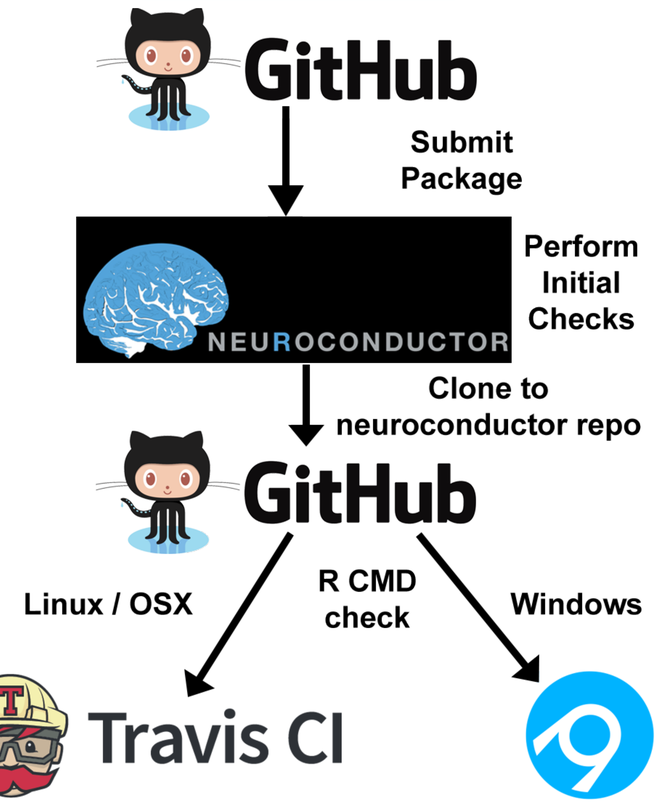
## Neuroconductor Developer Workflow




GitHub - a online hosting service of git repositories. All Neuroconductor packages are hosted on GitHub.

Before uploading to GitHub, checks are performed, a confirmatory email is sent (reduce spam), and Travis/Appveyor configuration files are added

Travis CI (continuous integration) - an online service of Linux/Mac OSX virtual machines that build and check packages

AppVeyor - a similar CI service that builds and checks packages on Windows

## Potential Downsides to Neuroconductor

- More control over the workflow = more work (e.g. for statisticians)
- Users need external software (versions/installation)
- No control over external software
  - if maintainer changes something, not much recourse
- Need the content (buy-in from the imaging/R/statistical communities)