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)

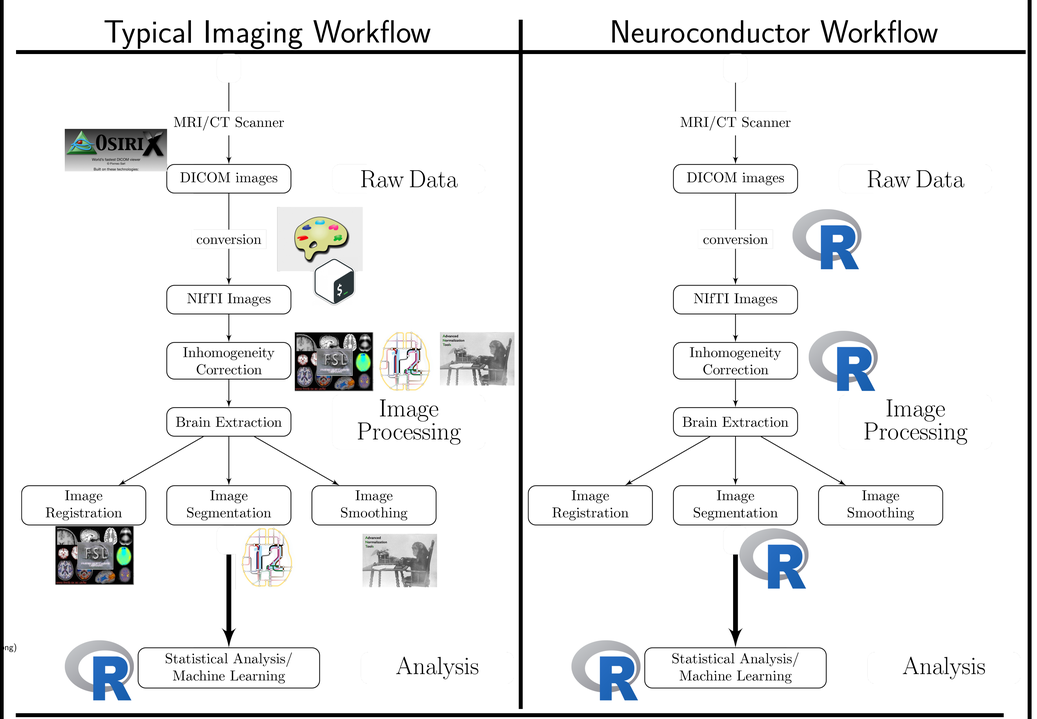
Current Neuroconductor Capabilities

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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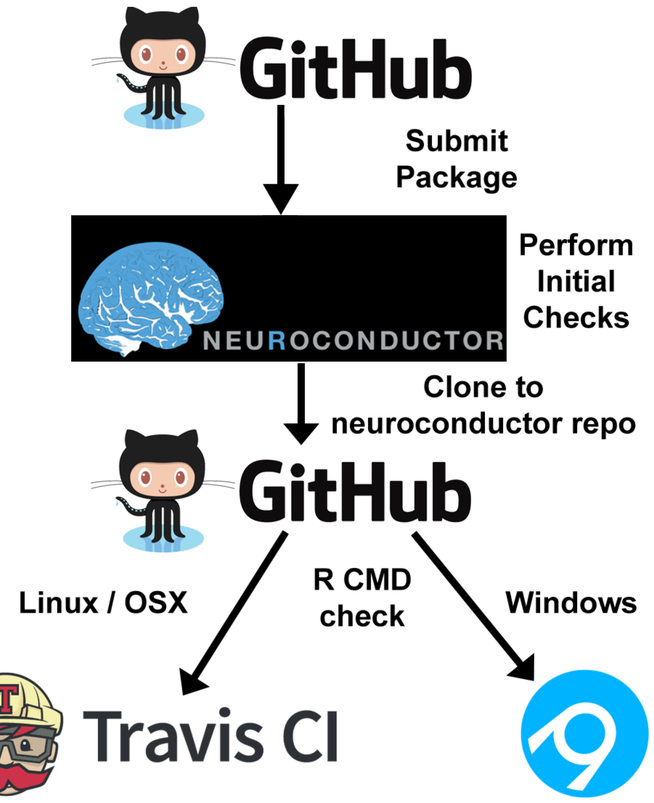
Neuroconductor Developer Workflow



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 communities)