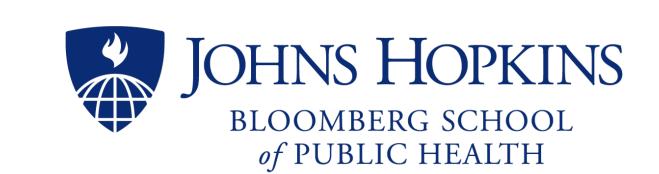
## Neuroconductor: An R Platform for Medical Imaging Analysis



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# What is Neuroconductor?

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

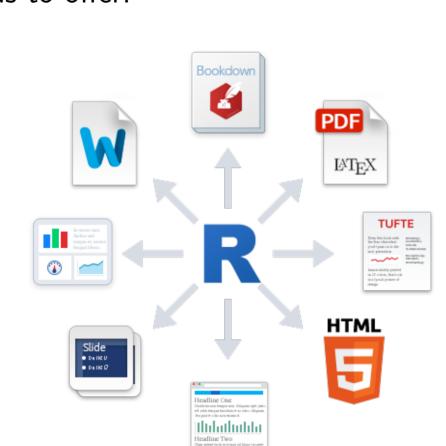
### Goals of Neuroconductor

- 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



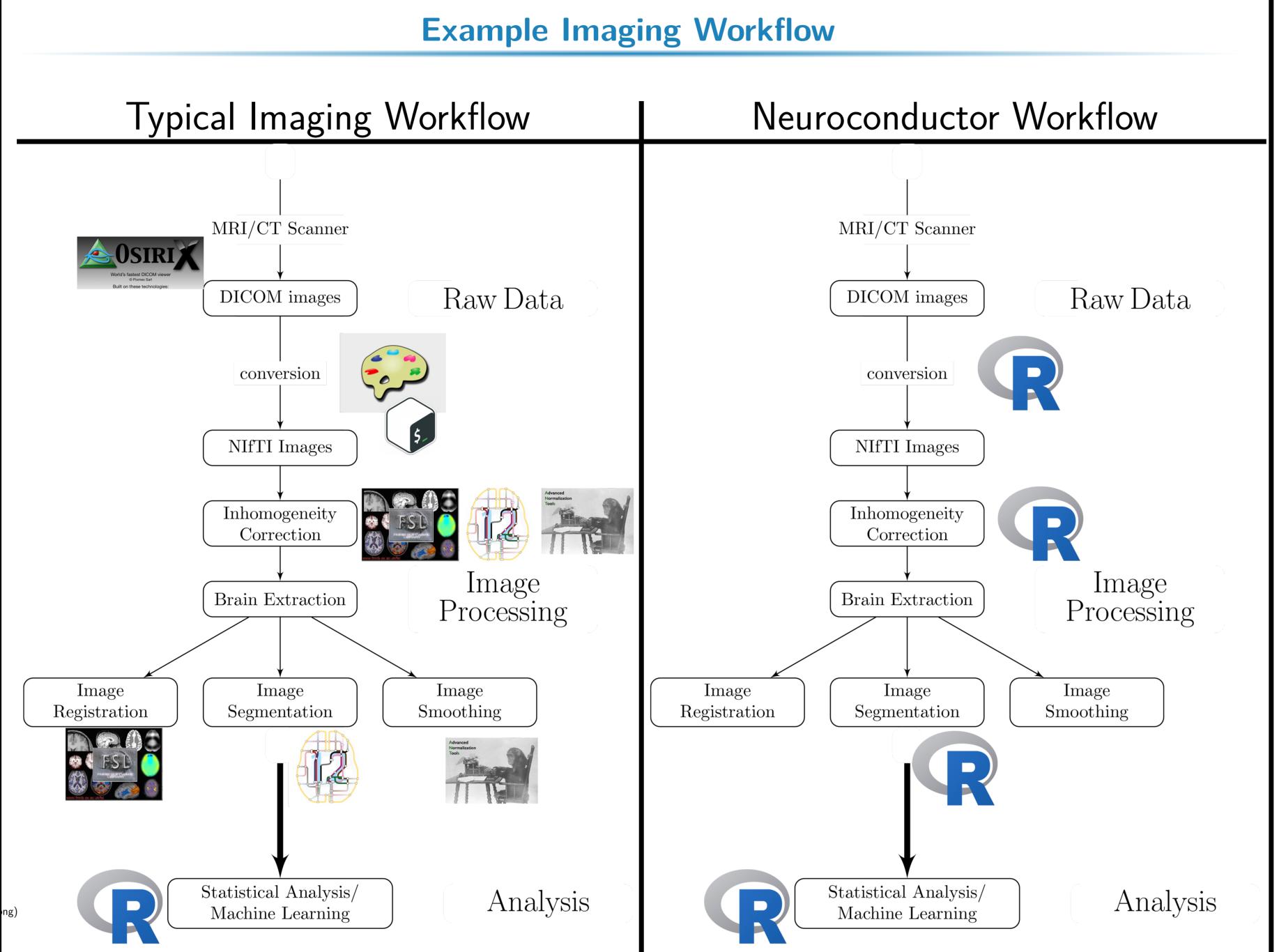
## (Image from http://rmarkdown.rstudio.com/images/RMarkdownOutputFormats.on

## **Current Neuroconductor Capabilities**

Capabilities Packages DICOM Images oro.dicom, dcm2niir, divest, ANTsR oro.nifti, RNifti, ANTsR NIfTI Images Image Registration spm12r, fslr, ANTsR, freesurfer spm12r, fslr, ANTsR Inhomogeneity Correction Brain Extraction spm12r, fslr, ANTsR, extrantsr spm12r, fslr, ANTsR, extrantsr, freesurfer Structure Segmentation WhiteStripe, neurobase, ANTsR Intensity Normalization ANTsR, spm12r, fslr 3D Smoothing spm12r, fslr, ANTsR Temporal Filtering spm12r, fslr Slice-timing correction 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–
- [3] Vladimir Fonov et al. "Unbiased average age-appropriate atlases for pediatric studies". In: NeuroImage 54.1 (2011),
- [4] Vladimir S Fonov et al. "Unbiased nonlinear average age-appropriate brain templates from birth to adulthood". In: Neurolmage 47 (2009), S102. [5] Bennett Allan Landman et al. MICCAI 2012 Workshop on Multi-Atlas Labeling. CreateSpace Independent Pub-
- lishing Platform, 2012.
- [6] David C Van Essen et al. "The WU-Minn human connectome project: an overview". In: Neuroimage 80 (2013), pp. 62–79.



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

MRIcroGL - imaging

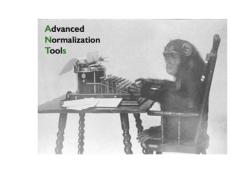
analysis suite, with

dcm2nii - DICOM to

NIfTI software



FSL (FMRIB Software Library) suite of neuroimaging analysis tools



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

ANTs (Advanced

Normalization Tools)

- state-of-the-art

# **≜**0SIRI**X**

OsiriX - standalone DICOM viewer



## **Data Packages**

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

### **Sources of Funding**

The project described and data used were supported by the NIH grants R01EB012547, T32AG000247, R01NS046309, R01NS060910, R01NS085211, R01NS046309, R01MH095836.

# Neuroconductor Developer Workflow GitHub Submit **Package Perform** Initial Checks NEUROCONDUCTOR Clone to neuroconductor repo GitHub R CMD Linux / OSX Windows check Travis CI



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 pack-



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)