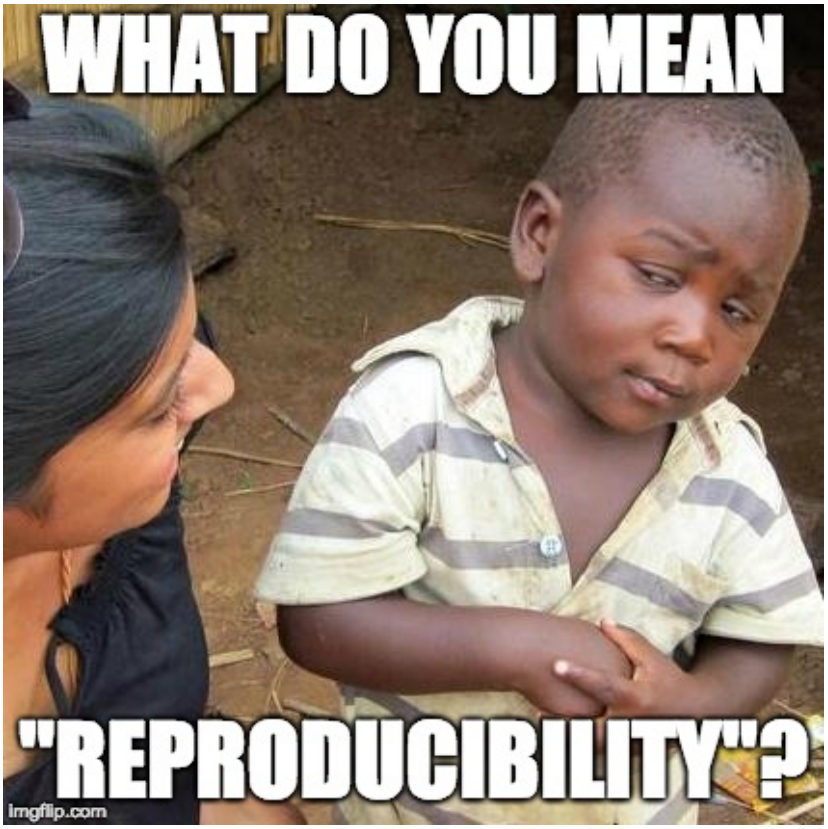
JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

Neuroconductor and Reproducibility: Imaging in R

https://github.com/muschellij2/Neuroimaging_in_R

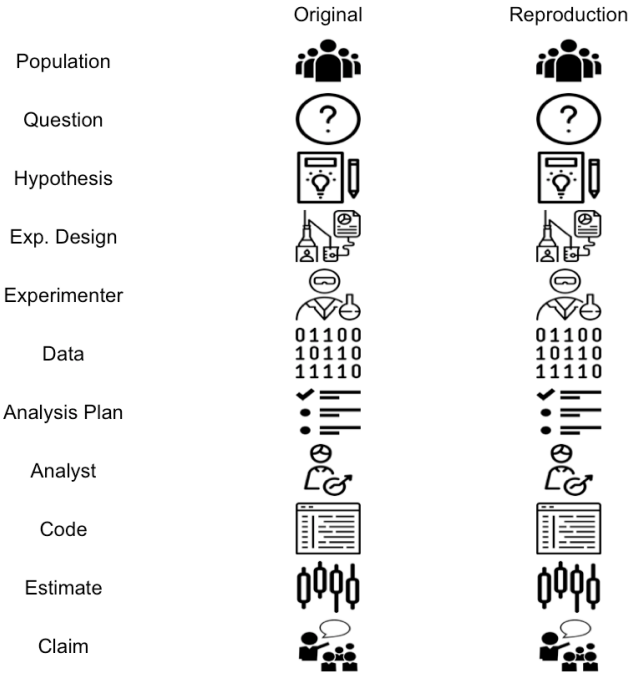
John Muschelli http://johnmuschelli.com/jsm_2018

https://imgflip.com/i/2ep2jb



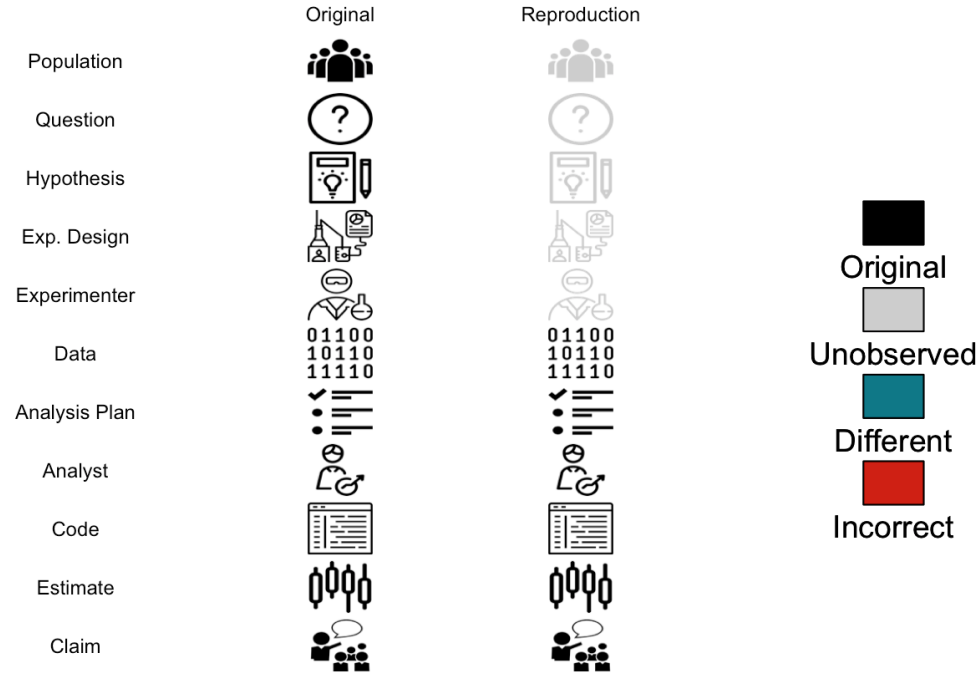
“Reproducibility” in General

(Patil, Peng, and Leek 2016)



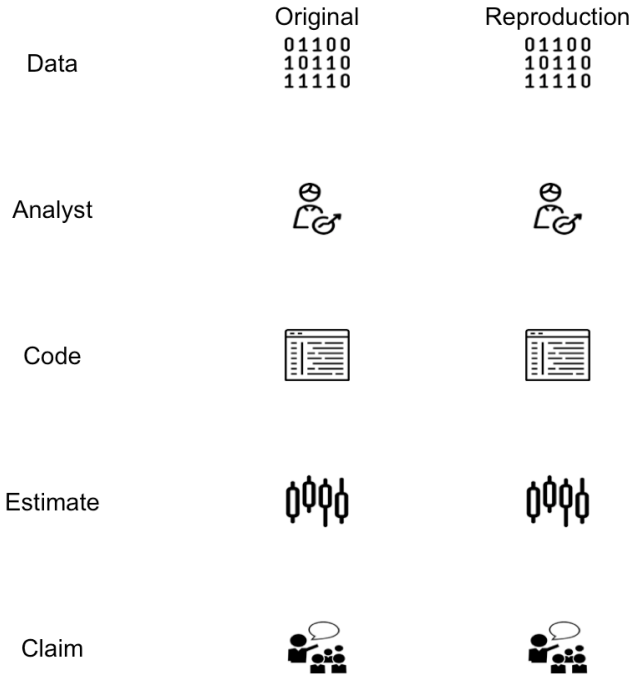
Neuroimaging Reproducibility

(Patil, Peng, and Leek 2016)



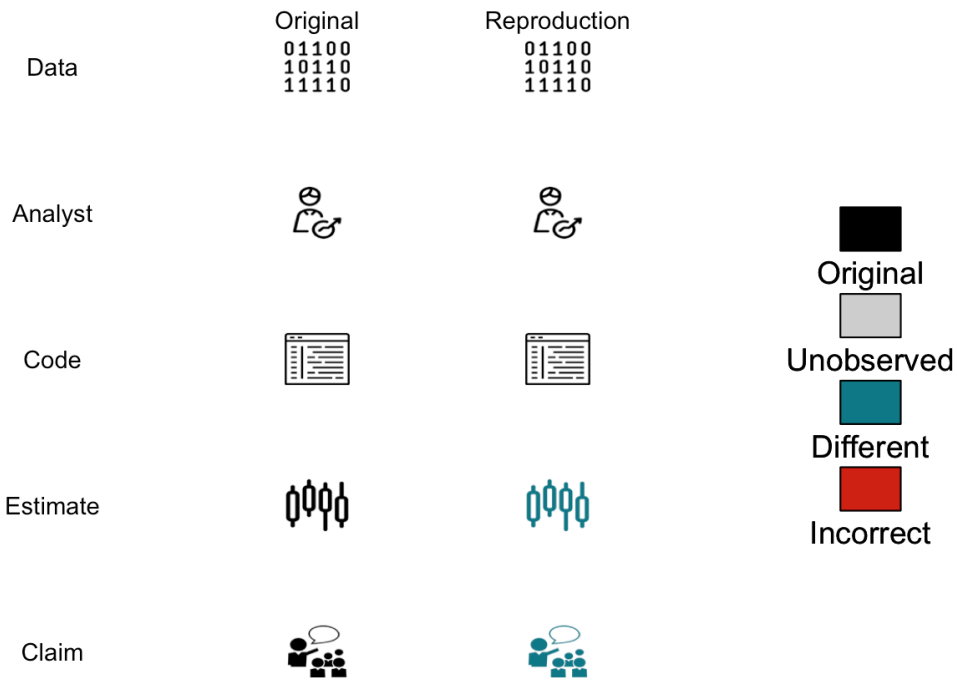
Neuroimaging Reproducibility Starts w/Data

(Patil, Peng, and Leek 2016)



Controversy in Neuroimaging: Won't Reproduce!

(Patil, Peng, and Leek 2016)



Controversy in Neuroimaging: Won't Reproduce!

(Patil, Peng, and Leek 2016)

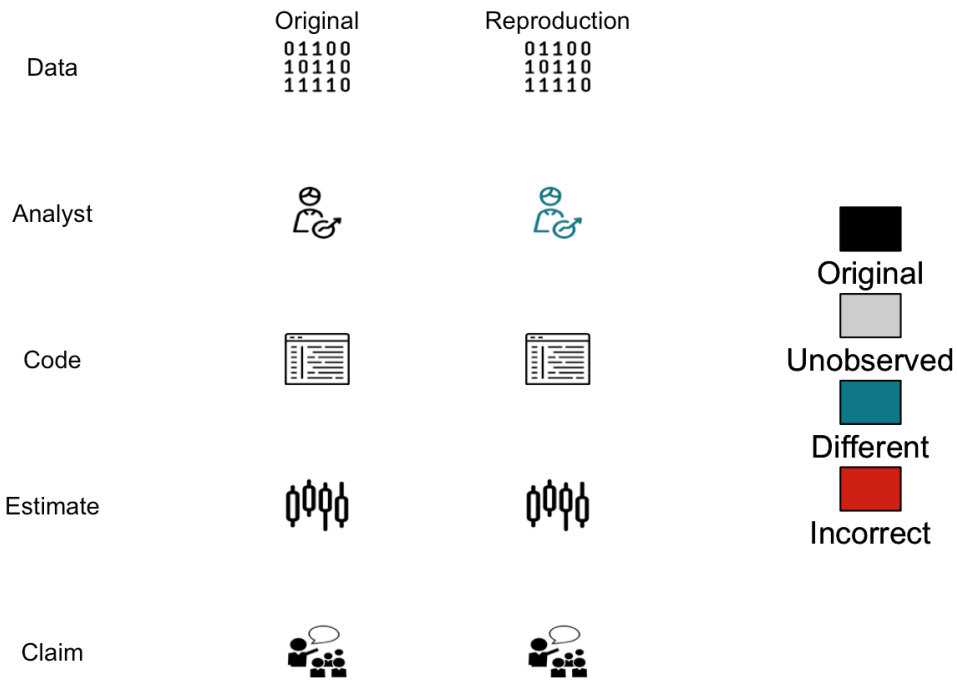
Software: Versions!

Gronenschild et al. (2012) (bold added):

“differences were on average 8.8±6.6% (range 1.3–64.0%) (volume) and 2.8±1.3% (1.1–7.7%) (cortical thickness). About a factor two smaller differences were detected between Macintosh and Hewlett-Packard workstations and between OSX 10.5 and OSX 10.6. **The observed differences are similar in magnitude as effect sizes reported in accuracy evaluations and neurodegenerative studies.**”

Minimum Reproducibility Goal

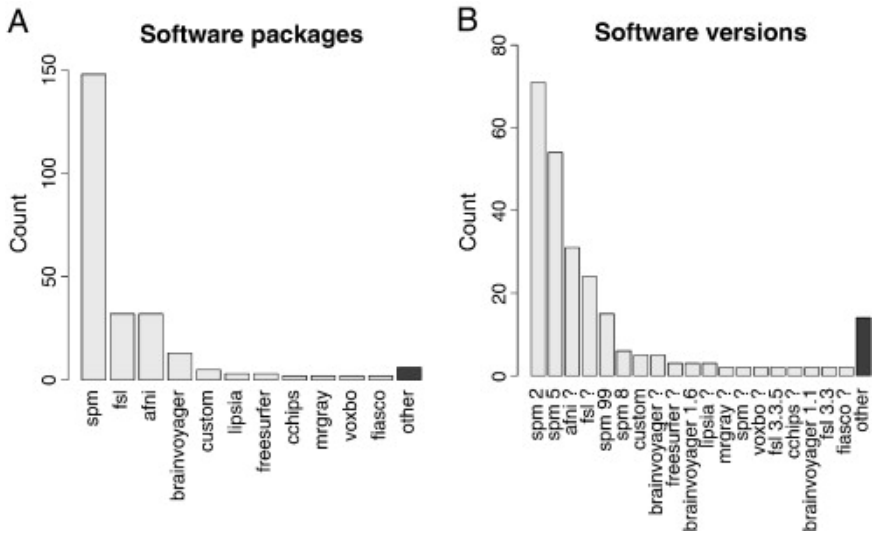
(Patil, Peng, and Leek 2016)



Controversy: Different Pipelines

(Patil, Peng, and Leek 2016)

It's typical to have lots of software choices



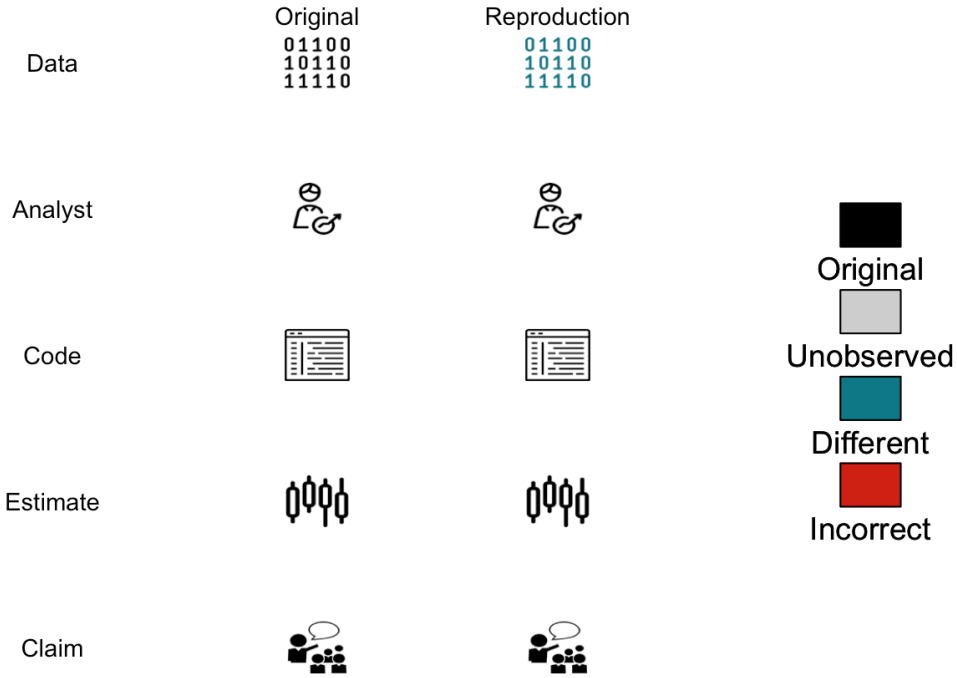
Carp, Joshua. "The secret lives of experiments: methods reporting in the fMRI literature." Neuroimage 63.1 (2012): 289-300. (Carp 2012)

Controversy: Ground Truth? (Replication)

(Patil, Peng, and Leek 2016)

Within-Population Replication (CV)

(Patil, Peng, and Leek 2016)



Genomics is one of the best examples of strives in Reproducibility: Data + Code Repositories

Bioinformatics Repository: Bioconductor

- centralized bioinformatics/genomics packages
- large community/number of packages (> 1300)
- **published tutorials and workflows**
- additional requirements to CRAN (e.g. packages need vignettes)

An R Platform for Medical Imaging Analysis

What is Neuroconductor?

1. A community of developers and users of R packages for imaging
2. A website https://neuroconductor.org/.
   - with tutorials and help
3. A team helping developers and users (John, Adi Gherman, Ciprian Crainiceanu, Brian Caffo)
4. A centralized repository of maintained packages

Goal: Centralize the packages (currently 73)

List Packages

View Dependency Graph | View Pending Packages

Show 50 entries | Search:

Package Name	Version	Package Title	Maintainer(s)	GitHub URL	Last updated
ANTsR	0.4.0	ANTs in R: quantification tools for biomedical images	Brian B. Avants	stnava/ANTsR	2017-03-18
ANTsRCore	0.0.0	ANTsRCore: core software infrastructure for ANTsR	Brian B. Avants	stnava/ANTsRCore.git	2017-03-18
brainR	1.4.2.1	Helper Functions to Misc3d and rgl Packages for Brain Imaging	John Muschelli	muschellij2/brainR	2017-05-26
cifti	0.4.2	Toolbox for Connectivity Informatics Technology Initiative ('CIFTI') Files	John Muschelli	muschellij2/cifti	2017-05-26
dcemriS4	0.57.1.2	A Package for Image Analysis of DCE-MRI (S4 Implementation)	Brandon, Whitcher	bjw34032/dcemriS4	2017-05-26
dcm2niir	0.5	Conversion of 'DICOM' to 'NIfTI' Imaging Files Through R	John Muschelli	muschellij2/dcm2niir	2017-02-24
divest	0.3.0.1	Get Images Out of DICOM Format Quickly	Jon Clayden	jonclayden/divest	2017-05-25
EveTemplate	0.99.14.2	JHU-MNI-ss (Eve) template	Jean-Philippe Fortin	Jfortin1/EveTemplate	2017-05-26
extrantsr	2.17.2.3	Extra Functions to Build on the ANTsR Package	John Muschelli	muschellij2/extrantsr.git	2017-05-26
freesurfer	1.6.6	Wrapper Functions for 'Freesurfer'	John Muschelli	muschellij2/freesurfer	2017-05-26
fslr	2.12.6	Wrapper Functions for FSL ('FMRIB' Software Library) from Functional MRI of the Brain ('FMRIB')	John Muschelli	muschellij2/fslr	2017-05-26
gifti	0.7	Reads in Neuroimaging 'GIFTI' Files with Geometry Information	John Muschelli	muschellij2/gifti	2016-11-09
ITKR	0.0.1	ITK in R	Brian B. Avants	stnava/ITKR	2017-02-24
itksnapr	2.1.6	Package of ITK-SNAP	John Muschelli	muschellij2/itksnapr	2017-05-26
kirby21.asl	1.5.1	Example ASL Data from the Multi-Modal MRI Reproducibility Resource	John Muschelli	muschellij2/kirby21.asl	2017-05-03

Many Cases in Neuroimaging: Why?

(Patil, Peng, and Leek 2016)

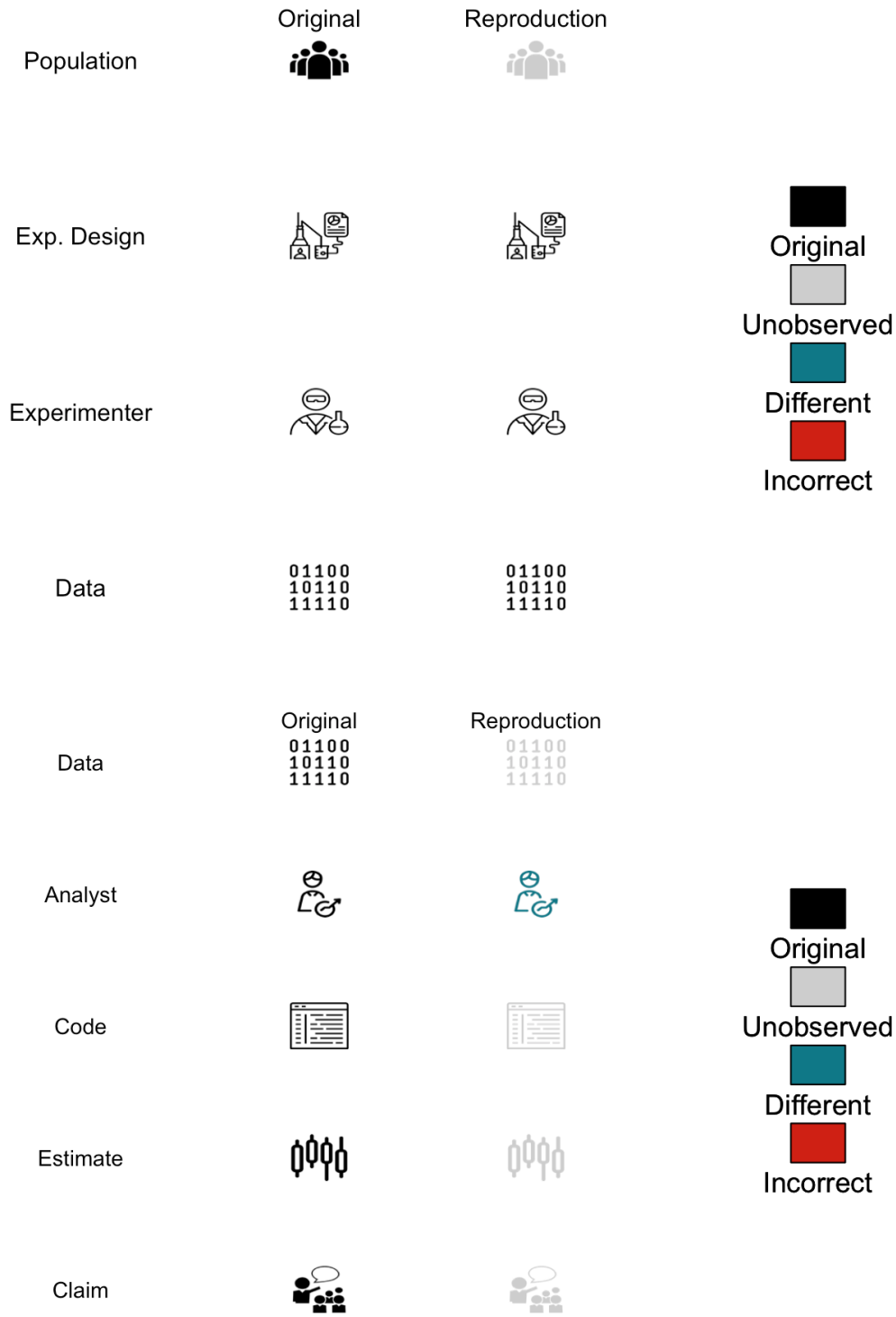
Data: Submitting Not Required

R packages to access these repositories

- so if there, need ability to access

Seldomly Reported Inclusion/Exclusion

(Patil, Peng, and Leek 2016)



Opportunities: RCT/CONSORT diagrams

https://imgflip.com/i/2bltgh

What we need: tutorials

Neuroconductor

2018-04-19

Guides for Developers

1. Preparing Your Package for Submission
2. Changes to your Package

Frequently Asked Questions (FAQ)

Please visit the FAQ for information on how to begin.

Installation Guides

1. Installing devtools
2. Installing ANTsR

Required Readings

1. NIfTI Basics

Data

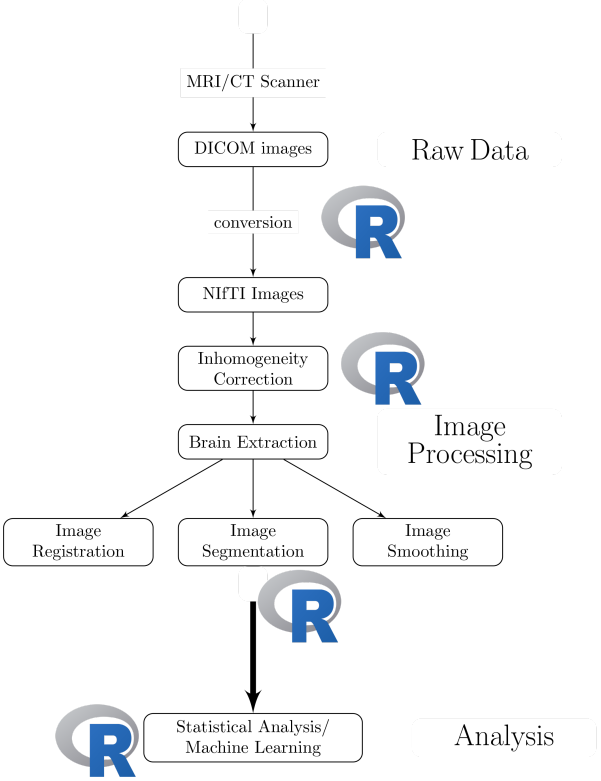
1. Downloading Human Connectome Project Data
2. Downloading Functional Connectomes Projects

Need Workflows

- all R code
  - interface/pipeline tool
  - "native" R code

Complete pipeline

- preprocessing and analysis



R Packages to Download Data

1. nitrcbot - download f/NITRC
2. neurovault - access neurovault
3. MNITemplate - population-level “template” image
4. EveTemplate - different template image
5. kirby21 - sample data with multimodal imaging
6. neurohcp - Human Connectome Project
7. Rxnat - XNAT interface
8. malf.templates - template images f/label fusion

Publishing Software should be Rewarded

- R Journal - see `rticles::rjournal_article()`
- F1000 - https://f1000research.com/collections/Neuroconductor
- JOSS - https://joss.theoj.org/
- JSS - see `rticles::jss_article()`
- `cranlogs` track downloads
- neuroconductor API tracks downloads

Conclusions

- Need data submitted (journals need to help)
  - but need easy tools to access the data
- Analysis tools exist but need more
- Develop more standardization like BioConductor
  - standard data structures
  - publishable pipelines

Bibliography

Carp, Joshua. 2012. “The Secret Lives of Experiments: Methods Reporting in the fMRI Literature.” 63 (1). Elsevier:289–300.

Gronenschild, Ed HBM, Petra Habets, Heidi IL Jacobs, Ron Mengelers, Nico Rozendaal, Jim Van Os, and Machteld Marcelis. 2012. “The Effects of Freesurfer Version, Workstation Type, and Macintosh Operating System Version on Anatomical Volume and Cortical Thickness Measurements.” 7 (6). Public Library of Science:e38234.

Patil, Prasad, Roger D. Peng, and Jeffrey Leek. 2016. “A Statistical Definition for Reproducibility and Replicability.” . Cold Spring Harbor Laboratory. https://doi.org/10.1101/066803.