Introduction and R

About Us

John Muschelli

Assistant Scientist, Department of Biostatistics

PhD in Biostatistics

- worked on fMRI, sMRI, and CT for ≈ 7 years

Email: jmusche1@jhu.edu

Kristin Linn

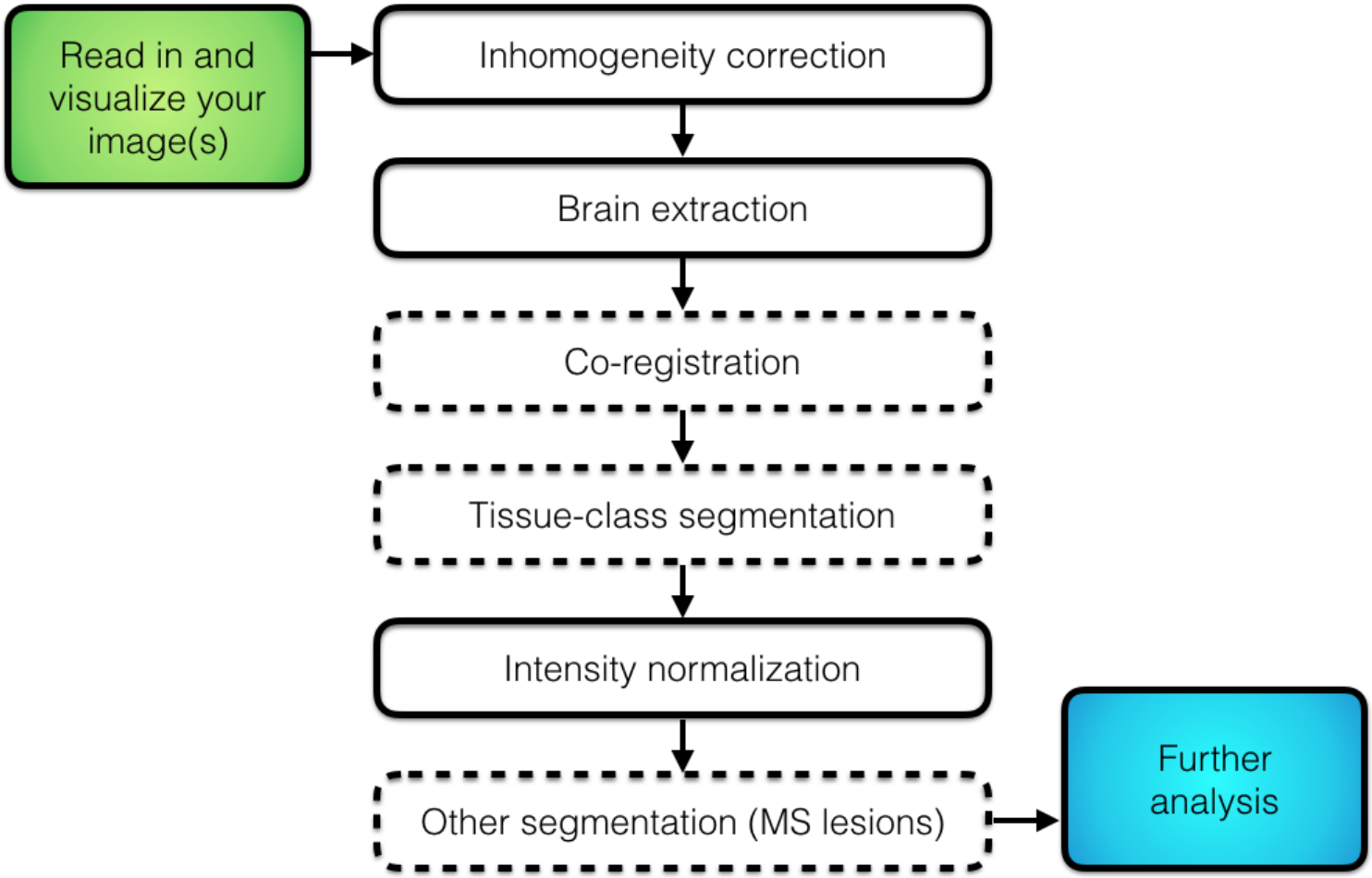
Assistant Professor, Department of Biostatistics and Epidemiology Perelman School of Medicine, University of Pennsylvania

PhD in Statistics

- worked on sMRI for 3 years

Email: klinn@mail.med.upenn.edu

Overall Pipeline

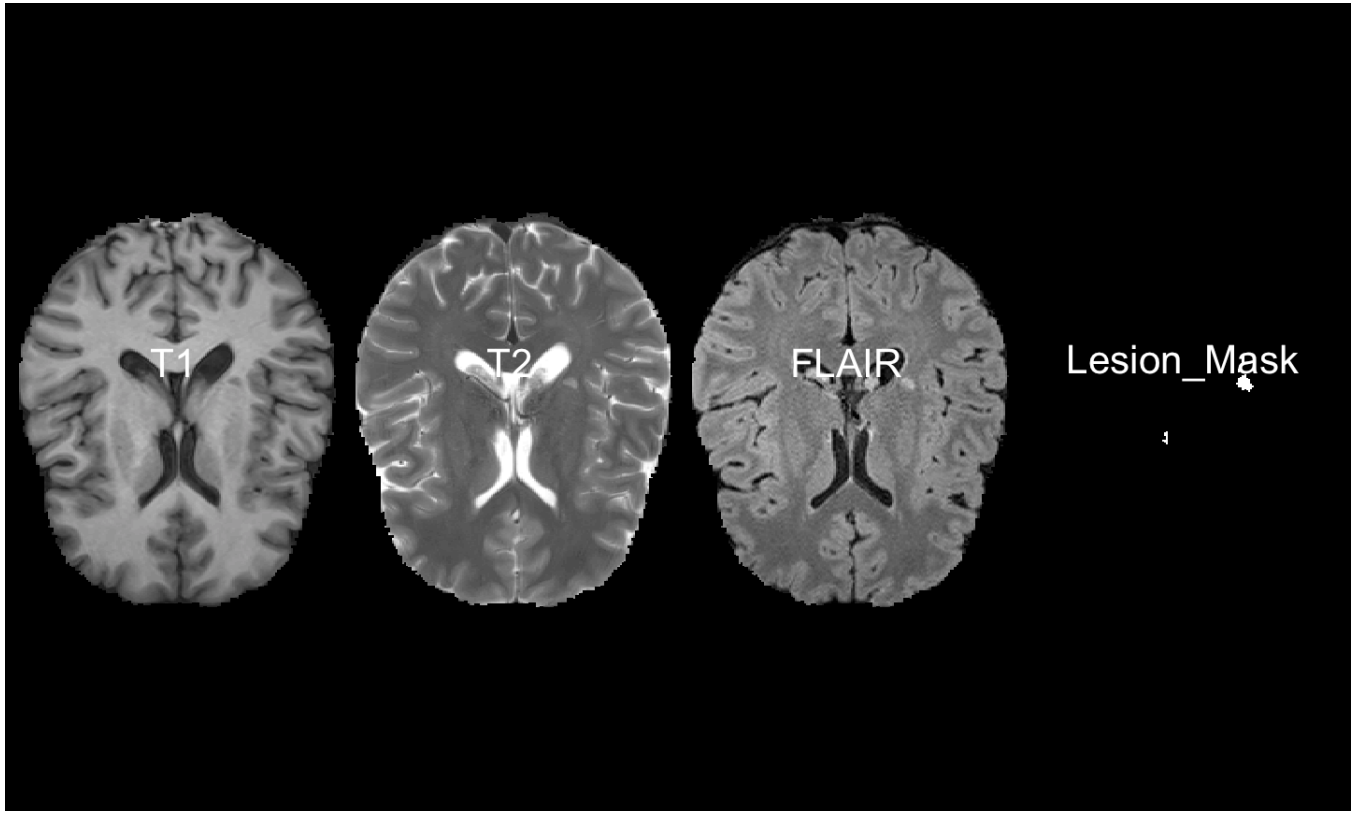


Imaging Data Used: Multiple Sclerosis

- Multiple sclerosis (MS) is a chronic disease of the central nervous system (brain, spinal chord, optic nerves)
- MS lesions in the brain are areas of active inflammation, demylenation, or permanent tissue damage.
    - lesions are primarily in the white matter
- The full data is available at https://smart-stats-tools.org.

Imaging Data Used: Multiple Sclerosis

- MRI is well-suited for assessing lesion burden (volume and patterns) because lesions appear as hyperintensities on FLAIR and T2-w images and as hypointensities on T1-w images.
- Using 5 training and 3 test subjects data from the MS lesion challenge 2016 (http://iacl.ece.jhu.edu/index.php/MSChallenge)



Formats of Images

There are multiple imaging formats. We will use NIfTI:

- NIfTI - Neuroimaging Informatics Technology Initiative (https://nifti.nimh.nih.gov/nifti-1)
  - essentially a header and data (binary format)
  - will have extension .nii (uncompressed) or .nii.gz (compressed)
  - we will use 3-D images (4-D and 5-D are possible)
- ANALYZE 7.5 was a precursor to NIfTI
  - had a `hdr` file (header) and `img` file (data)

Course Website/Materials

The Course overview is located at (with slides): http://johnmuschelli.com/ISBI_2017.html

All materials for this course (including source for the slides) is located at:

https://github.com/muschellij2/imaging_in_r

RStudio Server

For this course, we will use an RStudio Server because installing all the packages can be a lengthy process. Mostly all the code we show requires a Linux/Mac OSX platform for FSL and other systems:

http://johnmuschelli.com/rstudio_server.html

Introduction to R

What is R?

- R is a language and environment for statistical computing and graphics
- R was implemented over the S language, which was developed by Bell laboratories
- R is both open source and open development

(source: http://www.r-project.org/)

Why R?

- Powerful and flexible
- Free (open source)
- Extensive add-on software (packages)
- Designed for statistical computing
- High level language

Why not R?

- Fairly steep learning curve
- Little centralized support, relies on online community and package developers
- Slower, and more memory intensive, than the more traditional programming languages (C, Java, Perl, Python)

What comes with R

- R revolves around functions
  - Commands that take input, performs computations, and returns results
  - When you download R, it has a “base” set of functions/packages (**base R**)
- Functions are enclosed in packages
  - A package is collection of functions, documentation, data, and tutorials (called vignettes).
  - Written by R users/developers (like us) - **some are bad**
  - You install a package using the `install.packages` command/function:

```
install.packages("oro.nifti")
```

`install.packages` is a function, `"oro.nifti"` is a character string.

Neuroconductor

- Most packages are in a repository Comprehensive R Archive Network (CRAN)
- Neuroconductor (https://neuroconductor.org/) has packages related to medical imaging

```
source("https://neuroconductor.org/neurocLite.R")
neuro_install("oro.nifti")
```

Loading Packages

When you install a package, it's downloaded to the hard disk. That mean that you can use the functions from that package just yet.

- You "load"/import a package into memory using the `library` command

For example, to load the `oro.nifti` package:

```
library(oro.nifti)
```

Now, functions from the `oro.nifti` package can be used.

RStudio (the software)

RStudio is an Integrated Development Environment (IDE) for R (made by RStudio the company)

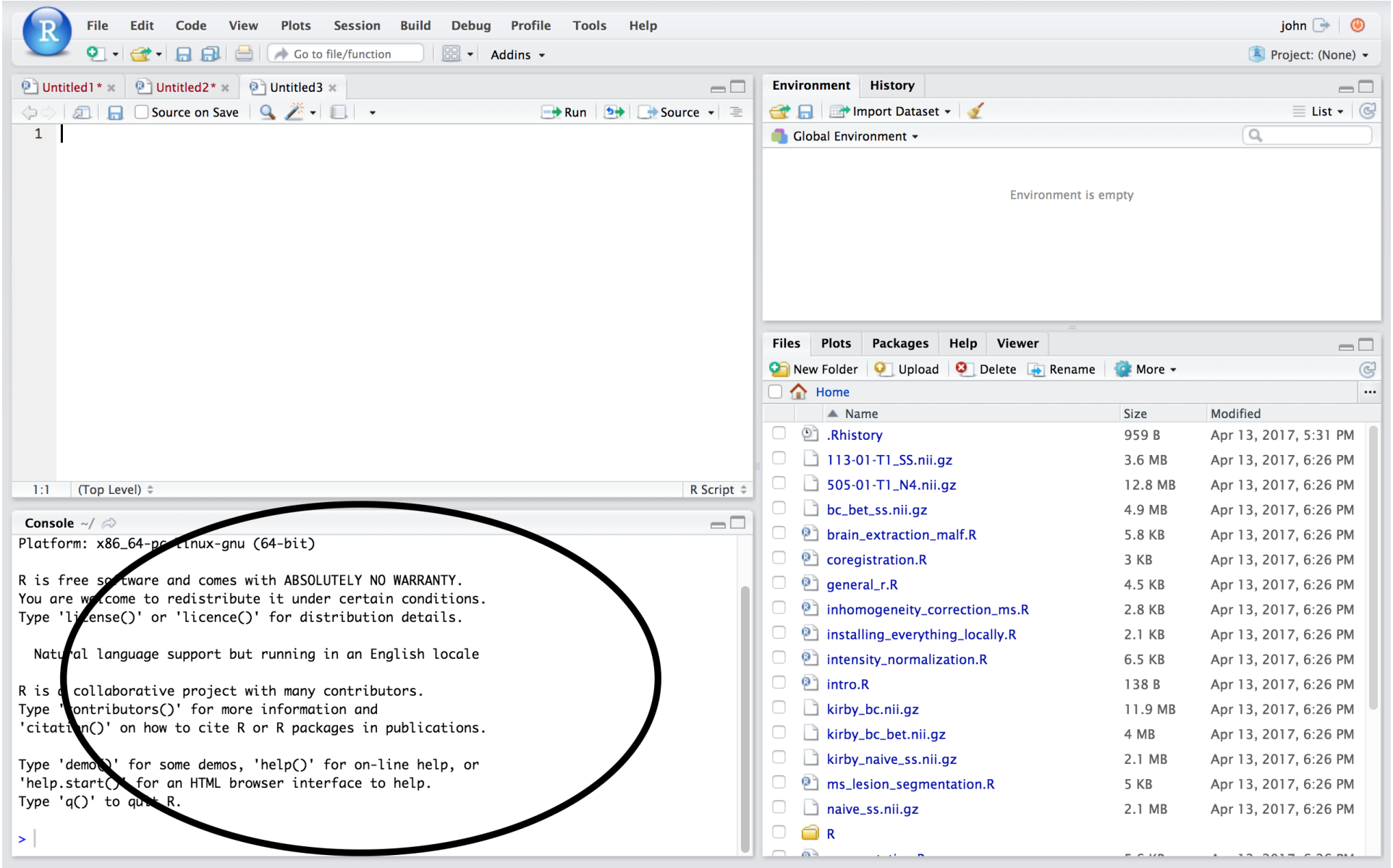
- It helps the user effectively and more easily use R.
  - Syntax highlighting, code completion, and smart indentation
  - Easily manage multiple working directories and projects
- Is NOT dropdown statistical tools (such as Stata)
  - See Rcmdr or Radiant

R essentially is a command line with a set of functions loaded

RStudio/R Console

- Where code is executed (where things happen)
- You can type here for things interactively
- Code is **not saved** on your disk
    - Can act as a calculator
    - Creating variables/objects
    - Applying functions

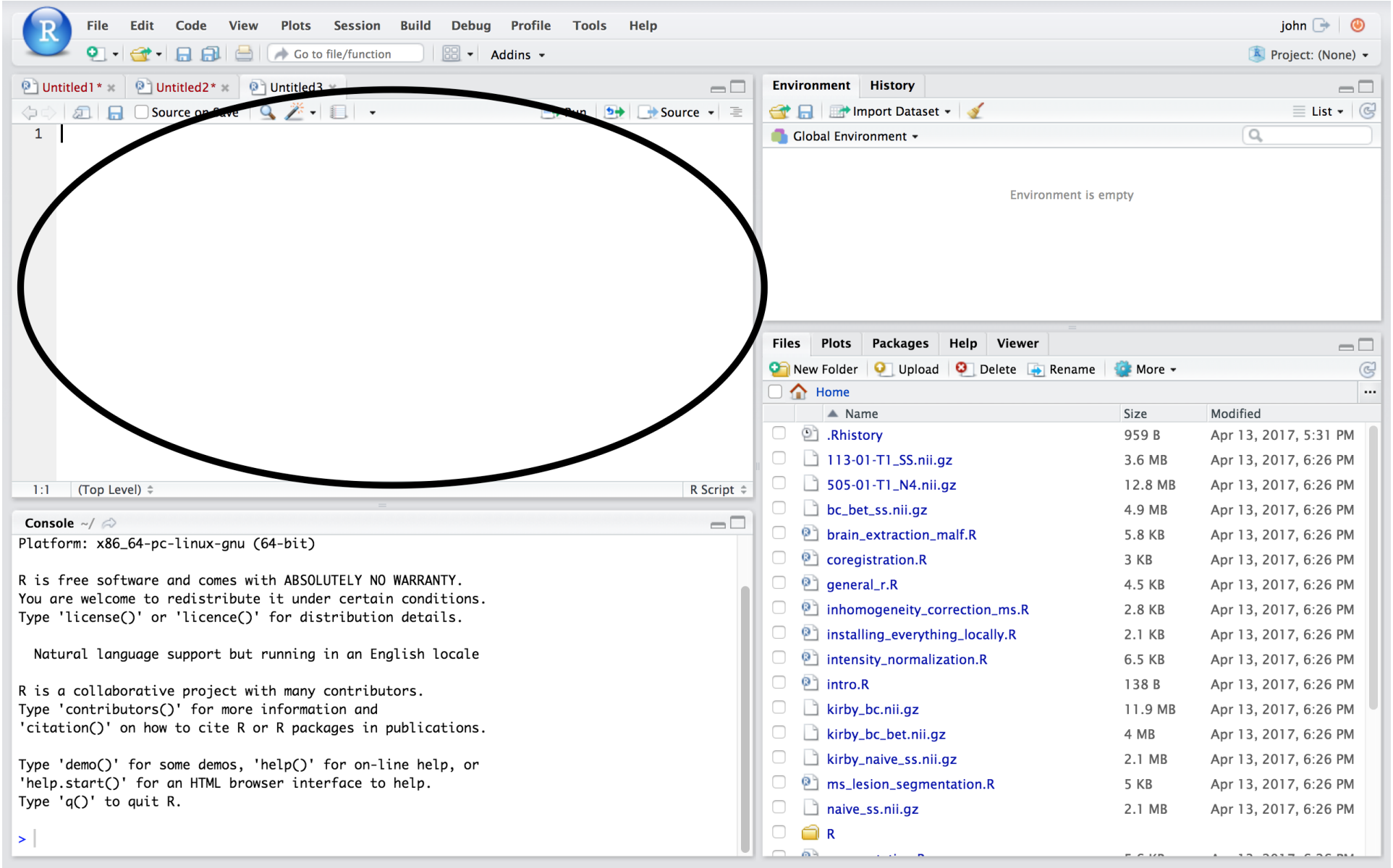
RStudio/R Console



Source

- Where files open to
- Have R code and comments in them
  - Static copy of what you did (reproducability)
  - Try things out interactively, then add to your script
- Can highlight and press (CMD+Enter (Mac) or Ctrl+Enter (Windows)) to run the code
- Code is saved to disk

Source/Editor



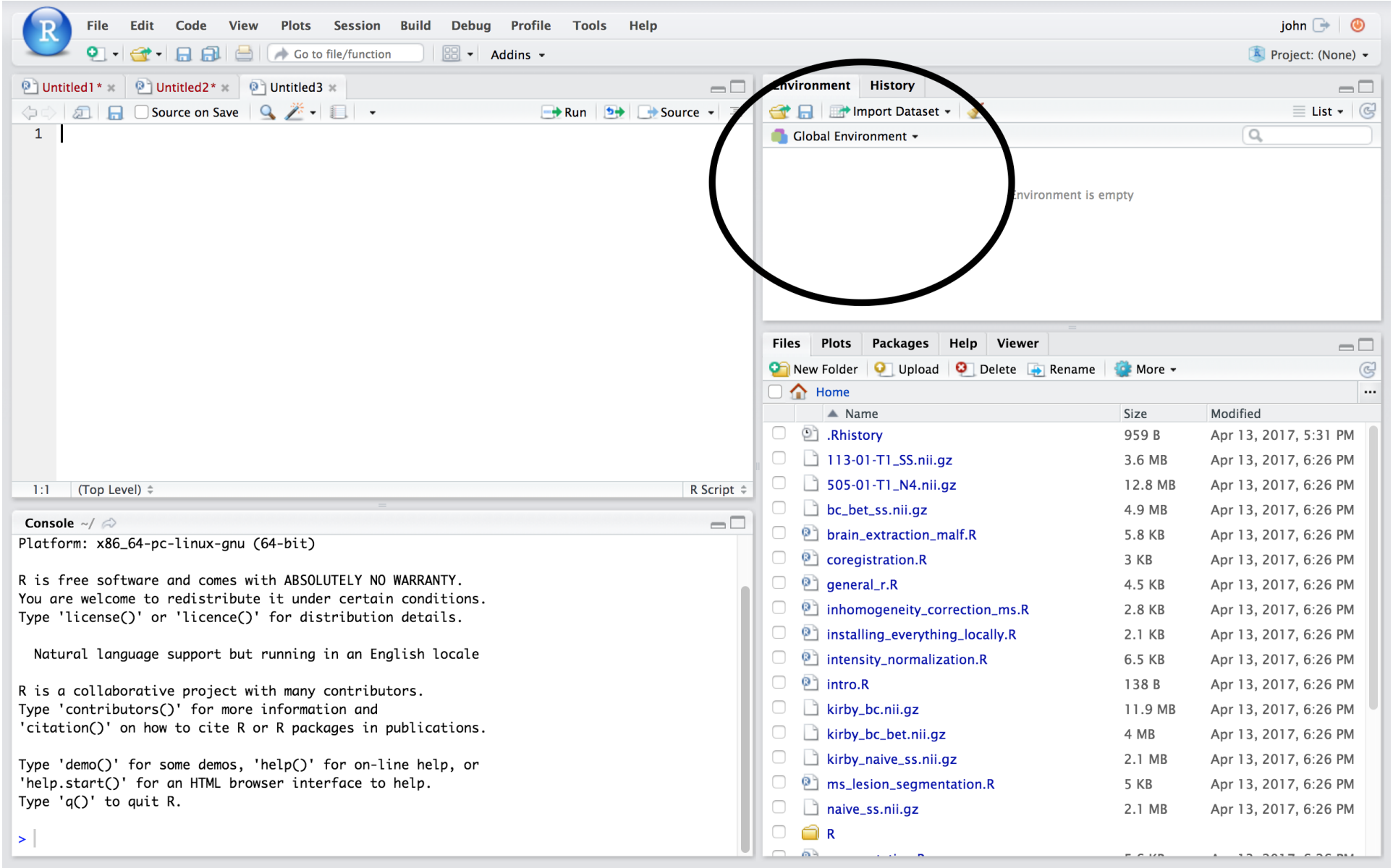
Workspace/Environment

- Tells you what **objects** are in R
- What exists in memory/what is loaded?/what did I read in?

History

- Shows previous commands. Good to look at for debugging, but **don't rely** on it as a script. Make a script!
- Also type the "up" key in the Console to scroll through previous commands

Workspace/Environment



Other Panes

- **Files** - shows the files on your computer of the directory you are working in
- **Viewer** - can view data or R objects
- **Help** - shows help of R commands
- **Plots** - pretty pictures
- **Packages** - list of R packages that are loaded in memory

Website

http://johnmuschelli.com/imaging_in_r