Introduction to R

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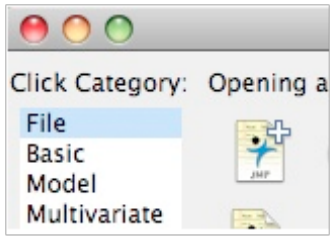
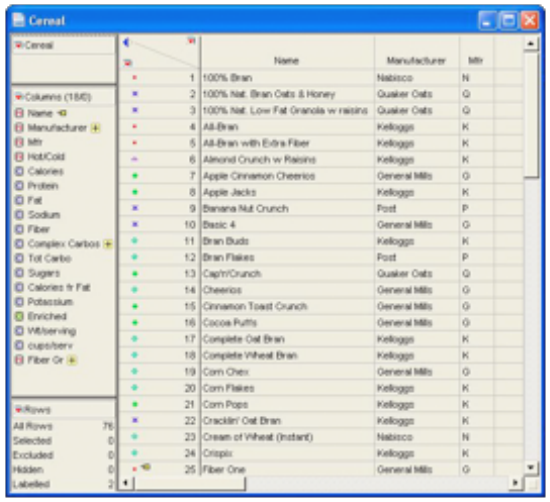
M to see all slides, G to go to a specific slide

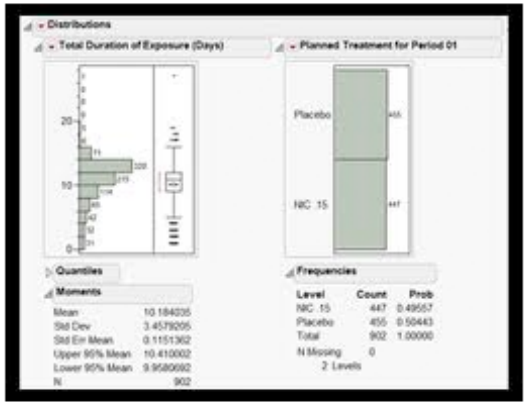
R is a language that's easy to learn badly

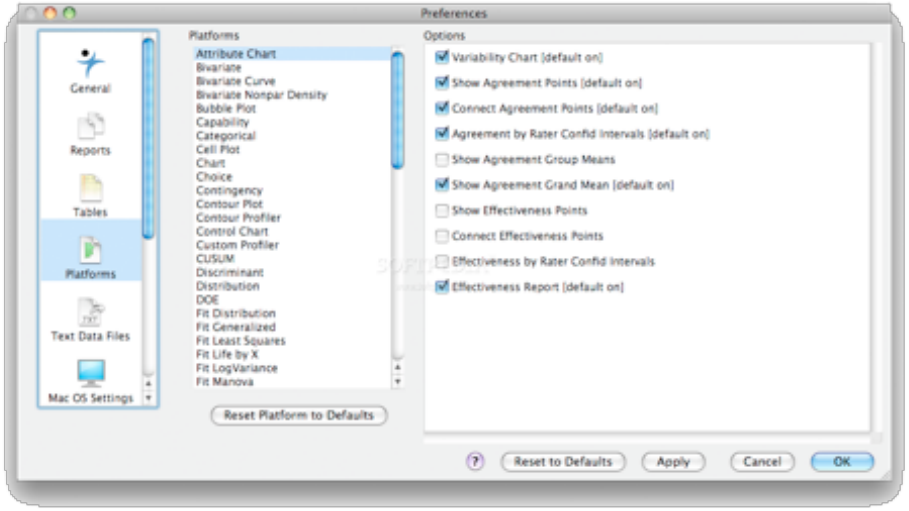
Why R?

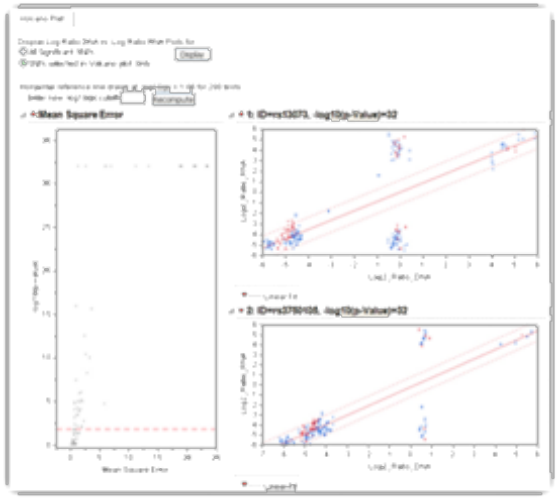
The old way...


Click Category: Opening a
File
Basic
Model
Multivariate


Cereal
Name
Manufacturer
1 100% Bran Nabisco
2 100% Nat. Bran Oats & Honey Quaker Oats
3 100% Nat. Low Fat Granola w raisins Quaker Oats
4 All-Bran Kelloggs
5 All-Bran with Extra Fiber Kelloggs
6 Almond Crunch w Raisins Kelloggs
7 Apple Cinnamon Cheerios General Mills
8 Apple Jacks Kelloggs
9 Banana Nut Crunch Post
10 Basic 4 General Mills
11 Bran Buds Kelloggs
12 Bran Flakes Post
13 Cap'n'Crunch Quaker Oats
14 Cheerios General Mills
15 Cinnamon Toast Crunch General Mills
16 Cocoa Puffs General Mills
17 Complete Oat Bran Kelloggs
18 Complete Wheat Bran Kelloggs
19 Corn Chex General Mills
20 Corn Flakes Kelloggs
21 Corn Pops Kelloggs
22 Crackin' Oat Bran Kelloggs
23 Cream of Wheat (Instant) Nabisco
24 Crispix Kelloggs
25 Fiber One General Mills


Distributions
Total Duration of Exposure (Days)
Planned Treatment for Period 01
Placebo
NIC 15
Quantiles
Moments
Mean 10.184035
Std Dev 3.4579205
Std Err Mean 0.1151362
Upper 95% Mean 10.410002
Lower 95% Mean 9.9580682
N 902
Frequencies
Level Count Prob
NIC 15 447 0.49557
Placebo 455 0.50443
Total 902 1.00000
N Missing 0
2 Levels


Preferences
General
Reports
Tables
Platforms
Text Data Files
Mac OS Settings
Platforms
Attribute Chart
Bivariate
Bivariate Curve
Bivariate Nonpar Density
Bubble Plot
Capability
Categorical
Cell Plot
Chart
Choice
Contingency
Contour Plot
Contour Profiler
Control Chart
Custom Profiler
CUSUM
Discriminant
Distribution
DOE
Fit Distribution
Fit Generalized
Fit Least Squares
Fit Life by X
Fit LogVariance
Fit Manova
Reset Platform to Defaults
Options
Variability Chart [default on]
Show Agreement Points [default on]
Connect Agreement Points [default on]
Agreement by Rater Confid Intervals [default on]
Show Agreement Group Means
Show Agreement Grand Mean [default on]
Show Effectiveness Points
Connect Effectiveness Points
Effectiveness by Rater Confid Intervals
Effectiveness Report [default on]
Reset to Defaults
Apply
Cancel
OK


Mean Square Error

Why R?

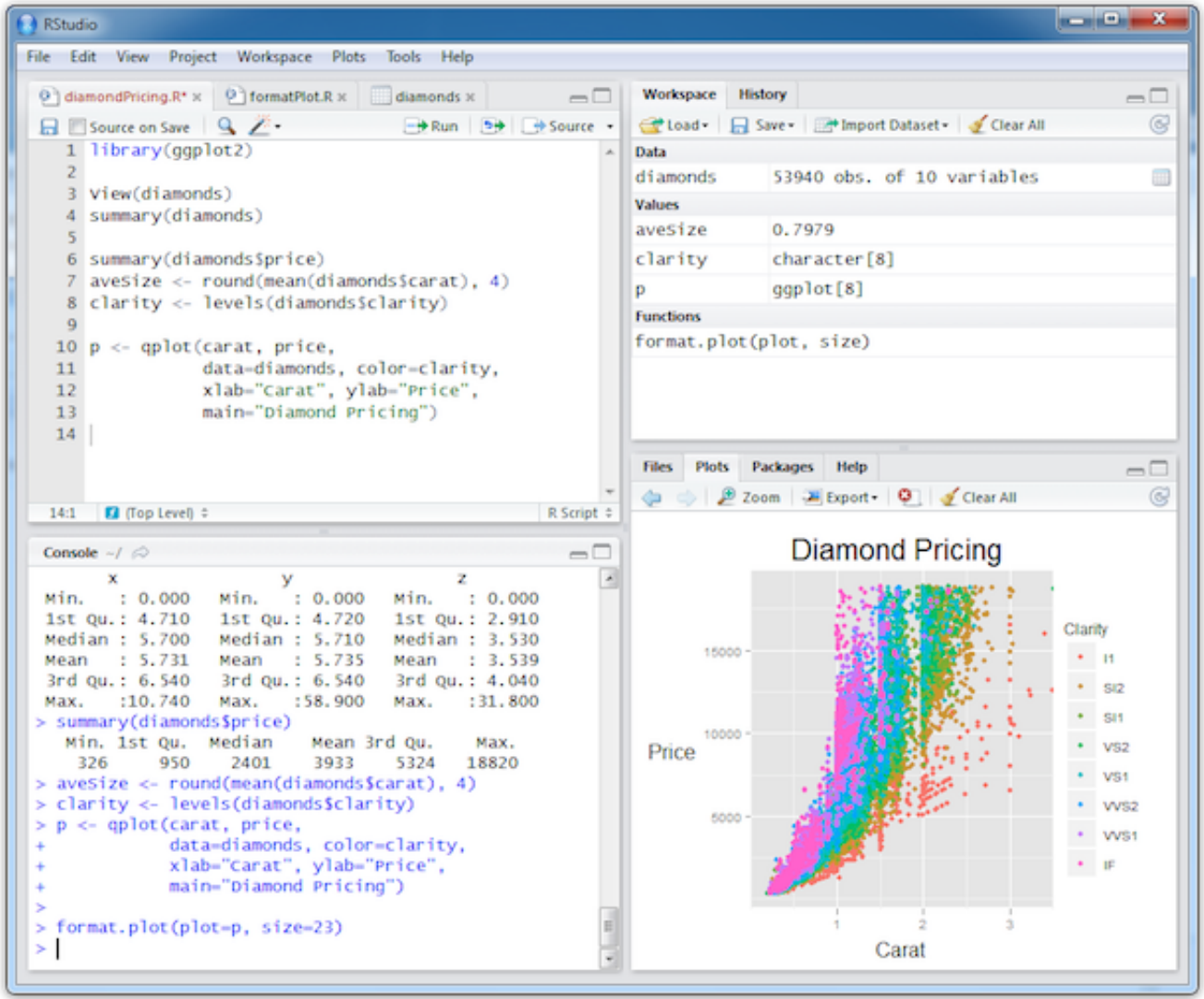
A better way

```
glm(y ~ -1 + a + c + z + a:z, data = mydata, maxit = 30)
```

This is reproducible, repeatable and will make sense to you (and everyone else) further down the line.

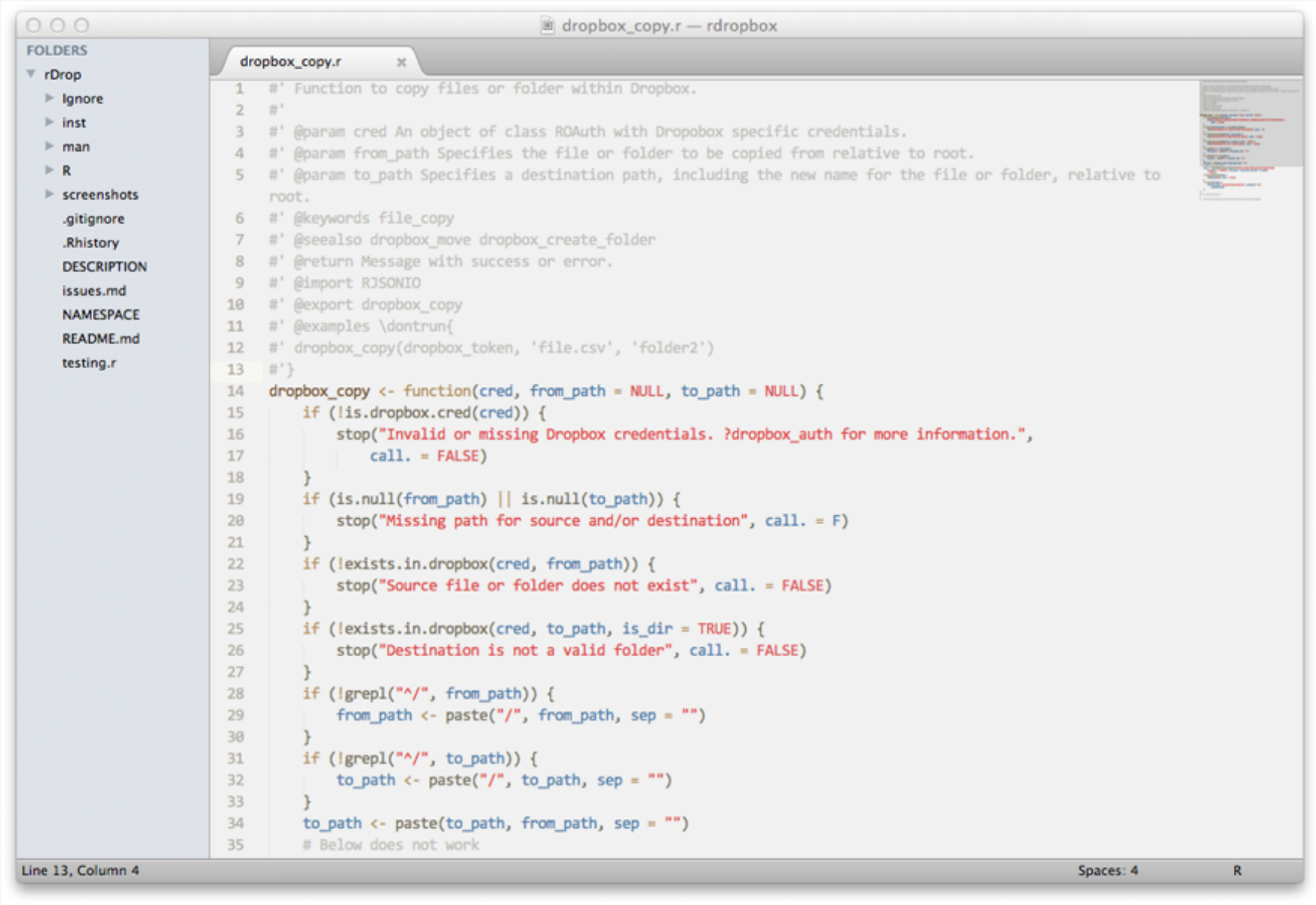
Choose an appropriate code editor

I. **R Studio**


RStudio
File Edit View Project Workspace Plots Tools Help
diamondPricing.R* formatPlot.R diamonds
Source on Save Run Source
1 library(ggplot2)
2
3 View(diamonds)
4 summary(diamonds)
5
6 summary(diamonds$price)
7 aveSize <- round(mean(diamonds$carat), 4)
8 clarity <- levels(diamonds$clarity)
9
10 p <- qplot(carat, price,
11 data=diamonds, color=clarity,
12 xlab="Carat", ylab="Price",
13 main="Diamond Pricing")
14
14:1 (Top Level) R Script
Workspace History
Load Save Import Dataset Clear All
Data
diamonds 53940 obs. of 10 variables
Values
aveSize 0.7979
clarity character[8]
p ggplot[8]
Functions
format.plot(plot, size)
Files Plots Packages Help
Zoom Export Clear All
Diamond Pricing
Price
Carat
Clarity
I1
SI2
SI1
VS2
VS1
VVS2
VVS1
IF
15000
10000
5000
1
2
3
Console ~/
x y z
Min. : 0.000 Min. : 0.000 Min. : 0.000
1st Qu.: 4.710 1st Qu.: 4.720 1st Qu.: 2.910
Median : 5.700 Median : 5.710 Median : 3.530
Mean : 5.731 Mean : 5.735 Mean : 3.539
3rd Qu.: 6.540 3rd Qu.: 6.540 3rd Qu.: 4.040
Max. :10.740 Max. :58.900 Max. :31.800
> summary(diamonds$price)
Min. 1st Qu. Median Mean 3rd Qu. Max.
326 950 2401 3933 5324 18820
> aveSize <- round(mean(diamonds$carat), 4)
> clarity <- levels(diamonds$clarity)
> p <- qplot(carat, price,
+ data=diamonds, color=clarity,
+ xlab="Carat", ylab="Price",
+ main="Diamond Pricing")
>
> format.plot(plot=p, size=23)
>

I. TinnR (Windows), Sublime Text (all), Text Wrangler (osx) etc.

All come with key bindings. Pick one that you like.



Establish a workflow

A workflow (best suited to you) will help keep your analysis streamlined and reproducible.

A sample workflow

load.r

load all raw untransformed data.

→

clean.r

Transform and clean messy data incl. missing values.

→

functions.r

Keep all functions in one separate file.

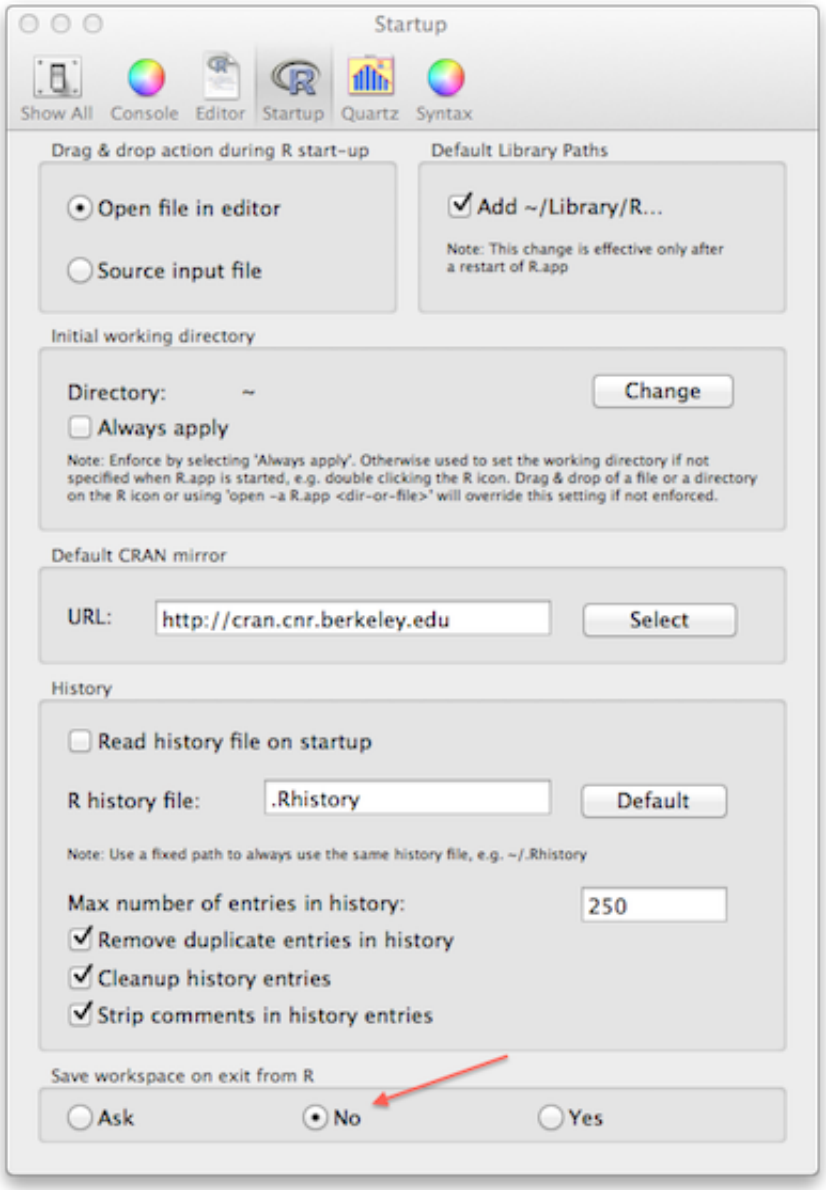
→

do.r

Your actual analysis. Load cleaned data and source all functions.

```
# File: do.r
source("functions.r")
load("cleaned_data.rdata")
```

Avoid restoring workspaces



Workflow...

Set working directores from scripts, not the console.

```
# My_script.r
setwd("path/to/dir")
# Removing any extra objects from my workspace (just in case)
rm(list = ls())
# Keeps my current file clutter free
source("related_r_scripts.r")
```

Workflow...

Never attach data

```
~~attach(mydata)~~
```

Always refer to it explicitly

```
mydata$column_name
```

Environments and Namespaces

Global Environment

```
a <-  rnorm(100)
```

Function or Namespace

```
a <- 5
```

Annotate your code clearly

Good ✔

```
# Script to analyze
rainfall data.
# loading lib: plyr_1.7.1,
devtools_0.6,
ggplot2_0.9.0
library(stringr)
library(ggplot2)
library(plyr)
# reading previously
cleaned data
load("data_files.rdata")
# Sourcing functions
source("functions.r")
# Setting up parameters
annual_mean <- 25
# mean value is in cm
```

Bad ✖

```
library(ggplot2)
foo <-
read.csv("file1.csv")
a <- 1
b <- 3
test <-
function(foo2) {
    return(a + b)
}
```

Quick guide to R data types

```
# Vector: (single dimension, all same type)
vec1 <- 1:10
class(vec1)
## [1] "integer"
vec2 <- letters[1:10]
class(vec2)
## [1] "character"
# Data Frame: Each column is a vector, but adjacent vectors can hold
different things
# Matrix: Just like a data.frame except it's all numeric
# List: (any dimension, mix and match)
l1 <- list(A = data.frame(x = 1:10, y = rnorm(10)),
    B = 1, C = letters[1:3])
str(l1)
## List of 3
  $ A:'data.frame':     10 obs. of  2 variables:
   ..$ x: int [1:10] 1 2 3 4 5 6 7 8 9 10
   ..$ y: num [1:10] 0.618 0.519 0.343 0.428 -0.885 ...
  $ B: num 1
```

```
$ C: chr [1:3] "a" "b" "c"
```

Finding Help

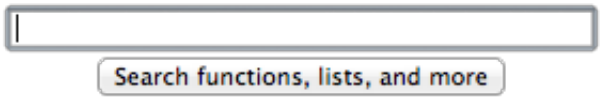
Locally

```
?function_name
??function_name
RSiteSearch("function_name")
```

Online

StackOverflow.com/questions/tagged/r

Rseek.org



sessionInfo()

```
sessionInfo()
## R version 2.14.2 (2012-02-29)
 Platform: x86_64-apple-darwin9.8.0/x86_64 (64-bit)

 locale:
 [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8

 attached base packages:
 [1] graphics  grDevices utils     datasets  stats     methods
base

 other attached packages:
 [1] knitr_0.3      formatR_0.3-4  devtools_0.6   plyr_1.7.1
 [5] reshape2_1.2.1 ggplot2_0.9.0

 loaded via a namespace (and not attached):
  [1] codetools_0.2-8    colorspace_1.1-1   dichromat_1.2-4
  [4] digest_0.5.1       evaluate_0.4.1     gdata_2.8.2
  [7] grid_2.14.2        gtools_2.6.2       highlight_0.3.1
```

```
[10] MASS_7.3-17        memoise_0.1        munsell_0.3
[13] parser_0.0-14      proto_0.3-9.2      RColorBrewer_1.0-5
[16] Rcpp_0.9.10        RCurl_1.91-1       scales_0.2.0
[19] stringr_0.6        tools_2.14.2
```

Use `dput()` to share some data

```
dput(head(mtcars))
structure(list(mpg = c(21, 21, 22.8, 21.4, 18.7, 18.1), cyl = c(6,
 6, 4, 6, 8, 6), disp = c(160, 160, 108, 258, 360, 225), hp = c(110,
 110, 93, 110, 175, 105), drat = c(3.9, 3.9, 3.85, 3.08, 3.15,
 2.76), wt = c(2.62, 2.875, 2.32, 3.215, 3.44, 3.46), qsec =
c(16.46,
 17.02, 18.61, 19.44, 17.02, 20.22), vs = c(0, 0, 1, 1, 0, 1),
     am = c(1, 1, 1, 0, 0, 0), gear = c(4, 4, 4, 3, 3, 3), carb =
c(4,
     4, 1, 1, 2, 1)), .Names = c("mpg", "cyl", "disp", "hp", "drat",
 "wt", "qsec", "vs", "am", "gear", "carb"), row.names = c("Mazda
RX4",
 "Mazda RX4 Wag", "Datsun 710", "Hornet 4 Drive", "Hornet
Sportabout",
 "Valiant"), class = "data.frame")
```

Leverage your `.rprofile`

Set `options`

```
options(max.print = 2000)
options(prompt = "$ ")
options(stringsAsFactors = FALSE)
# Store API keys
options(MendeleyKey = "My_secret_key")
```

```
See ?options for more information on settings
options() to list current settings
```

Leverage your `.rprofile`

Load frequently used libraries

```
library(ggplot2)
library(stringr)
library(plyr)
library(devtools)
```

Leverage your `.rprofile`

Load custom functions

```
# A function that tells me which packages are out of date
check.packages <- function() {
    if (!is.null(utils::old.packages())) {
        old_packages <- utils::old.packages()
        cat("Notification:", dim(old_packages)[1], "packages are out
of date \n")
        cat(unname(old_packages[, 1]), sep = ",", "\n")
    }
    if (is.null(utils::old.packages())) {
        cat("All packages are current \n")
    }
}
```

Word of caution regarding `.rprofile`

While the `.rprofile` does make life convenient, remember that any code/settings stored there are not reproducible by others.

Be sure to test your code without loading the file before sharing/deploying code.

```
# To load R without the .rprofile
R -- vanilla
```

Thanks to Hadley for pointing this out oversight.

Reading Data

from flat text files

```
read.table
```

from databases

```
Use packages RODBC, RMySQL
```

from cloud storage

```
Amazon S3, Google Docs, Dropbox etc.
```

Saving Data

Short-term

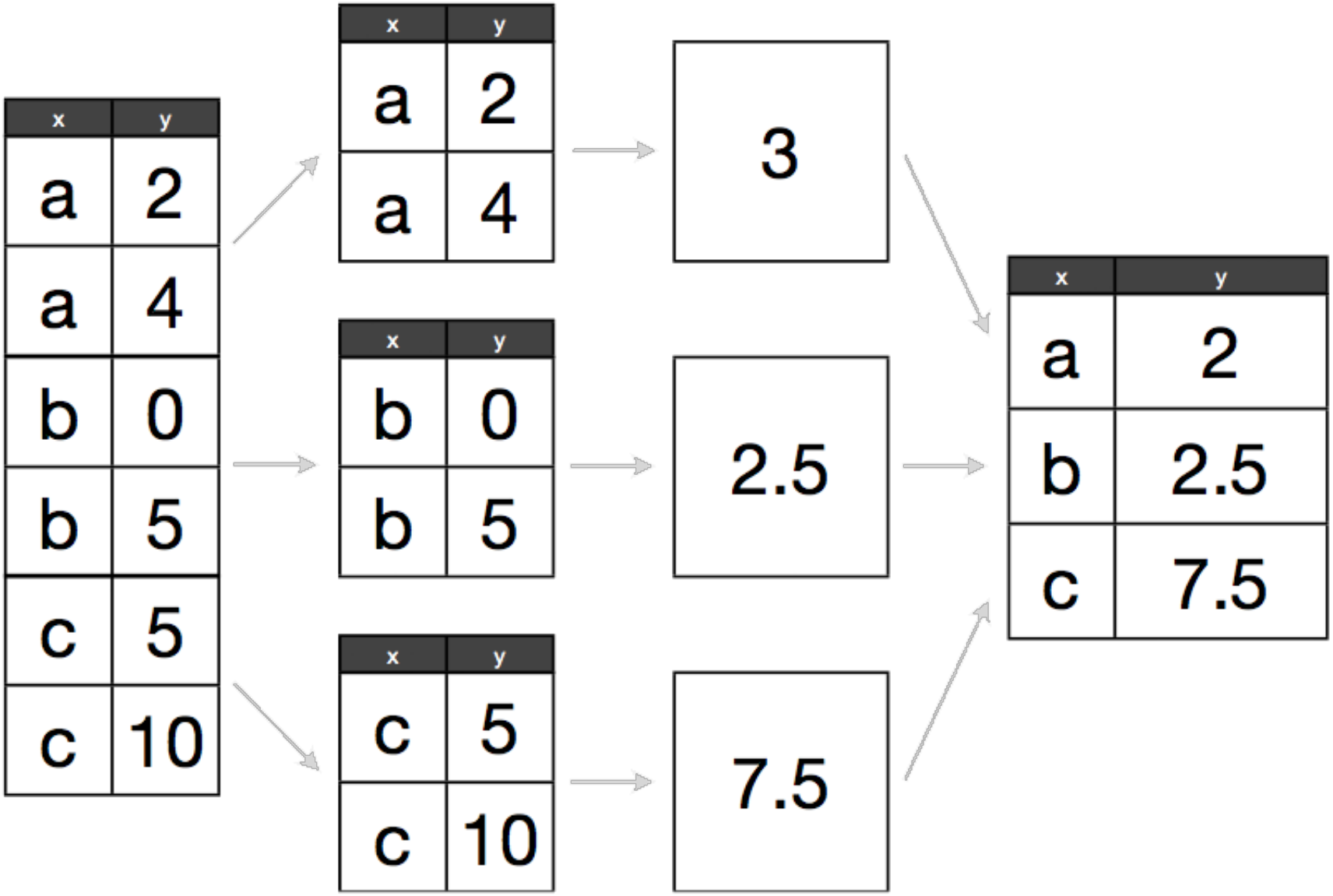
```
saveRDS(data, file = "slots.rdata")
```

Long-term

```
write.table(data, file = "slots-3.csv", sep = ",",
    row = F)
```

Manipulating Data - Plyr

The Split-Apply strategy



Hadley Wickham (2011). The Split-Apply-Combine Strategy for Data Analysis. JSS, 40(1), 1-29. for more details

ddply example

```
data <- data.frame(x = c("a", "a", "b", "b", "c",
    "c"), y = c(2, 4, 0, 5, 5, 10))
```

```
ddply(data, .(x), summarise, y = mean(y))
```

Plyr syntax

Function naming scheme: first letter of source R object + first letter of output R object + ply

```
result <- ddply(data, variable, summarise, n = sum(n))
```

```
result <- llply(list_name, function_name)
```

reshape2 allows you to reshape data into any format possible

```
dcast(melted_data, temp ~ light, length)
```

```
dcast(melted_data, temp ~ light, mean)
```

```
dcast(melted_data, temp ~ light, custom_function)
```

Example of melting and casting

```
test_data <- data.frame(id = 1:9, category =
factor(rep(sample(letters[1:3]),
    3)), treatment = rep(sample(c("control", "trt_1", "trt_2")),
    3), price_index = rnorm(9) * 200, prev_yr_index = rnorm(9) *
    200)
```

```
melted_data <- melt(test_data, id.vars = 1:3)
```

```
dcast(melted_data, category + treatment ~ variable,
    length)
dcast(melted_data, category + treatment ~ variable,
    mean)
```

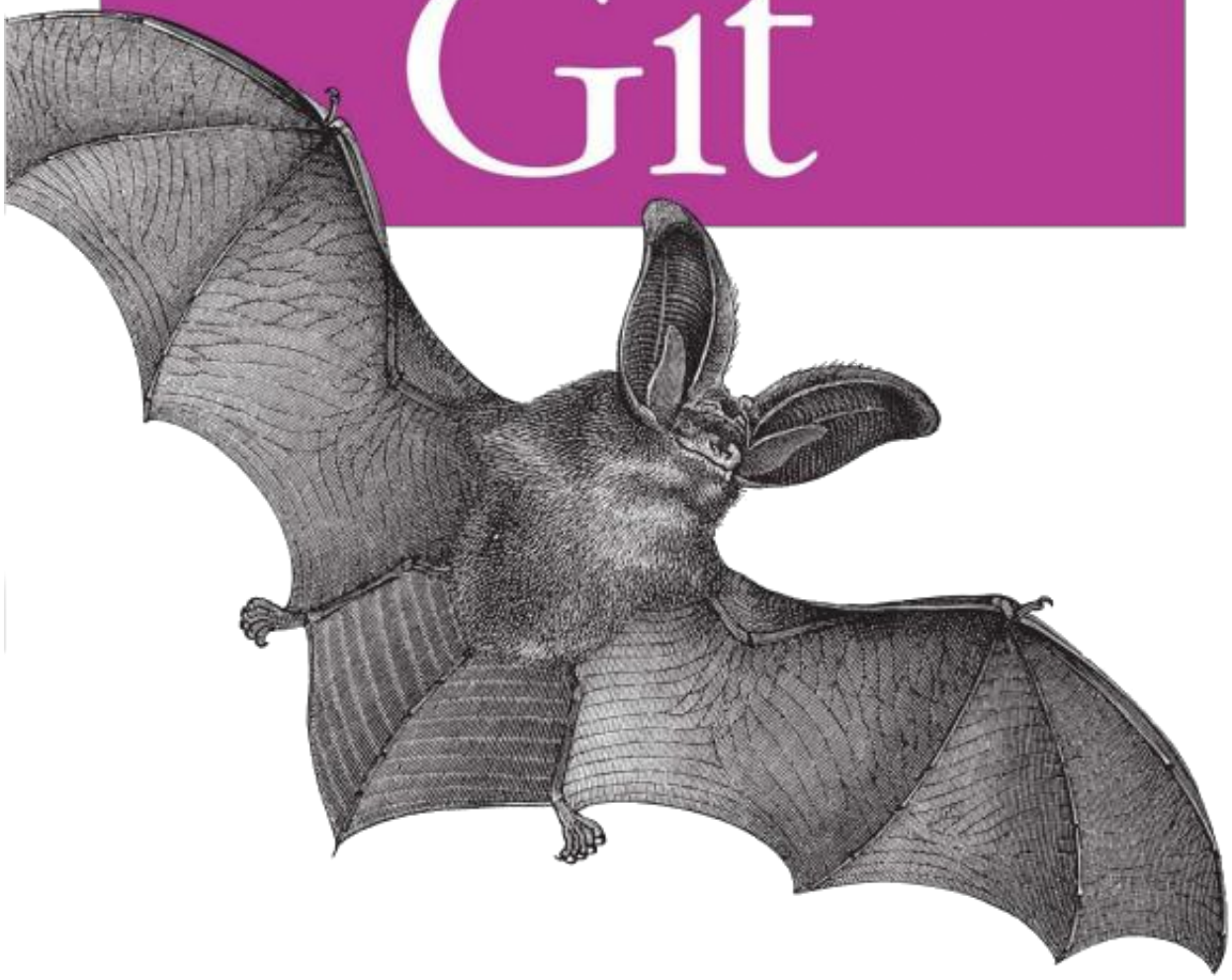
Writing Functions

> If you have to repeat the same 3-4 lines of code more than once, turn it into a function

Use a version control system like git

Version Control with

Git



Dynamic report generation

Home Objects Options Hooks Patterns Demos

knitr

Elegant, flexible and fast
dynamic report generation with R

```
# As easy as:
knit('report.rnw')


# All the syntax in this talk was generated using knitr
```

R on the cloud

R scales really well on cloud platforms (AWS, most anything)

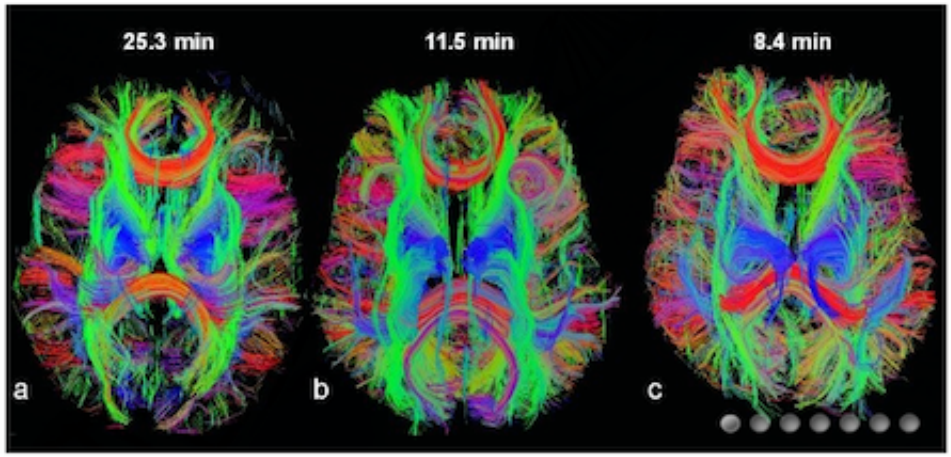
R can interact with any web service that has an API

Make function calls to R using REST API

opencpu.org

OpenCPU

Producing and Reproducing results



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The R programming language.

Become part of the Community.

Questions?