Practical R: Lecture 1

Introductions

- Abhijit Dasgupta (NIH/NIAMS)
  - PhD in Biostatistics
  - 15+ years using R
  - Runs the Statistical Programming DC meetup (formerly the R Users Group meetup)
  - Board member of Data Community DC
- Gene Buehler (NIH/NCATS)
  - PhD in Computer Science
  - 20 years in bioinformatics
  - R user for past ten years

Class Structure

- Weekly Lectures
- Suggested activities and online resources
- Semester Project

Semester Project

- Use R to import, manipulate, analyze and visualize a dataset.
- Ideally it will be your data, or your lab's data, or at least data relevant to your field
- Short presentations will be given on the last day of class for each project
- Grade will be based on your project presentation (although if you can't show up we can grade based on your presentation slides).

What this class isn't

- A programming class
- A bioinformatics class
- A workshop

Very Brief Course Outline

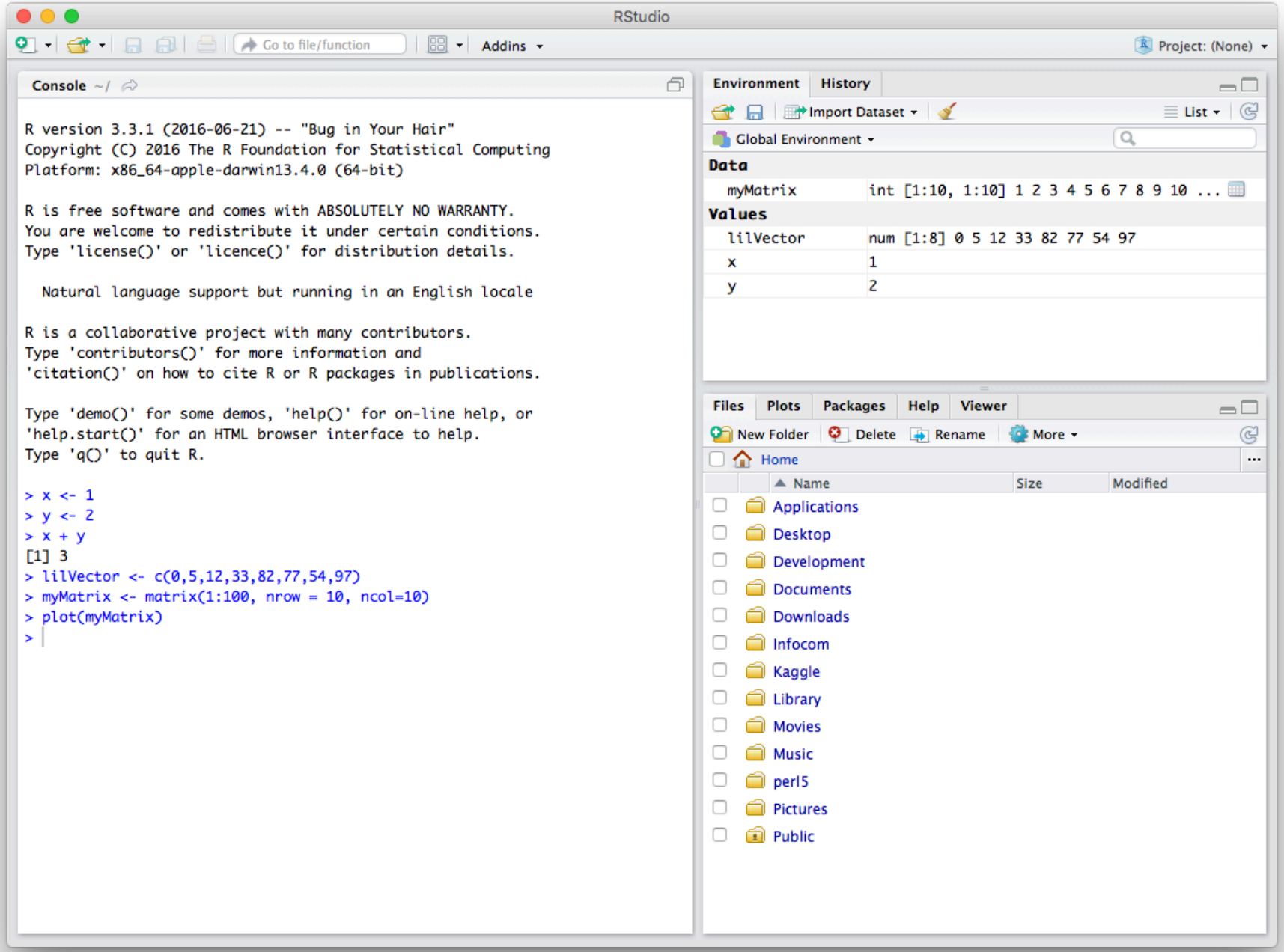
- Basics of using R (variables, functions, arguments)
- Getting Help (R help system, Google, command history)
- Importing data into R (from files, from URLs, and preloaded data)
- Packages: finding them, loading them, reading their documentation
- Visualizing Data: Graphs, graphs and more graphs
- Statistical Analysis: How and why
- Manipulating data: selecting, filtering, merging and more.
- Science specific analysis and visualization (eg. Heatmaps and dendograms for gene expression data)

There's more than one way

- Lots of ways to run R: command line, GUI, RStudio.
- Frequently more than one package to do what you want
- More than one statistical test you can use on a given type of data

Homework: Installing R and RStudio

- https://cran.rstudio.com
- https://www.**rstudio**.com/products/**rstudio**/download/
- Both are available for Windows, MacOSX, and Linux.


RStudio
Go to file/function
Addins
Project: (None)
Console ~/
R version 3.3.1 (2016-06-21) -- "Bug in Your Hair"
Copyright (C) 2016 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin13.4.0 (64-bit)
R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.
Natural language support but running in an English locale
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
> x <- 1
> y <- 2
> x + y
[1] 3
> lilVector <- c(0,5,12,33,82,77,54,97)
> myMatrix <- matrix(1:100, nrow = 10, ncol=10)
> plot(myMatrix)
>
Environment
History
Import Dataset
List
Global Environment
Data
myMatrix
int [1:10, 1:10] 1 2 3 4 5 6 7 8 9 10 ...
Values
lilVector
num [1:8] 0 5 12 33 82 77 54 97
x
1
y
2
Files
Plots
Packages
Help
Viewer
New Folder
Delete
Rename
More
Home
Name
Size
Modified
Applications
Desktop
Development
Documents
Downloads
Infocom
Kaggle
Library
Movies
Music
perl5
Pictures
Public

RStudio

Go to file/function | Addins | Project: (None)

Console ~/

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Environment | History

To Console | To Source

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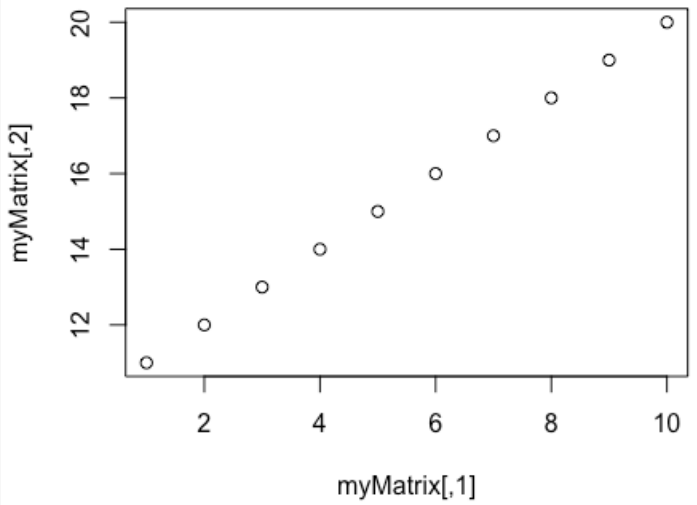
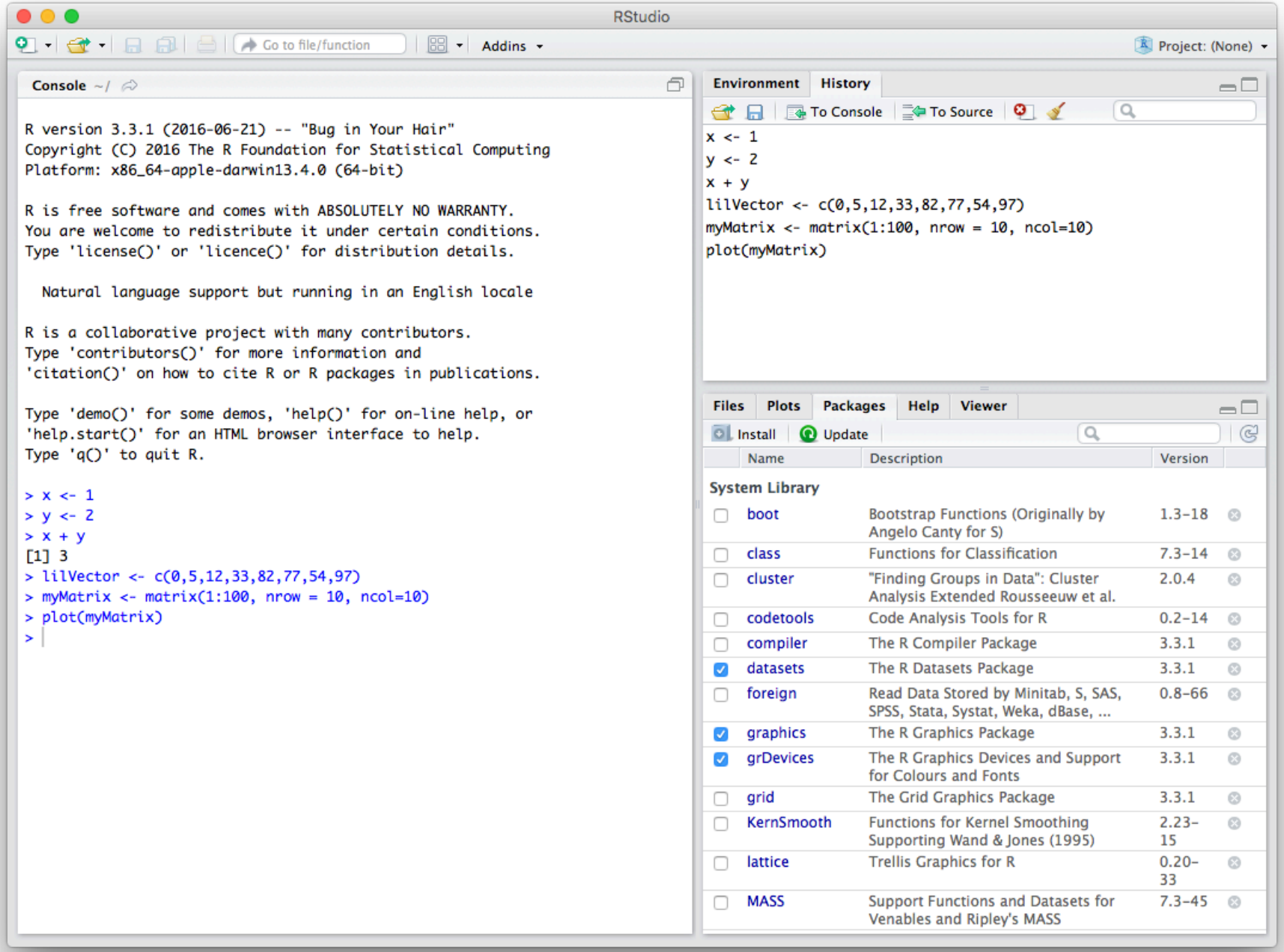
Files | Plots | Packages | Help | Viewer

Zoom | Export | Publish

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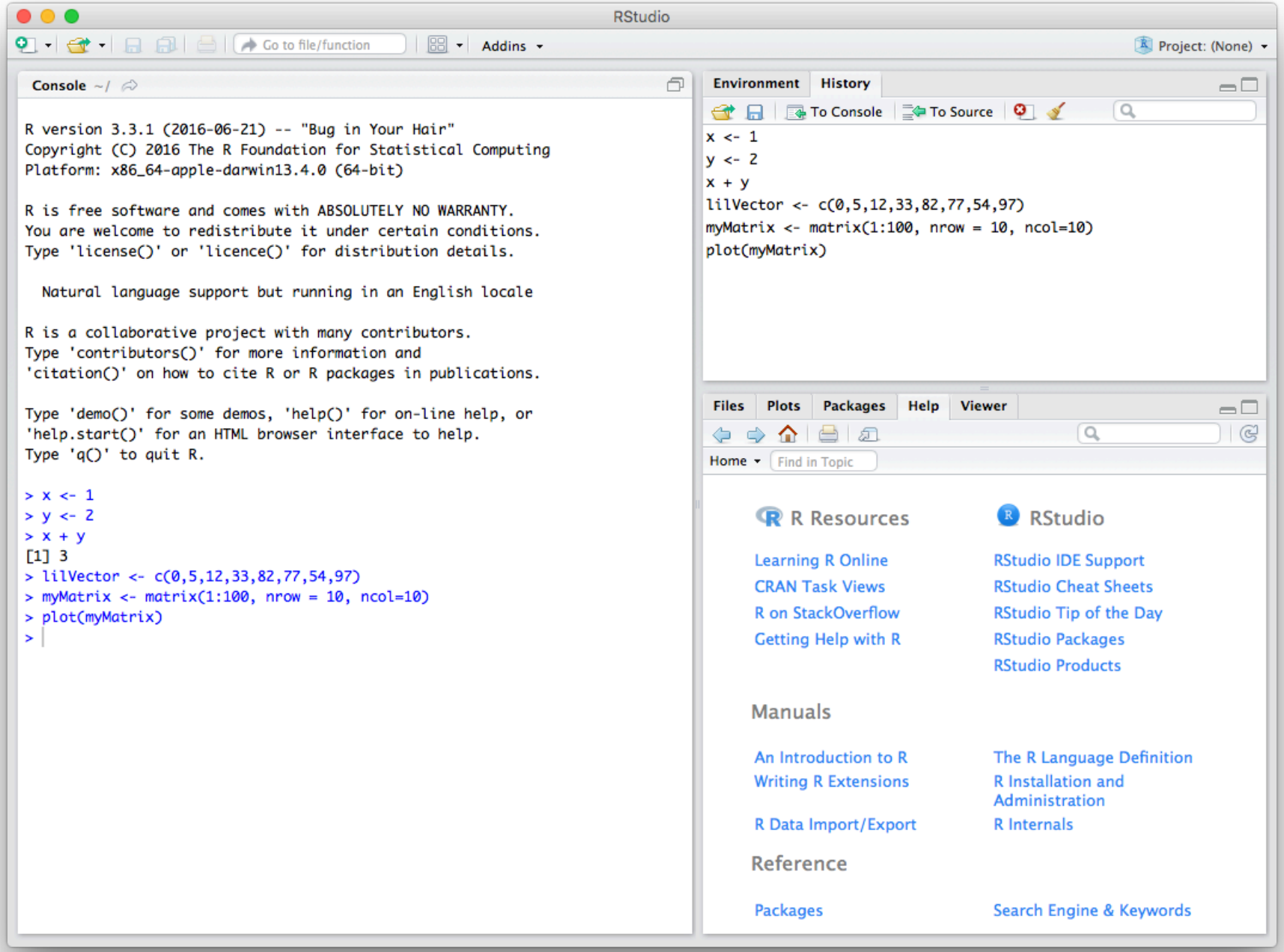
Files
Plots
Packages
Help
Viewer
Install
Update
Name
Description
Version
System Library
boot
Bootstrap Functions (Originally by Angelo Canty for S)
1.3-18
class
Functions for Classification
7.3-14
cluster
"Finding Groups in Data": Cluster Analysis Extended Rousseeuw et al.
2.0.4
codetools
Code Analysis Tools for R
0.2-14
compiler
The R Compiler Package
3.3.1
datasets
The R Datasets Package
3.3.1
foreign
Read Data Stored by Minitab, S, SAS, SPSS, Stata, Systat, Weka, dBase, ...
0.8-66
graphics
The R Graphics Package
3.3.1
grDevices
The R Graphics Devices and Support for Colours and Fonts
3.3.1
grid
The Grid Graphics Package
3.3.1
KernSmooth
Functions for Kernel Smoothing Supporting Wand & Jones (1995)
2.23-15
lattice
Trellis Graphics for R
0.20-33
MASS
Support Functions and Datasets for Venables and Ripley's MASS
7.3-45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Files
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Home
Find in Topic
R Resources
Learning R Online
CRAN Task Views
R on StackOverflow
Getting Help with R
RStudio
RStudio IDE Support
RStudio Cheat Sheets
RStudio Tip of the Day
RStudio Packages
RStudio Products
Manuals
An Introduction to R
Writing R Extensions
R Data Import/Export
The R Language Definition
R Installation and Administration
R Internals
Reference
Packages
Search Engine & Keywords

R Start-up Message

```
R version 3.2.0 (2015-04-16) -- "Full of Ingredients"
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Type 'q()' to quit R.

[Workspace loaded from ~/.RData]

>
```
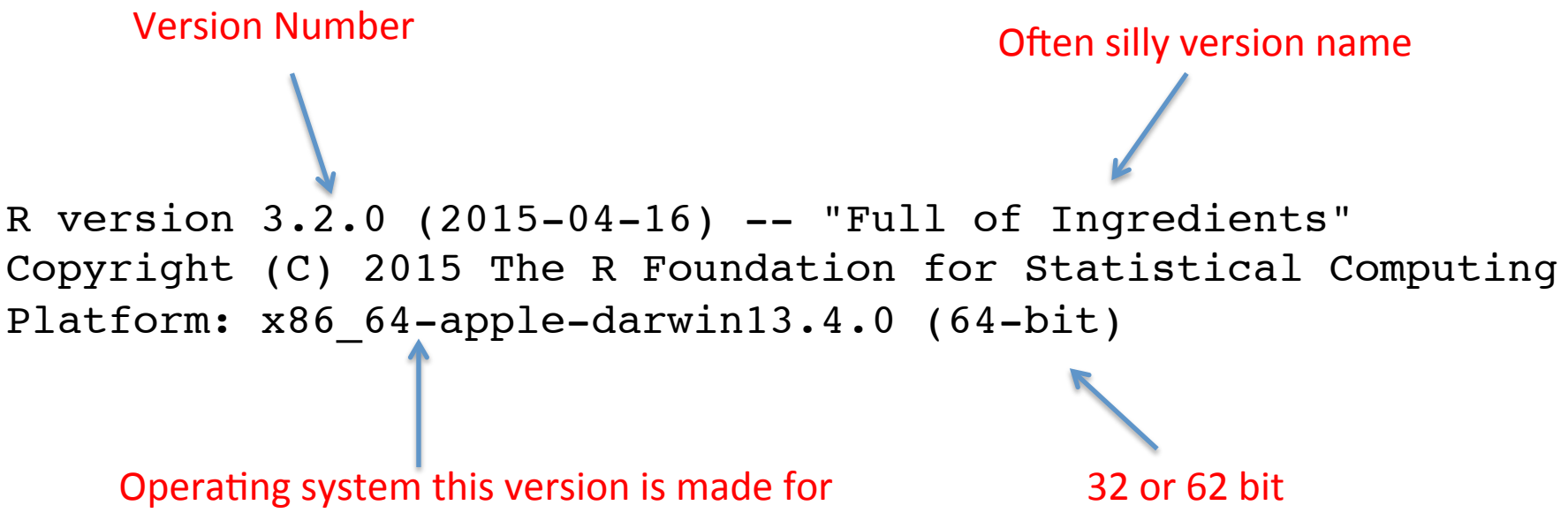
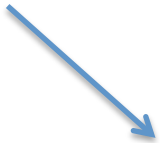

Unpacking the Startup



Unpacking the Startup

"Don't sue us"



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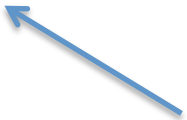

Terms under which you can distribute the software

Unpacking the Startup

R has support for different local conventions. For example, you can get it to use "," instead of "." for decimal notation

```
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```

R is made by real people who deserve credit (citations) for their work as much as you do. Please give it to them.

Unpacking the Startup

Some R packages have “demos” or their capabilities. For example, demo(graphics) will show you some of the cool graphs R can make.

R’s help function. You will probably use this a lot.

```
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Workspace loaded from ~/.RData]
```

How you quit R from the console.

A “workspace” is where the stuff you do in R gets stored when you quit.

Start of RMarkdown Presentation

Expressions

Typing "1+1" on the console will cause R to evaluate the expression and tell us the results

```
> 1+1
```

```
[1] 2
```

The "[1]" before the answer is R's line numbering scheme for reading long sets of numbers.
For example, if we were to type "letters" which is R's built in variable with the letters of the alphabet:

```
> letters
```

```
 [1] "a" "b" "c" "d" "e" "f" "g" "h" "i" "j" "k" "l"
[13] "m" "n" "o" "p" "q" "r" "s" "t" "u" "v" "w" "x"
[25] "y" "z"
```

Standard Math Stuff

Addition and subtraction symbols are what you would expect (+ and -). Multiplication and division are * and / respectively.

```
> 5-3
```

```
[1] 2
```

```
> 5*3
```

```
[1] 15
```

Order of Operations

Order of operations is as you might remember from math class. Multiplication and division before addition and subtraction. You can force the order of operations to be what you want by enclosing things you want done first in parentheses.

```
> 5 * 3 + 2
```

```
[1] 17
```

```
> 5 * (3 + 2)
```

```
[1] 25
```

Functions

Functions are how things get done in R. They take "arguments" as their input and output something useful (hopefully). R has a lot of built in functions. You can download and install packages to get access to more functions. You can easily write your own functions, but that won't be the focus of this course.

```
> sqrt(25)
```

```
[1] 5
```

Arguments, optional and required

```
log()
```
Error: argument “x” is missing, with no default

```
> log(100)
```

```
[1] 4.60517
```

```
> log(100, base=10)
```

```
[1] 2
```

Variable assignment

```
> x <- 2
> x * 5
```

```
[1] 10
```

Variable Naming

If you name your variables things like “x” and “y”, chances are excellent you will soon forget what they mean. R variable names can be long, so make them as long as you need to explain what they are.

```
> plate_map.csv <- read.csv("plate_map.csv")
> plate_map.csv.colnames <- colnames(plate_map.csv)
```

Basic "Atomic" Data types

For the purposes of this class, R has three base "types" of data (there are a few more we won't concern ourselves with, like for complex numbers).

```
> class(12)
```

```
[1] "numeric"
```

```
> class("Susan")
```

```
[1] "character"
```

```
> class(TRUE)
```

```
[1] "logical"
```

Vectors

A vector is an ordered list of values in R, all of the same type.

```
> childAges <- c(8,10)
> childNames <- c("Bronwyn","Margot")
> childLikesMacAndCheese <- c(FALSE, TRUE)
> c(TRUE, "Bronwyn", 8)
```

```
[1] "TRUE"    "Bronwyn" "8"
```

```
> c(8,12,35,"no data",16,82)
```

```
[1] "8"       "12"      "35"      "no data" "16"
[6] "82"
```

Describing Data

Data can be continuous or discrete. Continuous data takes on values in a range. Discrete data can take on only a limmited number of values. Its important to think about the meaning of the data, so that the way in which R stores it does not confuse the meaning of the data.

```
> myChromosomes <- c(1,3,8)
> myChromosomes
```

```
[1] 1 3 8
```

```
> factor(c(1,3,8), levels=1:22)
```

```
[1] 1 3 8
22 Levels: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 ... 22
```

Ordinal Data

An ordinal variable is one that has a natural ordering to it. Whereas there is no natural ordering to eye colors (a nominal variable), there would be a natural ordering to grades.

```
> classGrades <- factor(c("B","D","A"),
+                       levels=c("F","D","C","B","A"),
+                       ordered=TRUE)
> classGrades
```

```
[1] B D A
Levels: F < D < C < B < A
```

Telling R that our data is ordinal will help it do the right statistical tests and build models correctly.