Eric Pitman Summer Workshop in Computational Science

1. The R command line; using variables

CENTER FOR COMPUTATIONAL RESEARCH

University at Buffalo
The State University of New York

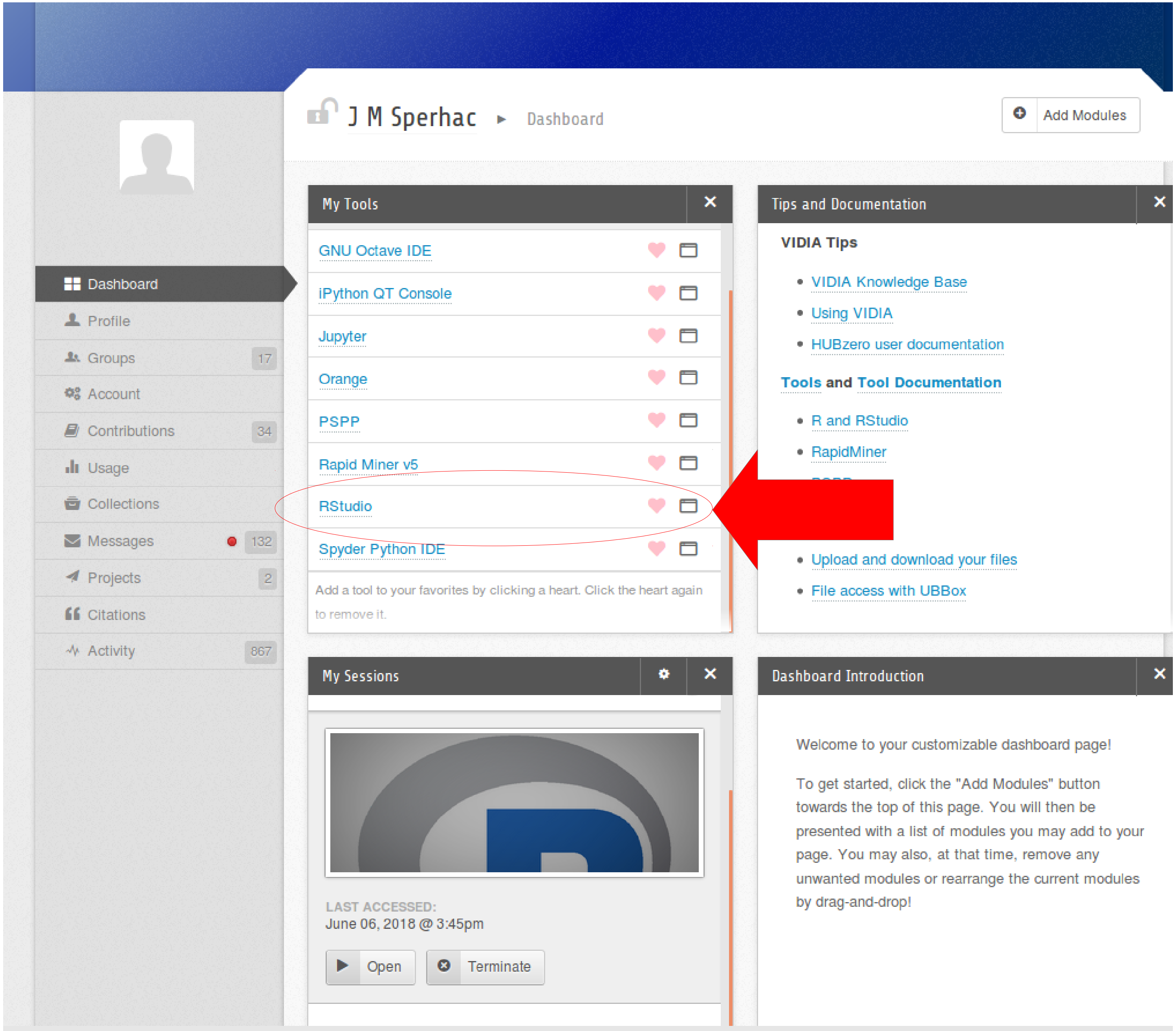
The Plan:

- Basic R syntax and approach
  - Variables, datatypes, data structures
  - Functional, vector-based language
  - Descriptive statistics and plotting
  - Pointers to useful references
- Introduce development and prototyping environments
  - RStudio
  - Jupyter Notebooks for R

Introductions: R

- Functional language
  - Functions are first-class objects
- Vector-based
  - There are no scalars
- Open-source language
- (Many!) User-contributed packages
- Visualization

VIDIA Dashboard: RStudio Tool



J M Sperhac ▸ Dashboard

Add Modules

- Dashboard
- Profile
- Groups 17
- Account
- Contributions 34
- Usage
- Collections
- Messages 132
- Projects 2
- Citations
- Activity 867

My Tools

- GNU Octave IDE
- iPython QT Console
- Jupyter
- Orange
- PSPP
- Rapid Miner v5
- RStudio
- Spyder Python IDE

Add a tool to your favorites by clicking a heart. Click the heart again to remove it.

Tips and Documentation

VIDIA Tips

- VIDIA Knowledge Base
- Using VIDIA
- HUBzero user documentation

Tools and Tool Documentation

- R and RStudio
- RapidMiner
- Upload and download your files
- File access with UBBox

My Sessions

LAST ACCESSED:
June 06, 2018 @ 3:45pm

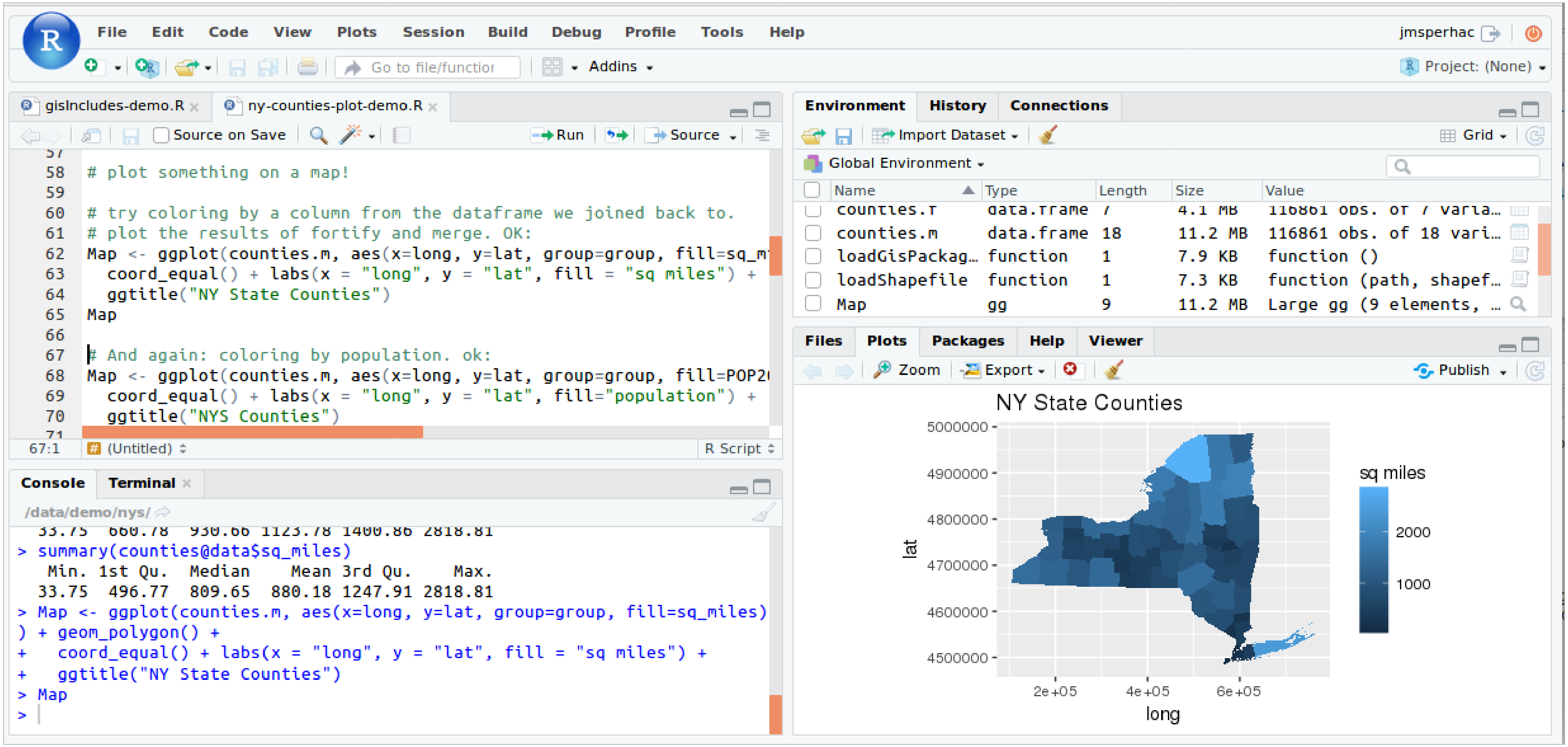
▶ Open ⊗ Terminate

Dashboard Introduction

Welcome to your customizable dashboard page!

To get started, click the "Add Modules" button towards the top of this page. You will then be presented with a list of modules you may add to your page. You may also, at that time, remove any unwanted modules or rearrange the current modules by drag-and-drop!

RStudio



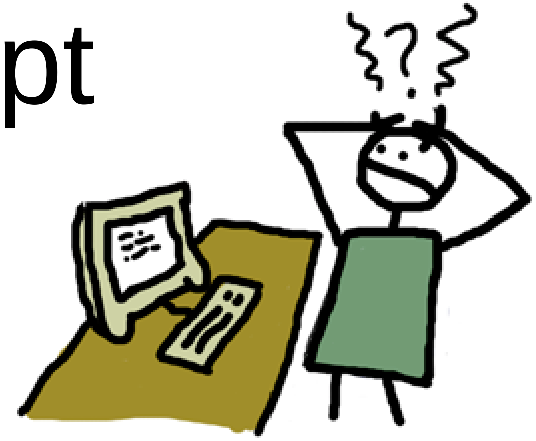
```
# plot something on a map!

# try coloring by a column from the dataframe we joined back to.
# plot the results of fortify and merge. OK:
Map <- ggplot(counties.m, aes(x=long, y=lat, group=group, fill=sq_mi
  coord_equal() + labs(x = "long", y = "lat", fill = "sq miles") +
  ggtitle("NY State Counties")
Map

# And again: coloring by population. ok:
Map <- ggplot(counties.m, aes(x=long, y=lat, group=group, fill=POP2(
  coord_equal() + labs(x = "long", y = "lat", fill="population") +
  ggtitle("NYS Counties")
```

☐	Name	Type	Length	Size	Value
☐	counties.f	data.frame	7	4.1 MB	116861 obs. of 7 varia…
☐	counties.m	data.frame	18	11.2 MB	116861 obs. of 18 vari…
☐	loadGisPackag…	function	1	7.9 KB	function ()
☐	loadShapefile	function	1	7.3 KB	function (path, shapef…
☐	Map	gg	9	11.2 MB	Large gg (9 elements, …

```
  33.75  660.78  930.66 1123.78 1400.86 2818.81
> summary(counties@data$sq_miles)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  33.75  496.77  809.65  880.18 1247.91 2818.81
> Map <- ggplot(counties.m, aes(x=long, y=lat, group=group, fill=sq_miles)
) + geom_polygon() +
+   coord_equal() + labs(x = "long", y = "lat", fill = "sq miles") +
+   ggtitle("NY State Counties")
> Map
> 
```

Four Rstudio panes: Editor, Environment/History, Plots/Help, Console

Command Line Prompt



- RStudio:

```
>
```

- Jupyter:

```
In [integer]
```

R Practical Matters

RStudio characteristics

- R is case sensitive (R != r)
- Command line prompt is >
- To run R code: use command line, or save script and source("script_name")
- To separate commands, use ; or a newline
- The # character marks a non-executed *comment*
- To display help files:

  ?<command-name> or ??<command-name>

R as a Calculator

```
>  2 + 3 * 5       # Order of operations

> (2 + 3)*5       # Spaces are optional
```

On the RStudio command line...

R Output

```
> 2 + 3 * 5
[1] 17
```

Q: What's that [1] about?

A: R numbers outputs with [*n*]

```
# Try this in the command line:
> 1:500
```

About Comments

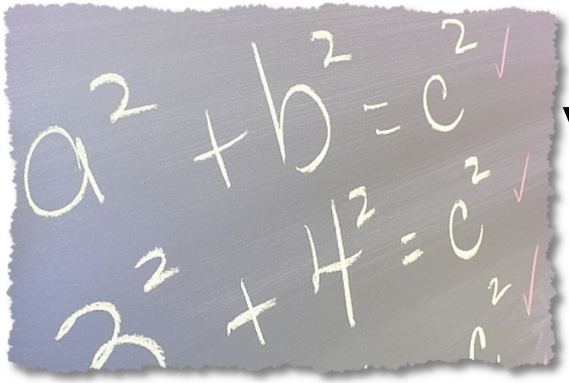
```
> 2 + 3 * 5      # Order of operations

#  A comment is:
#  Text useful to humans, ignored by computer
#  Helps you understand what code does, or why
#  Denoted by a pound sign in R
```

Use them!!

R as a Calculator

Try these in your RStudio console:

```
> 4^2            # 4 raised to the second power
> 3/2            # Division
> sqrt(16)       # Square root
> 3 - 7          # Subtraction
> log(10)        # Natural logarithm
                 #        with base e=2.718282
```



Variables: Save It

How do we keep a value for later use?

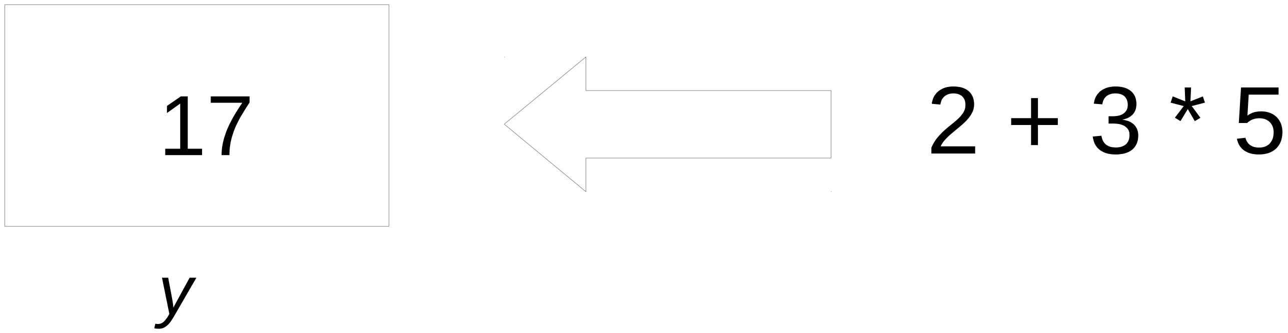
Variable assignment!

```
> y = 2 + 3 * 5       # Do some arithmetic
> y                    # R stores this value as y
[1] 17
```

y can be found under Values in the Workspace window

Variable Assignment

```
> y = 2 + 3 * 5   # R stores this value as y
```



17

y

2 + 3 * 5

y can be found under Values in the Workspace window

Naming Variables in R

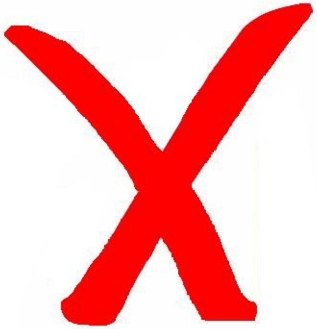
Variable names may consist of letters, numbers and the dot or underline characters. It should start with a letter. Keep it unique!

Good:

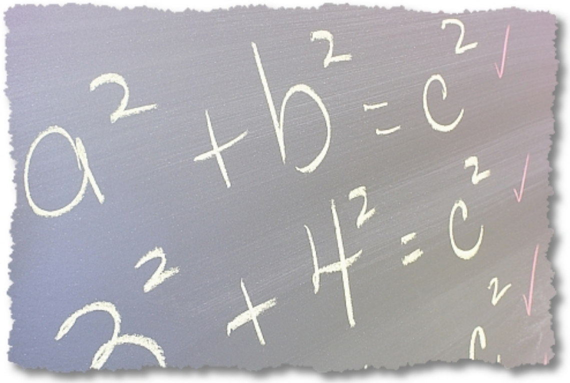
```
> y = 2
> try.this = 33.3
> oneMoreTime = “woohoo”
```

Bad:

```
> 2y = 2
> _z = 33.3
> function = “woohoo”
```



* *function* is a reserved word in R

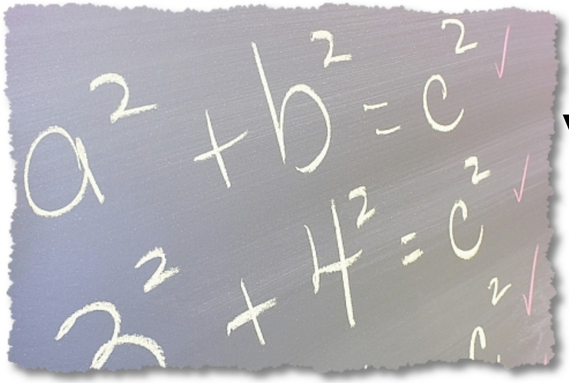


Assign Variables

Try these in your RStudio console:

```
# make variable assignments
> abc = 3
> Abc = log(2.8) * pi
> ABC = "fiddle"
```

Now, check Workspace: Values



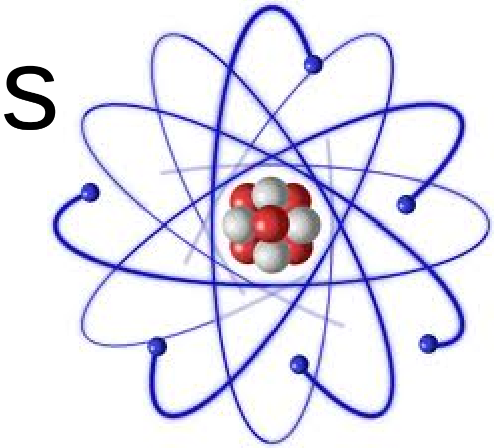
Variables: Save It

Alternate R syntax for assignment

```
> y =  2 + 3 * 5
> z <- 2 + 3 * 5          # Same thing as y
```

Variable assignment: Use = or <-

R's Atomic Data Types



Let's take a look at some available data types:

- Numeric (includes integer)
  3.14, 1, 2600

- Character (string)
  “hey, I'm a string”

- Logical
  TRUE or FALSE

- NA
  No value known

Numeric Data

Find the type of a variable using class()

```
> class(8)                        # numeric type
[1] "numeric"

> class(6.02e+24)                 # numeric type
[1] "numeric"

> class(pi)                       # numeric type (predefined in R)
[1] "numeric"
```

Character and Logical Data

Find the type of a variable using class()

```
> class("phooey")  # character type:
[1] "character"    # notice the quotes

> class(TRUE)      # logical type: no quotes
[1] "logical"

> class(NA)        # NA (no quotes) means “no value known”
[1] "logical"
```

RStudio Test Flight

To whet your appetite for RStudio, let's try:

- Using the editor
- Entering data
- Making a plot in R
- Sourcing a file

The M&M Exercise

On your workstation:

- Sign in to vidia.ccr.buffalo.edu
- Start the RStudio tool
- Create/Access Project from GitHub

    git://github.com/ubccr/hsws.git

- Files pane: click *examples*, then *mm*, then:

    mm-single-example.R

The M&M Exercise

Inside mm-single-example.R:

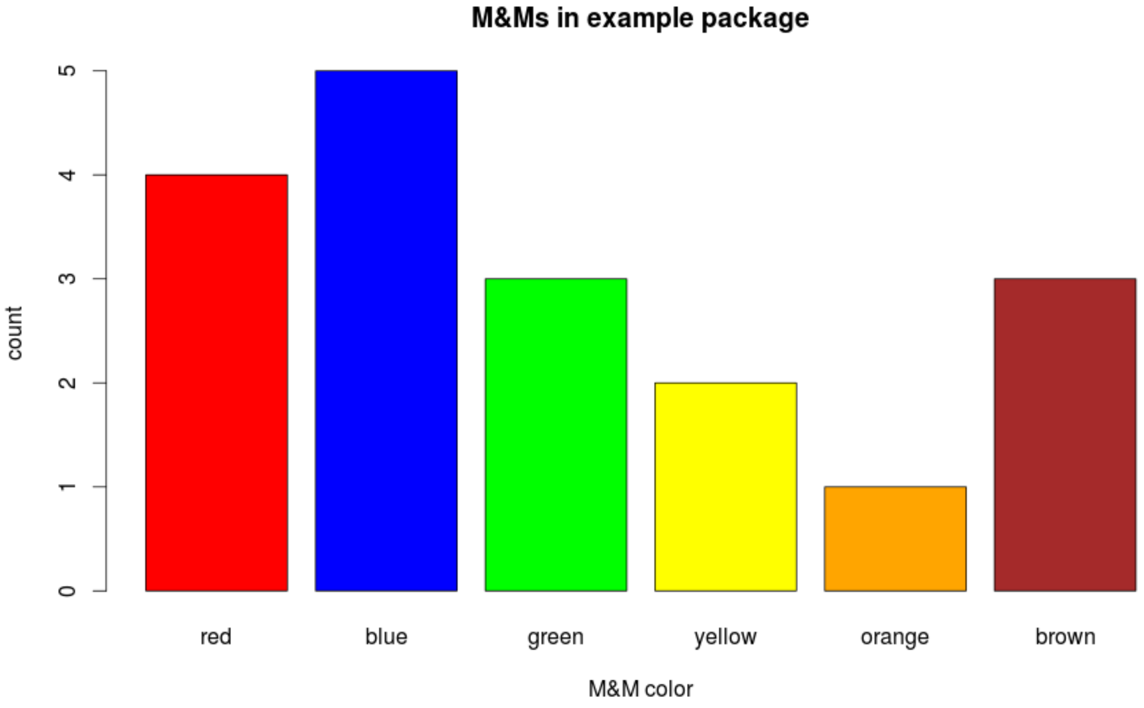
- Change the M&M color counts in the *mv* variable
- Edit *ptitle*, if you want

```
# EDIT HERE: ...
mvl = c("red", "blue", "green", "yellow", "orange", "brown")
mv = c(   4,      5,       3,        2,        1,       3)
ptitle = "M&Ms in example package"
```

The M&M Exercise

Inside mm-single-example.R:

- Save the file to your home directory (File:Save)
- Source the file (Source button)



The M&M Exercise

Questions:

- What have you plotted?
- What outputs does R provide in the console?
- What variables were created?
- What else happens inside this source file?

OK, now you can eat...

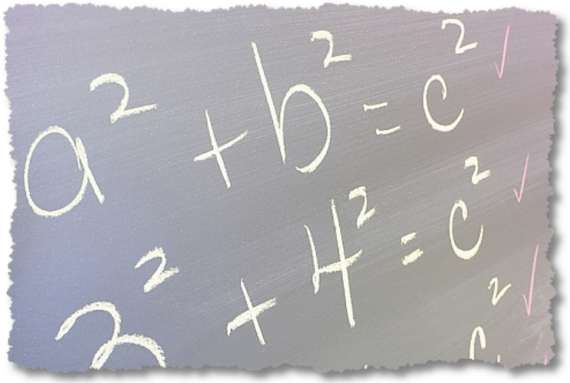
The M&M Exercise

- Distribution of colors across many samples
- Increase the number of samples—reveal the underlying distributions
- Barplot
  - Counts of colors in one sample
- Histogram
  - Instances of color counts across all samples

Using Logical Operators

```
1==2              # equivalence test: double equals
9 != 19           # “not equal” test
3 < 204           # less-than test
18 > 44           # greater-than test
“tree”==89        # comparing mixed data types
```

What should the results of these tests be?



A Logical Test

Compare R syntax for assignment

```
> y =  2 + 3 * 5
> z <- 2 + 3 * 5      # Same thing as y

> y==z                  # Here's the test...
[1] TRUE
```

Logical Data

A logical value is often created from a comparison between variables.

```
u & v        # Are u AND v both true?
u | v        # Is at least one of u OR v true?
!u           # “NOT u” flips the logical value of
             #          variable u
```

Learning about Object x

R stores everything, variables included, in Objects.

Objects have *attributes*, such as: name, dim, class.

Object x

```
> x <- 2.71
> print(x)              # print the value of the object
[1] 2.71

> class(x)              # what data type or object type?
[1] "numeric"

> is.na(x)               # is.na() tests whether a value has a
                         # known value
[1] FALSE
```

Interlude

Complete variable/atomic datatype exercises.

Open in the RStudio source editor:

<workshop>/exercises/1-exercises-variables-atomic-datatypes.R

Interlude++

Once you have completed the exercises, browse further information about R:

An R tutorial (Check out slides 25-32, then 45-49 for relevant material):

- http://jaredknowles.com/s/Tutorial1_Intro.html

The Vocabulary of R:

- http://adv-r.had.co.nz/Vocabulary.html