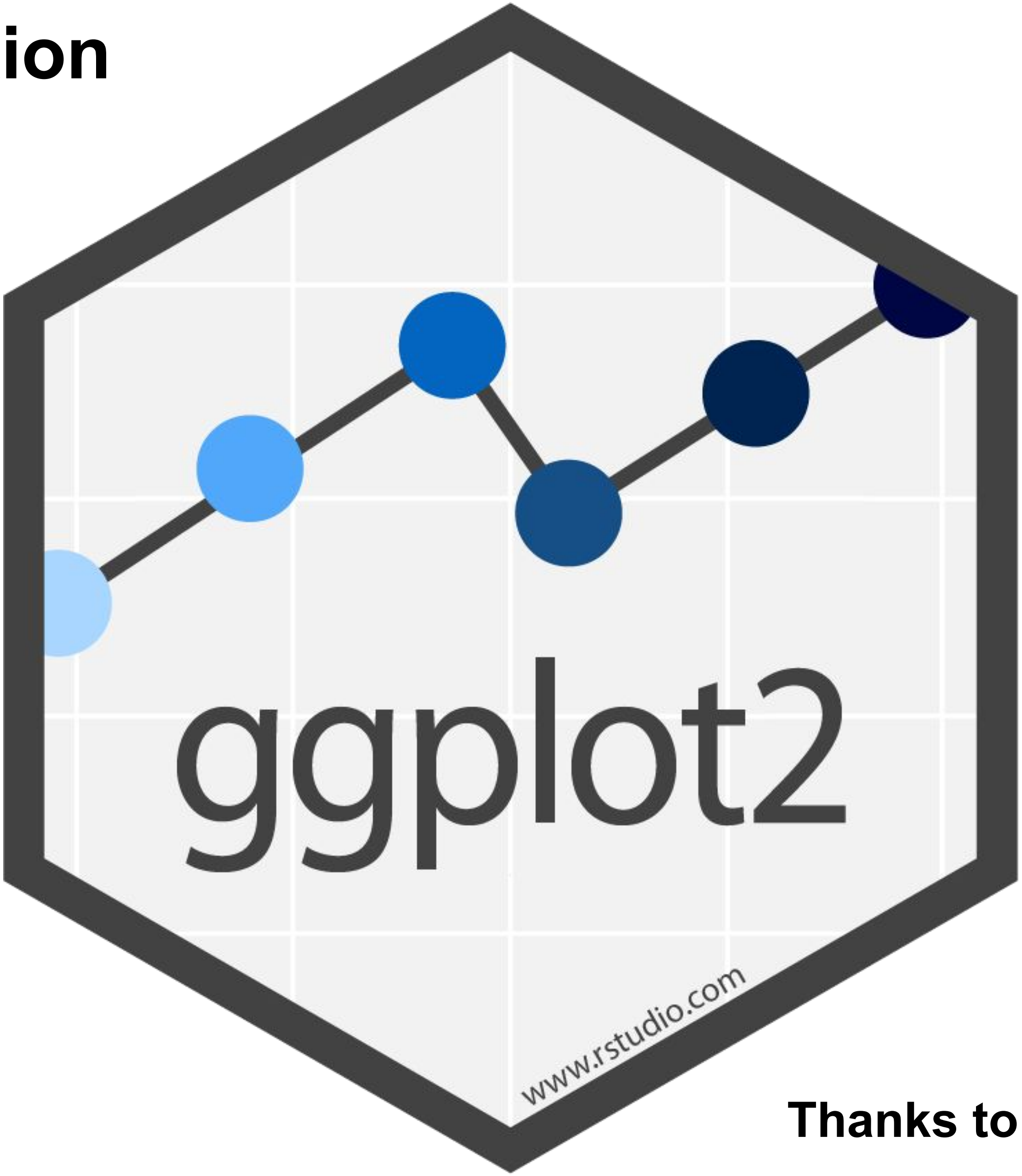
Introduction to….



Thanks to R-Ladies East Lansing for the slides!

RStudio®

First thing’s first….

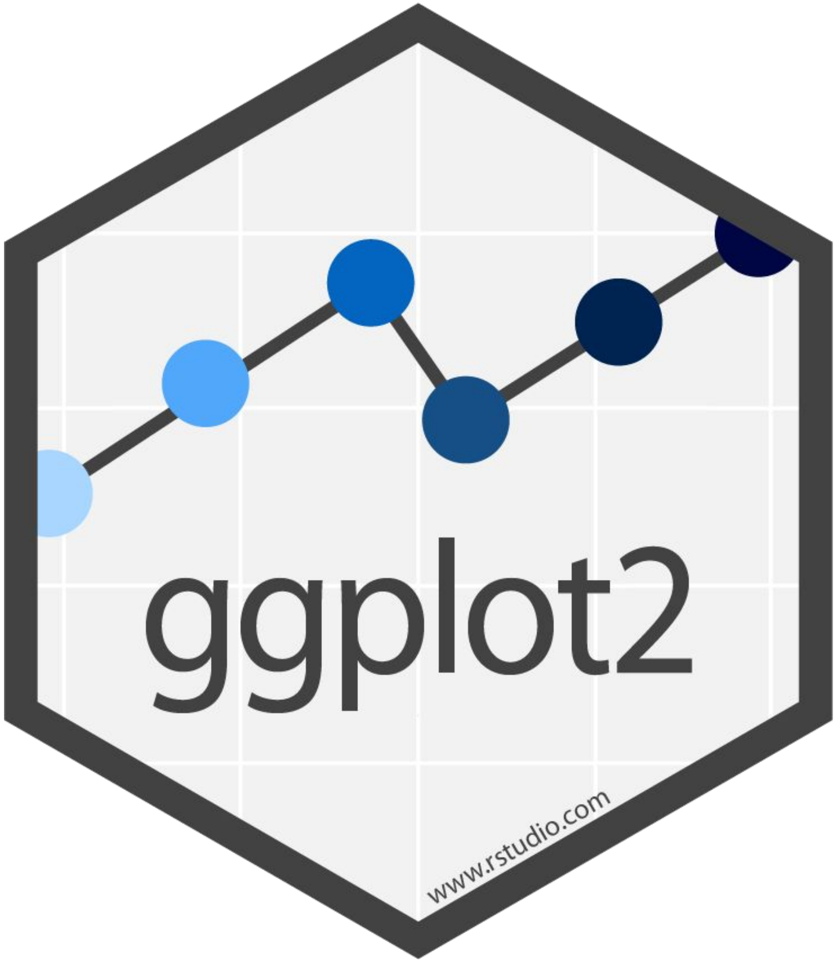
Have you already installed Rstudio? If not, do it now!

https://www.rstudio.com/products/rstudio/download/#download

What is ggplot?

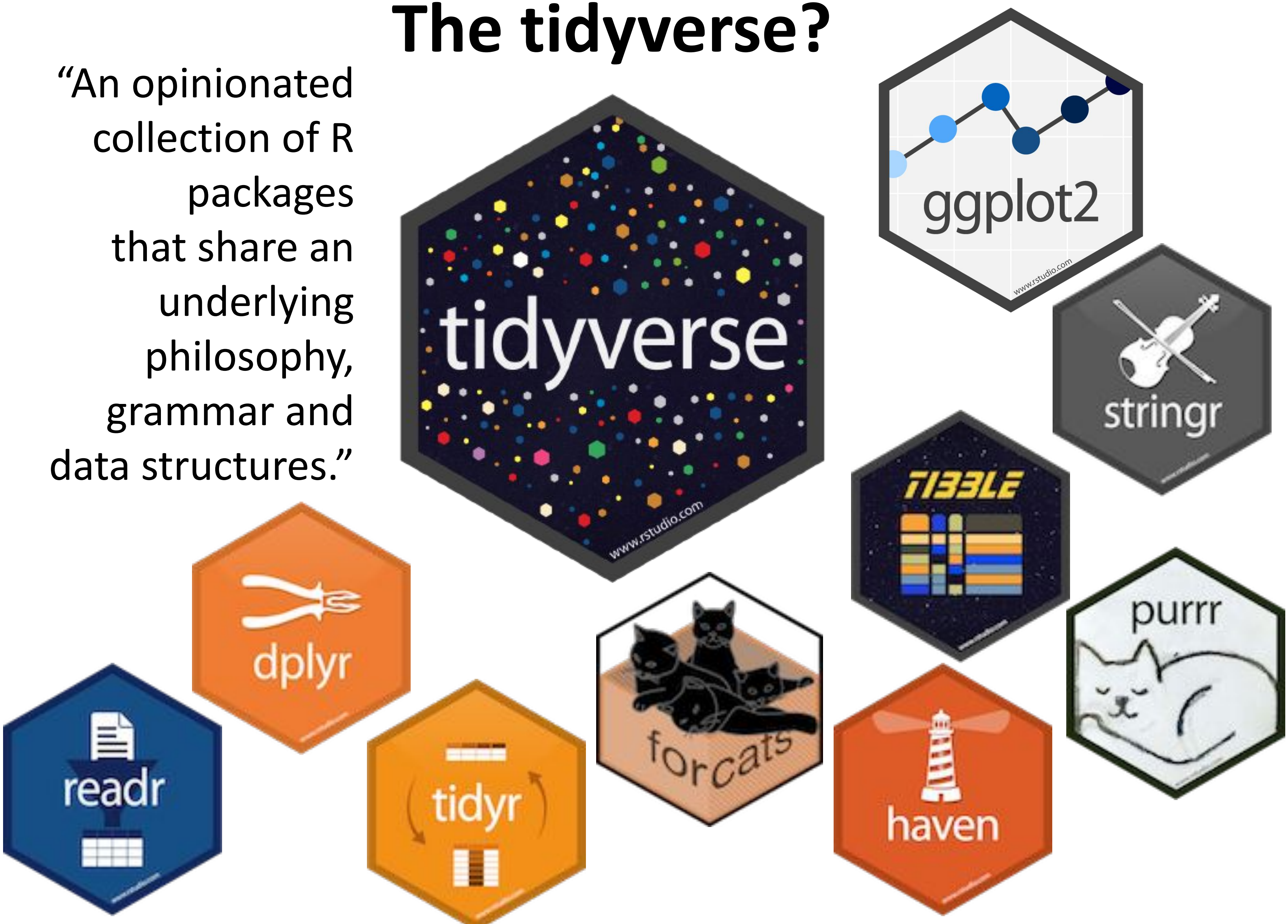
- ggplot is a package (ggplot2) for ‘rapid exploration of data’ graphically in R

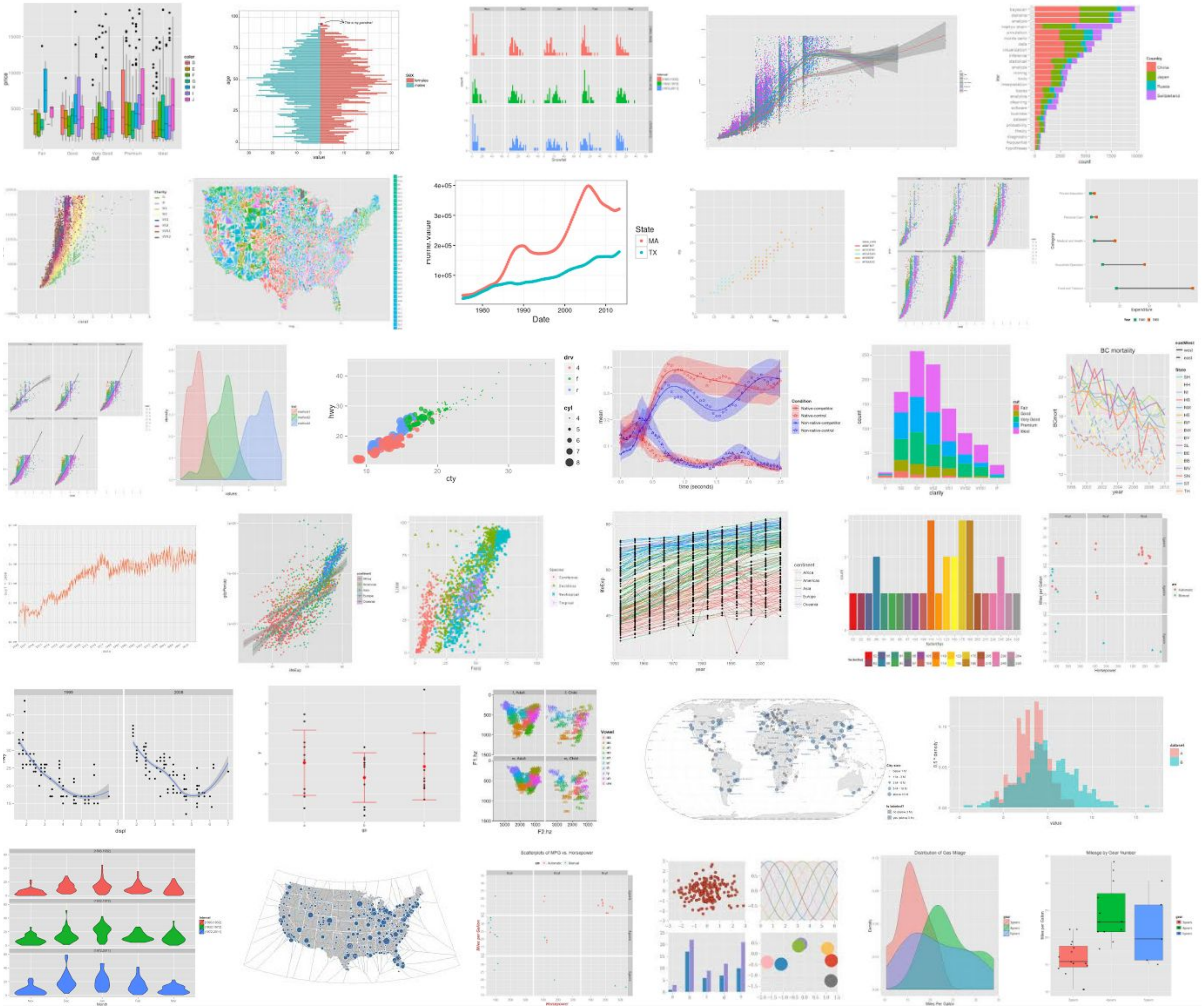
- It is part of the ‘tidyverse’



The tidyverse?

"An opinionated collection of R packages that share an underlying philosophy, grammar and data structures."




price
cut
color
age
value
sex
females
males
This is my paradise!
count
Country
China
Japan
Russia
Switzerland
carat
clarity
Home.Value
State
MA
TX
Date
1980
1990
2000
2010
1e+05
2e+05
3e+05
4e+05
Expenditure
density
values
hwy
cty
drv
4
f
r
cyl
5
6
7
8
10
20
30
40
mean
time (seconds)
Condition
Native-competitor
Native-control
Non-native-competitor
Non-native-control
clarity
cut
Fair
Good
Very Good
Premium
Ideal
BC mortality
BCmort
year
eastWest
east
west
State
lifeExp
continent
Africa
Americas
Asia
Europe
Oceania
Species
Horsepower
Miles per Gallon
displ
1999
2008
F1.hz
F2.hz
Vowel
value
dataset
Month
Scatterplots of MPG vs. Horsepower
Distribution of Gas Milage
Miles Per Gallon
Mileage by Gear Number

Why “gg”?

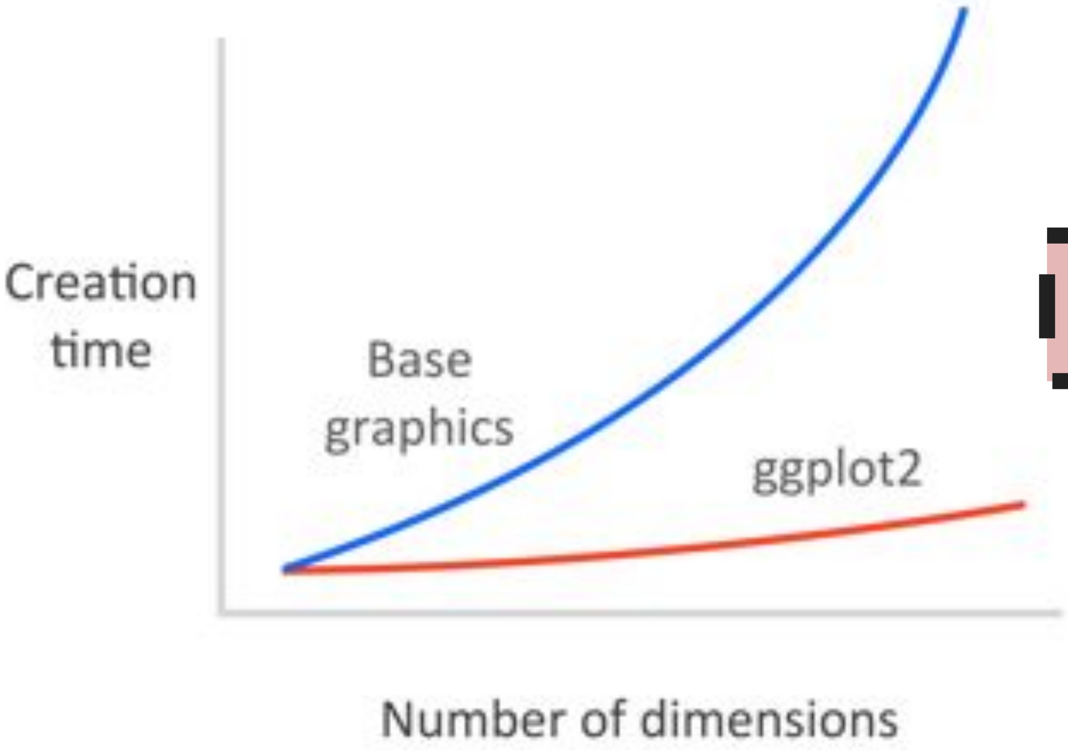
- **gg** is for “grammar of graphics”

- Uses a set of terms that defines the basic components of a plot

- Produces figures using coherent, consistent syntax

ggplot vs. base graphics

- **ggplot**: rapid data exploration
- **Base graphics**: customization / complexity



Saves time!

*From http://seananderson.ca/

ggplot uses specific grammar

- A basic **ggplot2** plot consists of:
  - **data**: Must be a data.frame
  - **aes**thetics: How your data are represented visually
    - x, y, color, size, shape, etc.

      +
  - **geom**etry: Geometries of plotted objects
    - points, lines, polygons, etc.
  - and more…

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+

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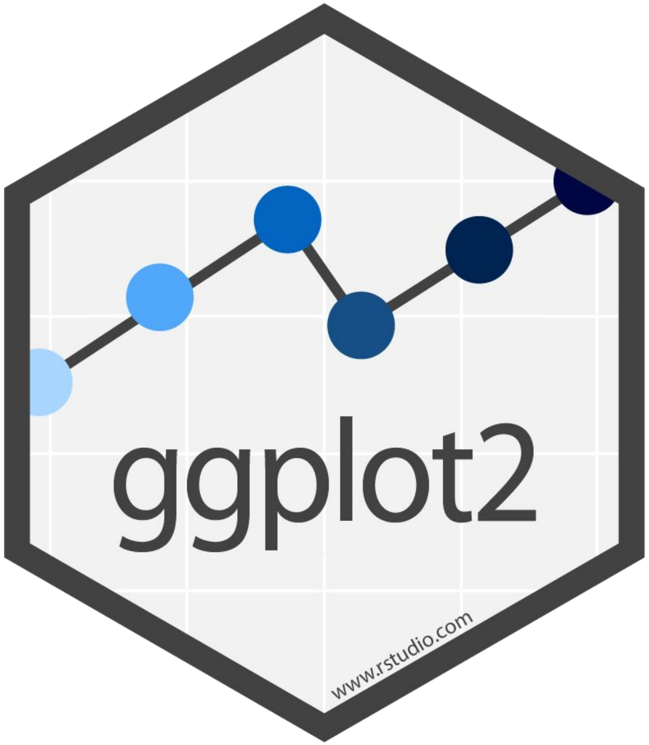
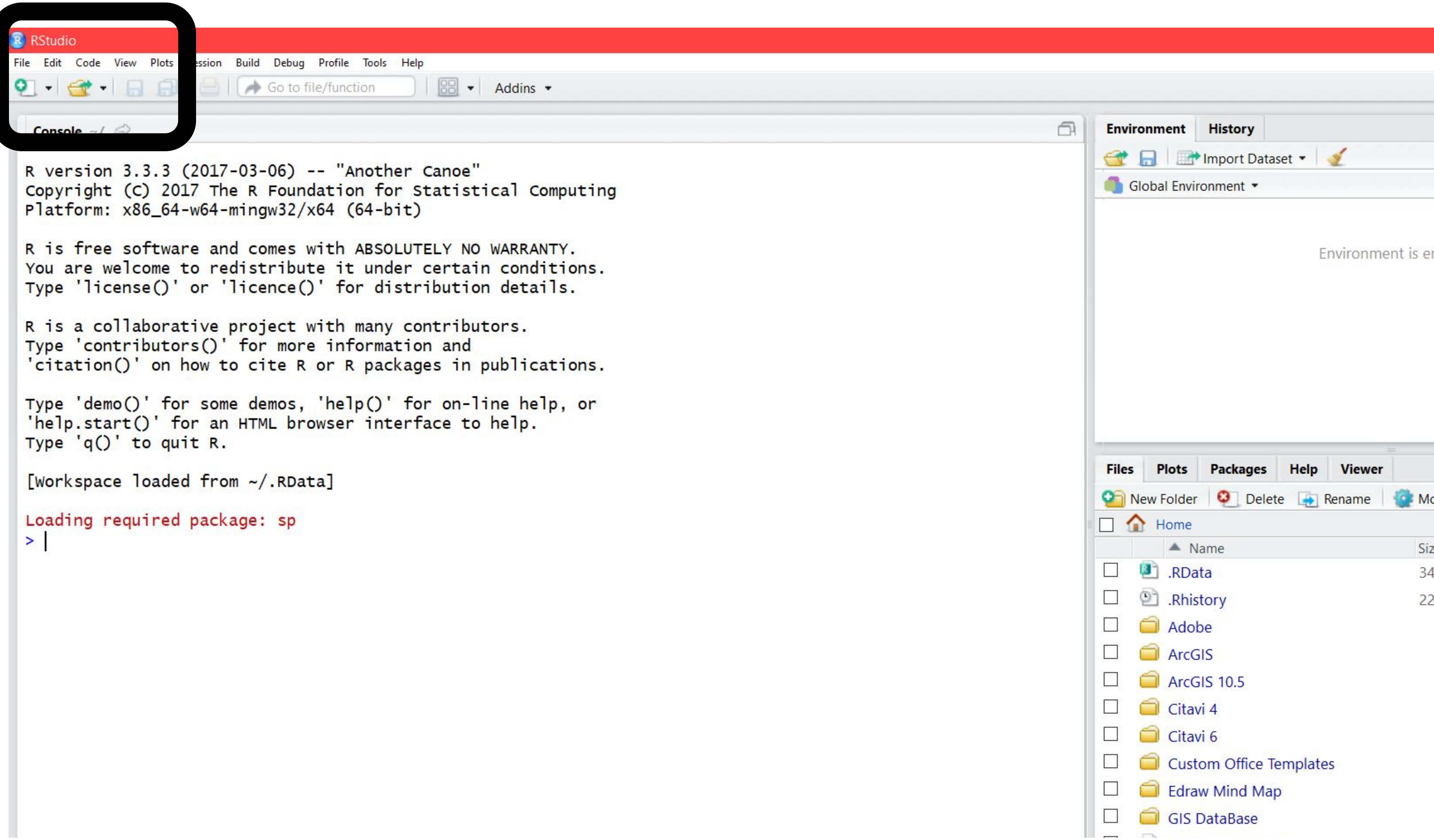


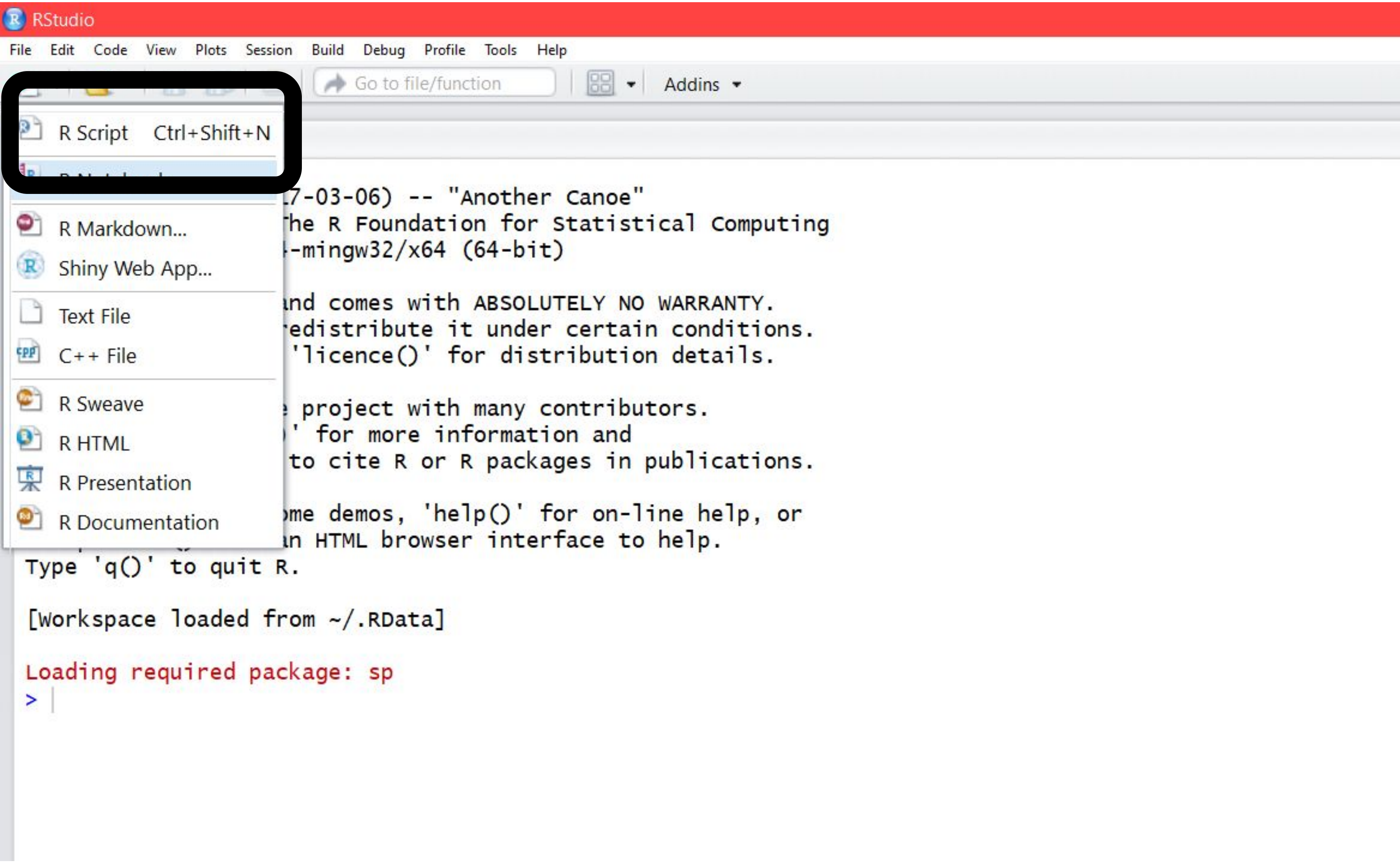
ggplot: Let’s get started!

Getting started: opening RStudio



```
R version 3.3.3 (2017-03-06) -- "Another Canoe"
Copyright (C) 2017 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (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.

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.

[Workspace loaded from ~/.RData]

Loading required package: sp
> 
```

Getting started: opening RStudio



```
7-03-06) -- "Another Canoe"
he R Foundation for Statistical Computing
-mingw32/x64 (64-bit)

nd comes with ABSOLUTELY NO WARRANTY.
edistribute it under certain conditions.
'licence()' for distribution details.

 project with many contributors.
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Type 'q()' to quit R.

[Workspace loaded from ~/.RData]

Loading required package: sp
> 
```
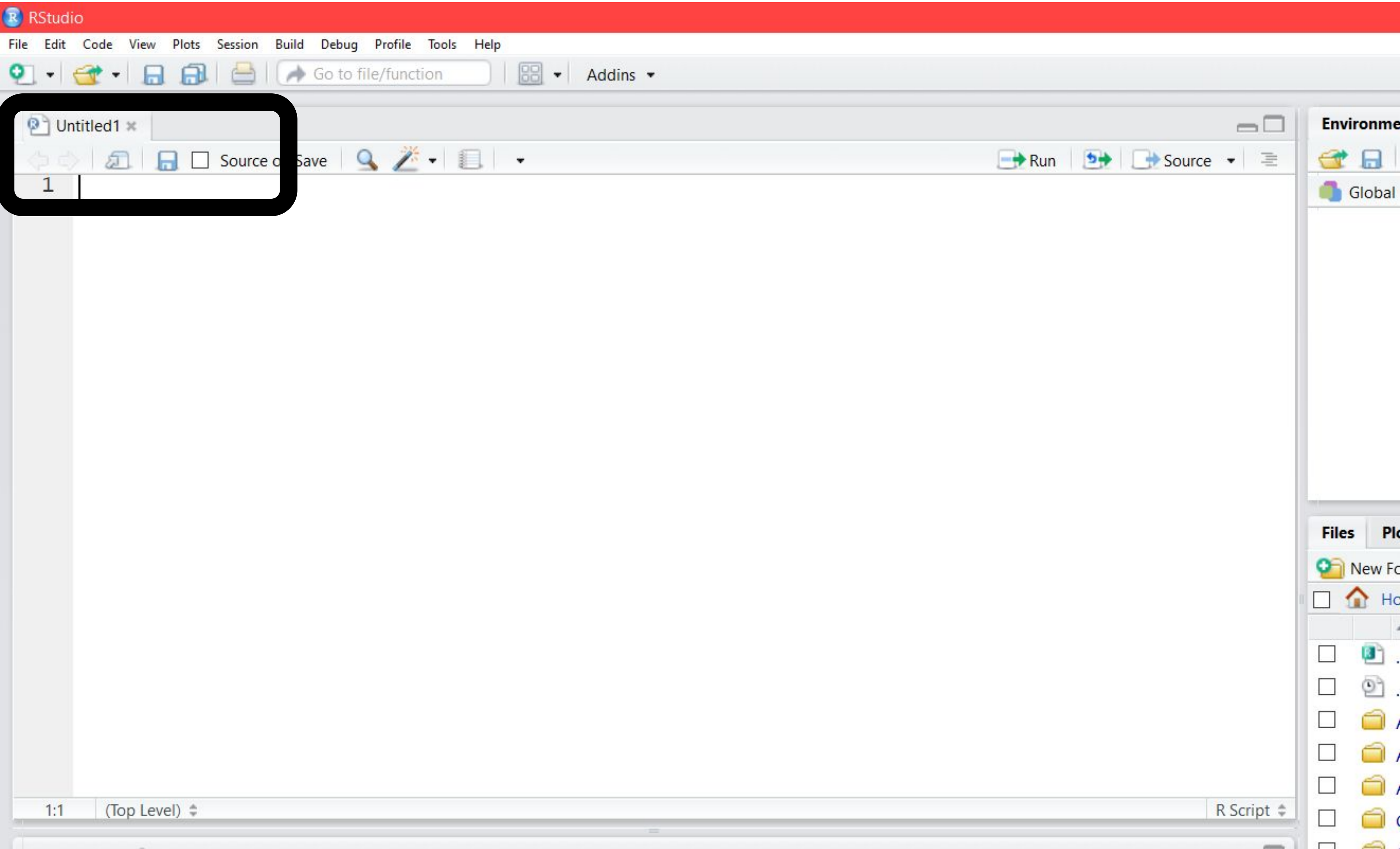

Getting started: opening RStudio



Getting started: using packages

1

```
install.packages("ggplot2")
```

Downloads files to computer

1 x per computer

Getting started: using packages

1

```
install.packages("ggplot2")
```

Downloads files to computer

1 x per computer

2

```
library("ggplot2")
```

Loads package

1 x per R Session

Getting started: using packages

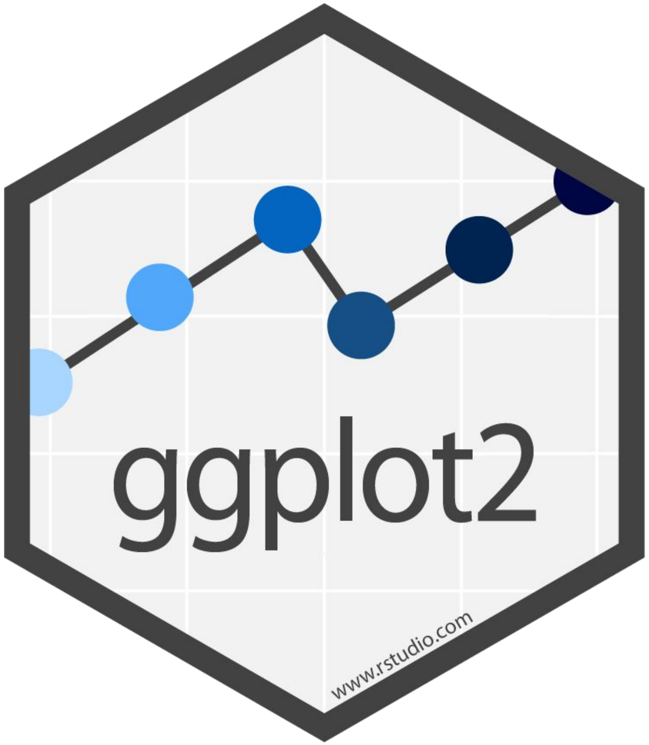
- To **install** ggplot and the rest of the tidyverse:

```
install.packages("tidyverse")
```

- To **load** tidyverse into workspace:

```
library("tidyverse")
```

Part 1: ggplot grammar!



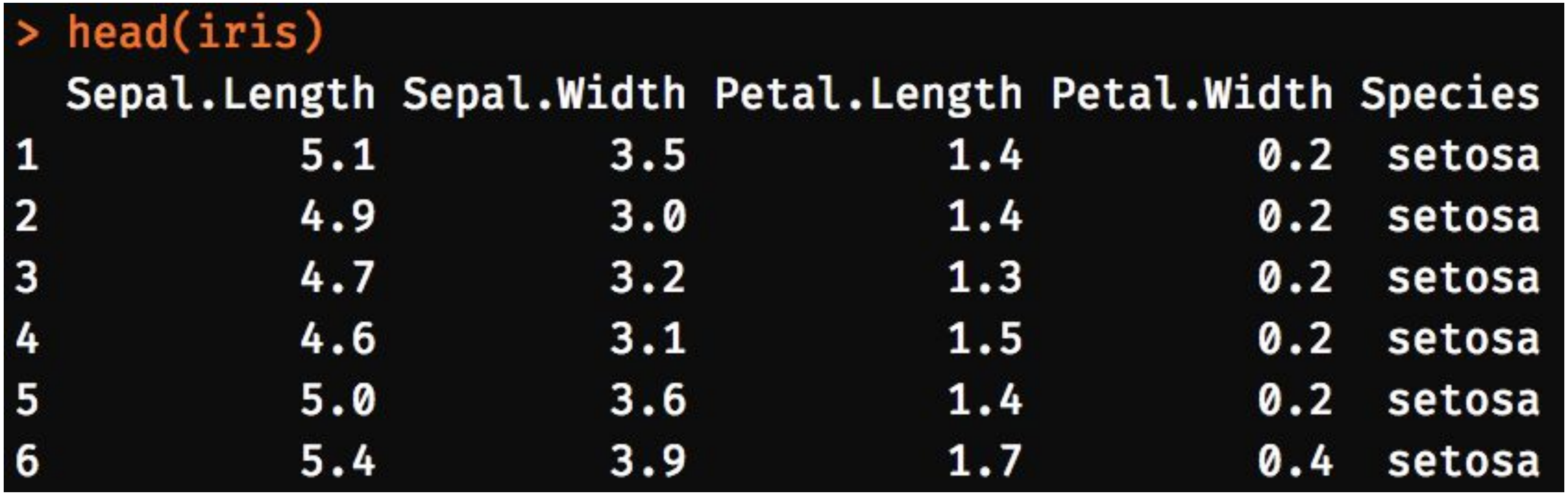
ggplot grammar: data

ggplot grammar: data

```
head(iris)
```

ggplot grammar: data

head(iris)



```
> head(iris)
  Sepal.Length Sepal.Width Petal.Length Petal.Width Species
1          5.1         3.5          1.4         0.2  setosa
2          4.9         3.0          1.4         0.2  setosa
3          4.7         3.2          1.3         0.2  setosa
4          4.6         3.1          1.5         0.2  setosa
5          5.0         3.6          1.4         0.2  setosa
6          5.4         3.9          1.7         0.4  setosa
```

Best Practices: start with tidy data!

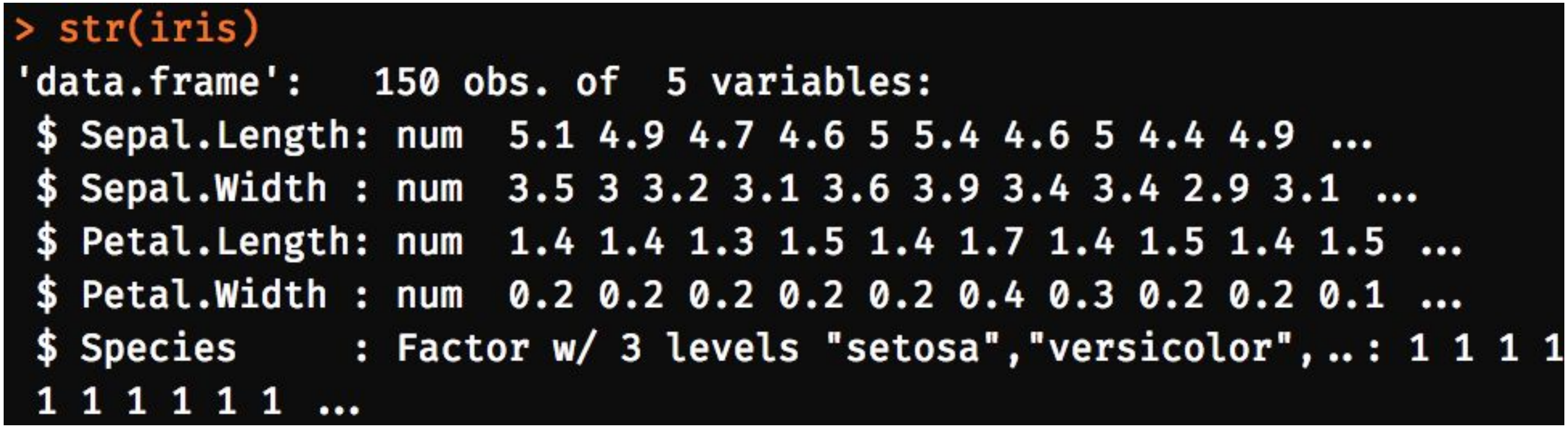
Psst. Attend our Nov 5 Tidy Data Workshop!

ggplot grammar: data

```
str(iris)
```

ggplot grammar: data

str(iris)



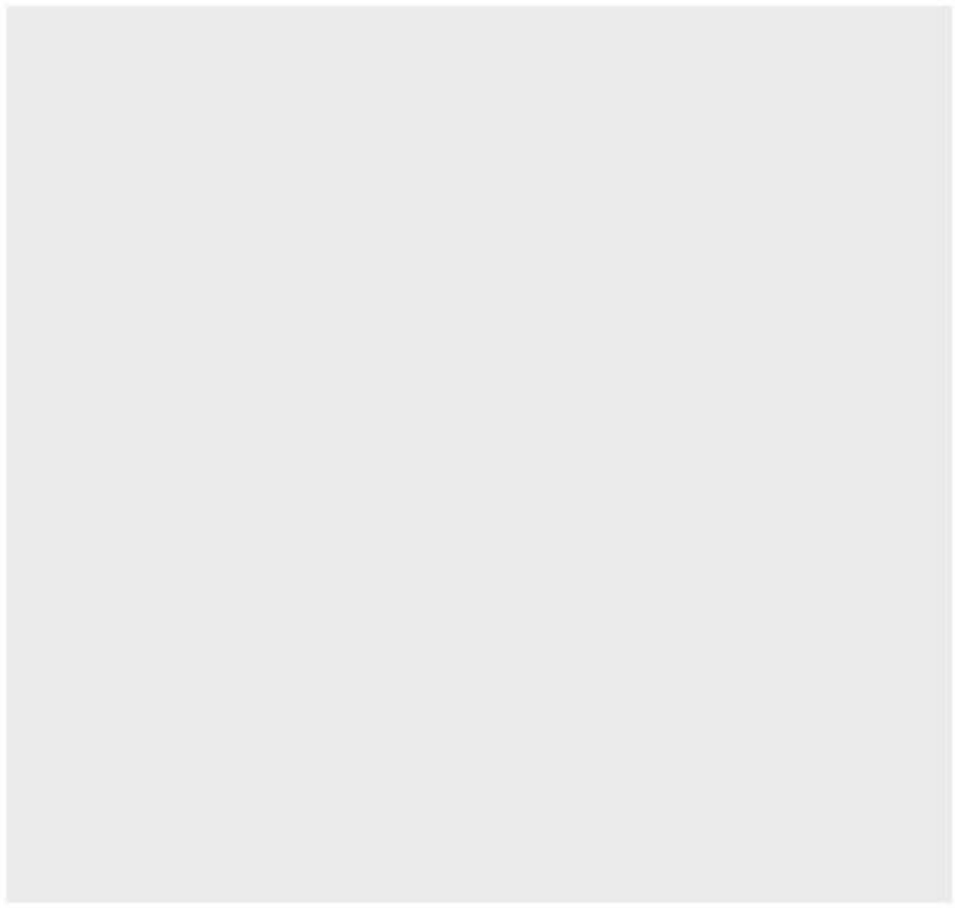
```
> str(iris)
'data.frame':	150 obs. of  5 variables:
 $ Sepal.Length: num  5.1 4.9 4.7 4.6 5 5.4 4.6 5 4.4 4.9 ...
 $ Sepal.Width : num  3.5 3 3.2 3.1 3.6 3.9 3.4 3.4 2.9 3.1 ...
 $ Petal.Length: num  1.4 1.4 1.3 1.5 1.4 1.7 1.4 1.5 1.4 1.5 ...
 $ Petal.Width : num  0.2 0.2 0.2 0.2 0.2 0.4 0.3 0.2 0.2 0.1 ...
 $ Species     : Factor w/ 3 levels "setosa","versicolor",..: 1 1 1 1
 1 1 1 1 1 1 ...
```

ggplot grammar: data

```
ggplot()
```

ggplot grammar: data

```
ggplot()
```



ggplot grammar: data

```
basic_plot <- ggplot(data=iris)
```

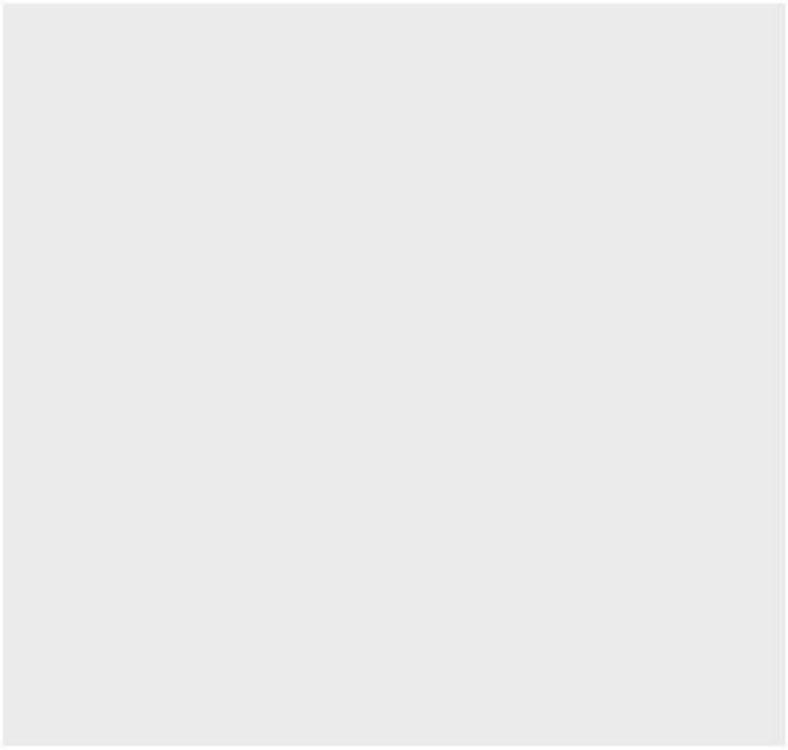
```
basic_plot
```

Best Practices: use informative names for your variables!

ggplot grammar: data

```
basic_plot <- ggplot(data=iris)
```

```
basic_plot
```



ggplot grammar: aesthetics

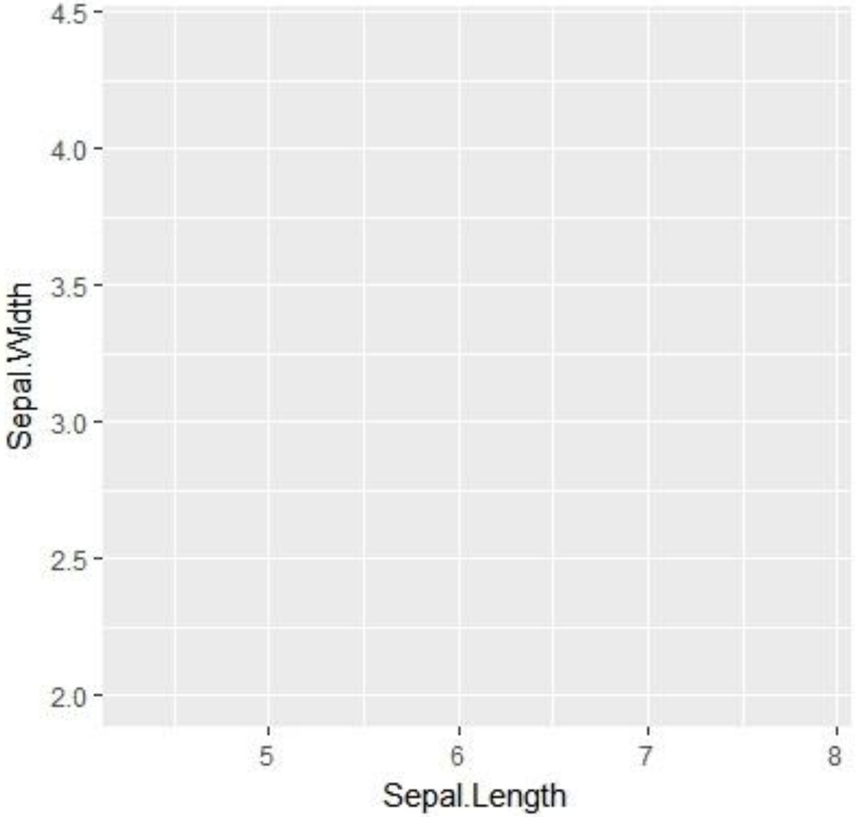
ggplot grammar: aesthetics

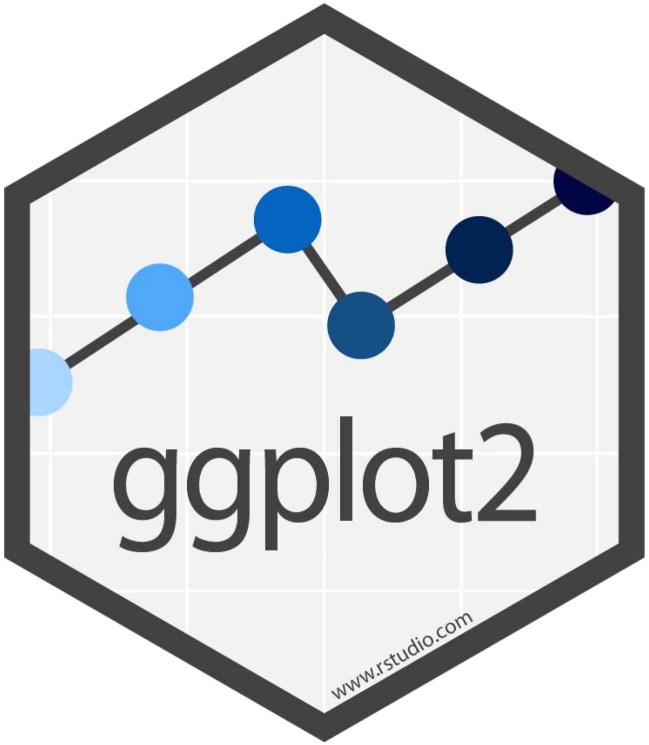
```
basic_plot +
        aes(x=Sepal.Length, y=Sepal.Width)
```

Reminder: basic_plot <- ggplot(data=iris)

ggplot grammar: aesthetics

```
basic_plot +
      aes(x=Sepal.Length, y=Sepal.Width)
```





ggplot grammar: **geom**etry

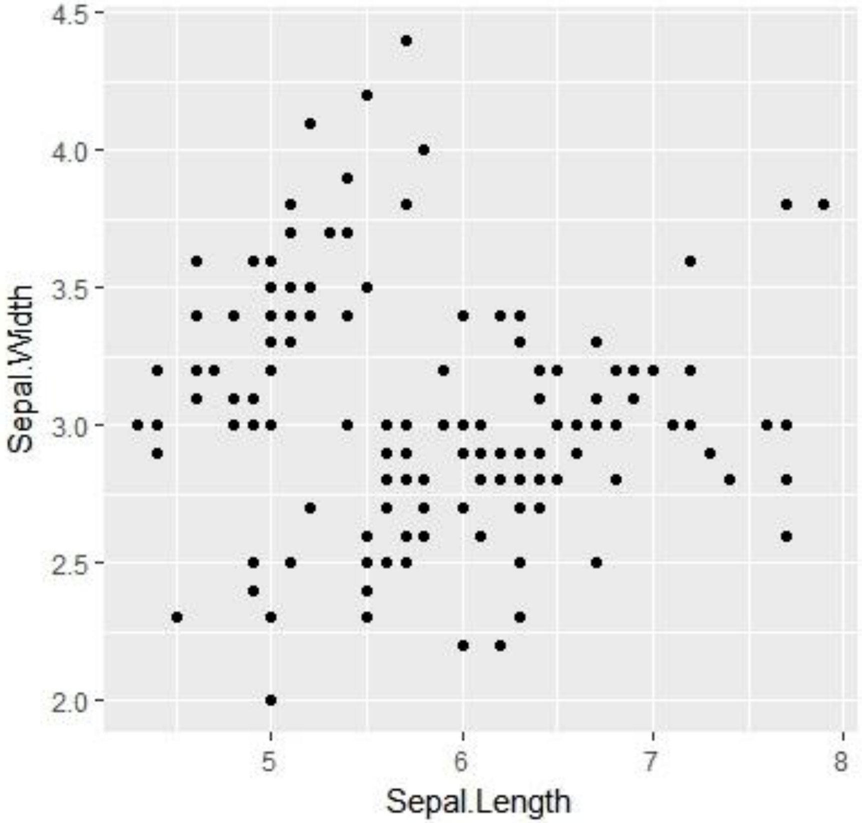
ggplot grammar: geometry

```
basic_plot +
    aes(x=Sepal.Length, y=Sepal.Width) +
    geom_point()
```

Reminder: basic_plot <- ggplot(data=iris)

ggplot grammar: geometry

```
basic_plot +
  aes(x=Sepal.Length, y=Sepal.Width) +
  geom_point()
```



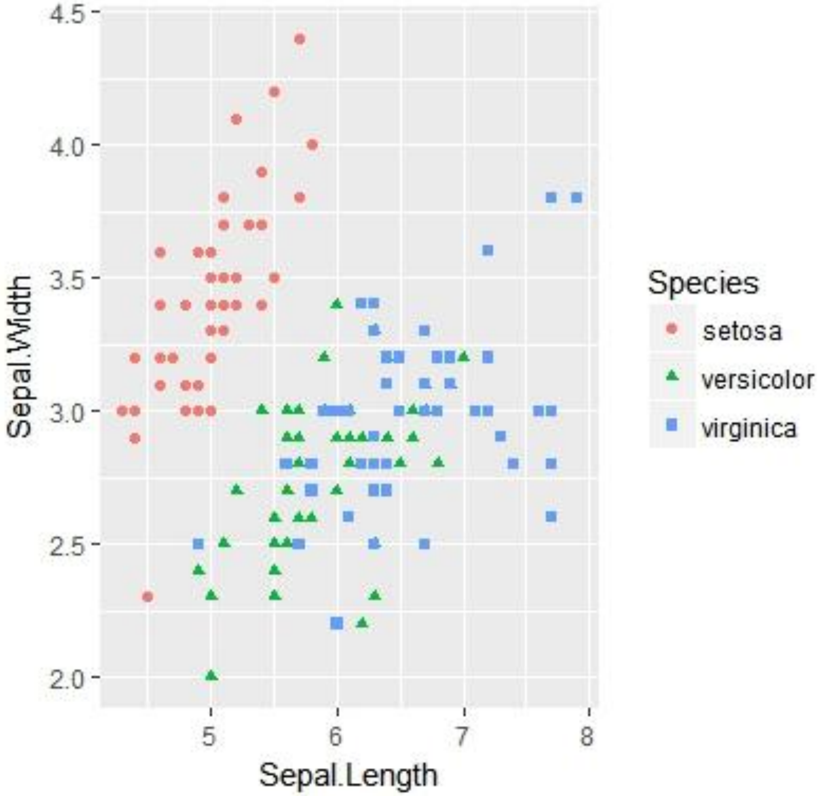
ggplot grammar: geometry & aesthetics

```
basic_plot +
        aes(x=Sepal.Length, y=Sepal.Width,
        color=Species, shape=Species) +
        geom_point()
```

Reminder: basic_plot <- ggplot(data=iris)

ggplot grammar: geometry & aesthetics

```
basic_plot +
        aes(x=Sepal.Length, y=Sepal.Width,
        color=Species, shape=Species) +
        geom_point()
```



ggplot grammar: geometry & aesthetics

```
basic_plot +
        aes(x=Sepal.Length, y=Sepal.Width,
        color=Species, shape=Species) +
        geom_point() +
        geom_smooth(method='lm')
```

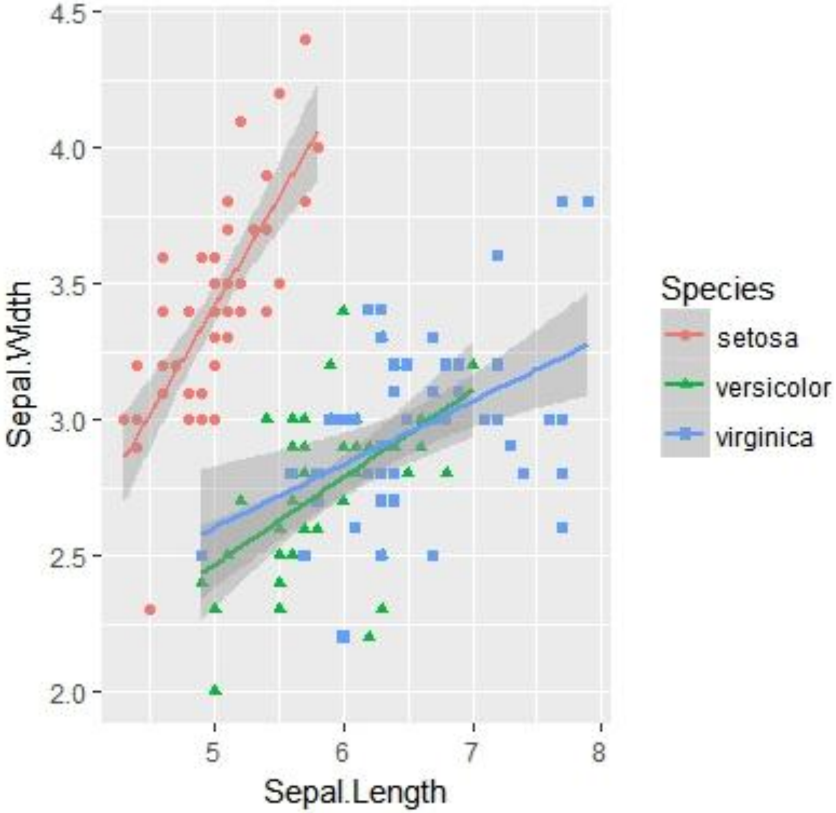
Reminder: basic_plot <- ggplot(data=iris)

ggplot grammar: geometry & aesthetics

```
basic_plot +
        aes(x=Sepal.Length, y=Sepal.Width,
        color=Species, shape=Species) +
        geom_point() +
        geom_smooth(method='lm')
```

Other **geom**'s also exist.

-coming soon!-



ggplot grammar: review

- Specify the data using **data=**

ggplot(data = ______) + aes(x=____, y=____) + …

or

ggplot(data = ______, aes(x=____, y=____)) + …

…use ‘+’ sign to add layers:

ggplot grammar: It’s your turn!

ggplot grammar: practice

- Make a plot called “quiz_1”
- Use the data set: mpg
- Make a box plot using “geom_boxplot()”
- Examine the relationship between “class” and “cty”

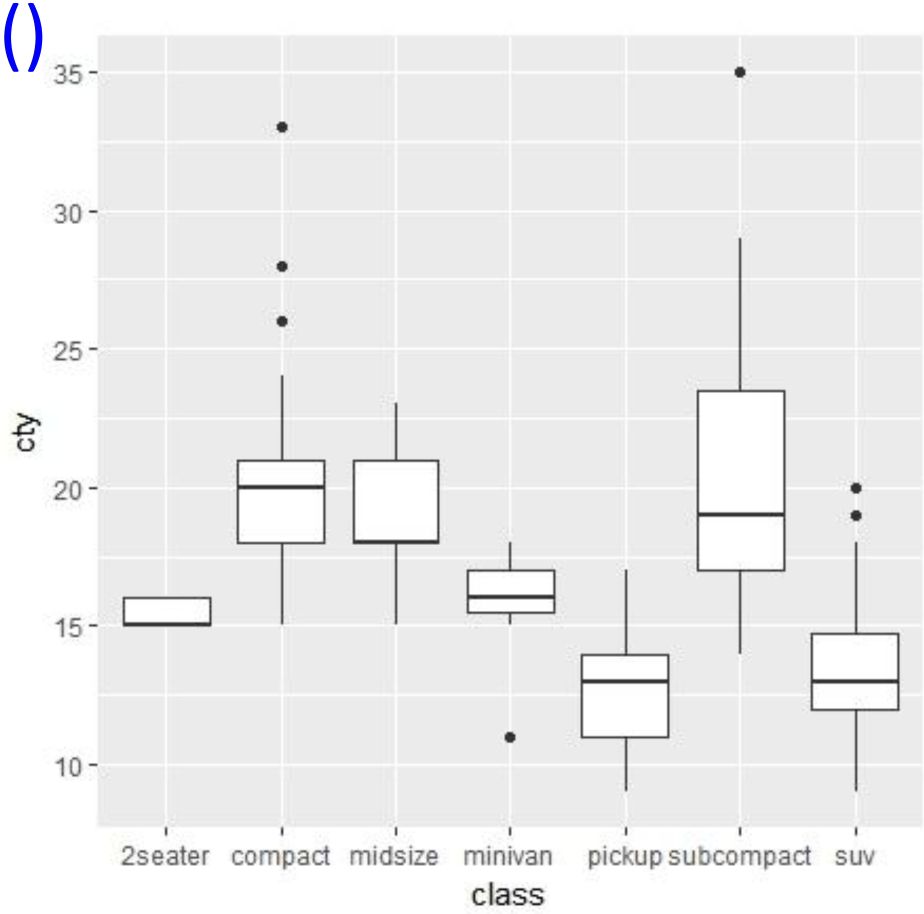
Put up a red post-it if you’re stuck!

ggplot grammar: practice

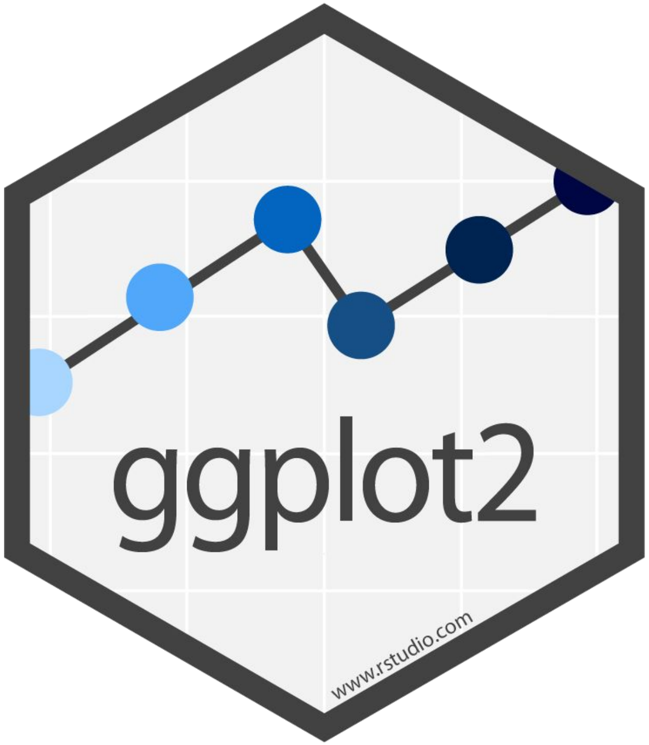
```
head(mpg)
str(mpg)
quiz_1 <- ggplot(data = mpg) +
           aes(x = class, y = cty) +
           geom_boxplot()
quiz_1
```

ggplot grammar: practice

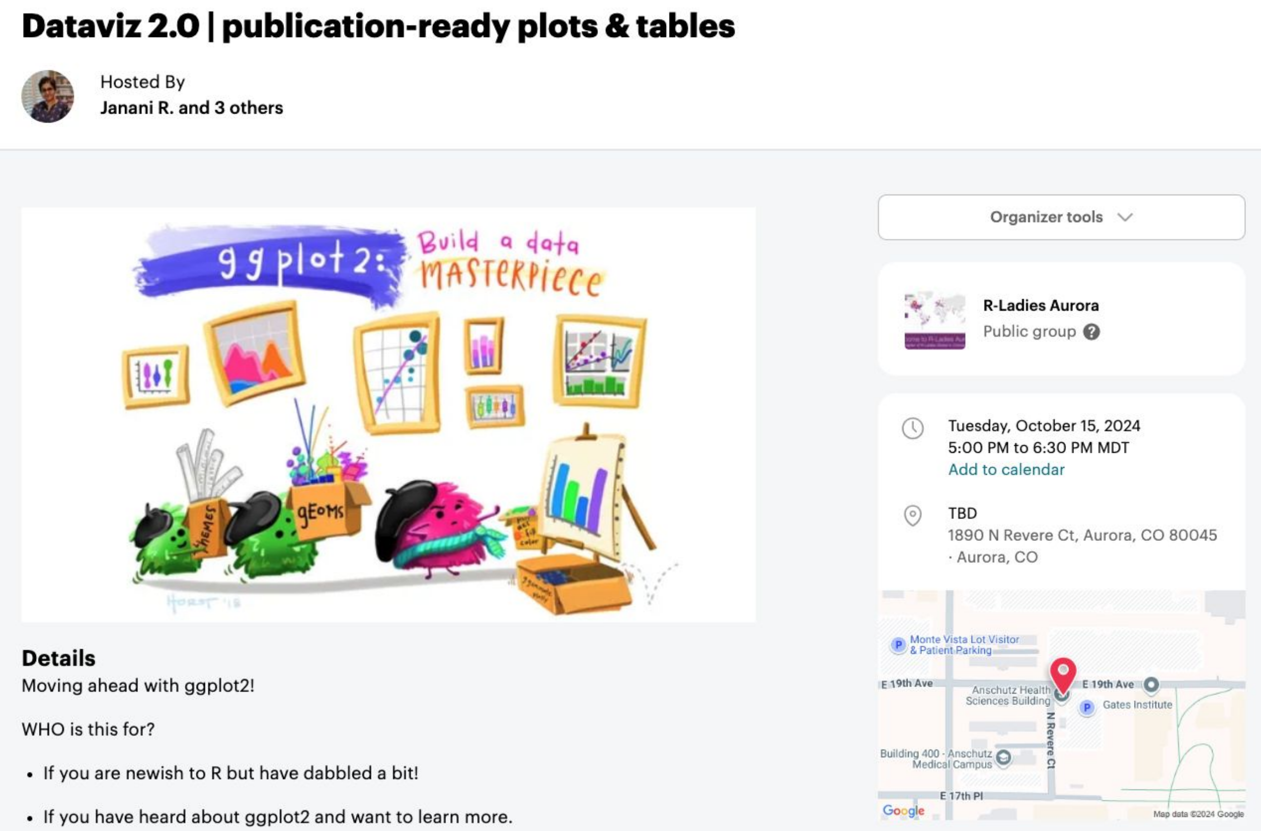
```
quiz_1 <- ggplot(data = mpg) +
              aes(x = class, y = cty) +
              geom_boxplot()
quiz_1
```



Inspired yet?



ggplot part 1: COMPLETE!



Dataviz 2.0 | publication-ready plots & tables

Hosted By
Janani R. and 3 others

ggplot2: Build a data MASTERPIECE
THEMES
GEOMS
Horst '18
Google
Map data ©2024 Google
Monte Vista Lot Visitor & Patient Parking
E 19th Ave
Anschutz Health Sciences Building
Gates Institute
N Revere Ct
Building 400 - Anschutz Medical Campus
E 17th Pl
Organizer tools

R-Ladies Aurora
Public group

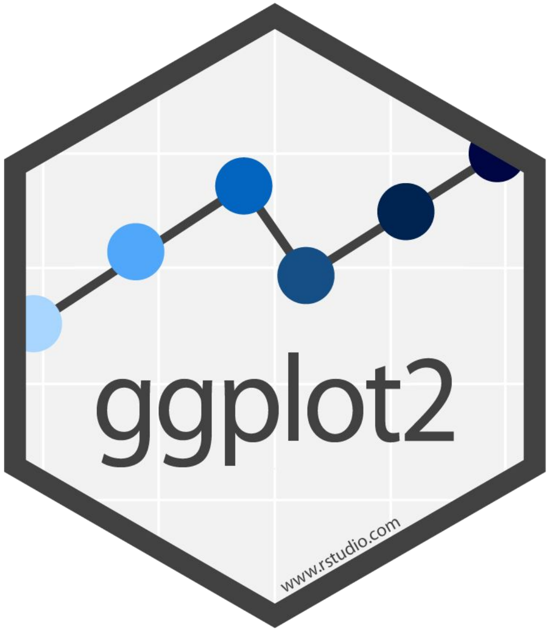
Tuesday, October 15, 2024
5:00 PM to 6:30 PM MDT
Add to calendar

TBD
1890 N Revere Ct, Aurora, CO 80045
· Aurora, CO

Details
Moving ahead with ggplot2!

WHO is this for?

- If you are newish to R but have dabbled a bit!
- If you have heard about ggplot2 and want to learn more.

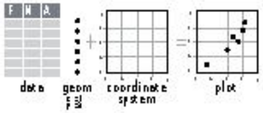


ggplot part 2: Making publication ready plots and tables

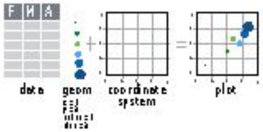
Data Visualization
with ggplot2
Cheat Sheet

Basics

ggplot2 is based on the grammar of graphics, the idea that you can build every graph from the same few components: a data set, a set of geoms—visual marks that represent data points, and a coordinate system.



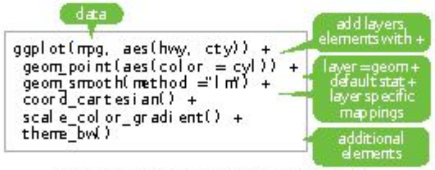
To display data values, map variables in the data set to aesthetic properties of the geom like size, color, and x and y locations.



Build a graph with ggplot() or qplot()

ggplot(data = mpg, aes(x = cty, y = hwy))

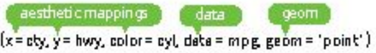
Begins a plot that you finish by adding layers to. No defaults, but provides more control than qplot().



data
add layers, elements with +
layer = geom + default stat + layer specific mappings
additional elements

```
ggplot(mpg, aes(hwy, cty)) +
 geom_point(aes(color = cyl)) +
 geom_smooth(method ="lm") +
 coord_cartesian() +
 scale_color_gradient() +
 theme_bw()
```

Add a new layer to a plot with a geom_*() or stat_*() function. Each provides a geom, a set of aesthetic mappings, and a default stat and position adjustment.



qplot(x = cty, y = hwy, color = cyl, data = mpg, geom = 'point')

Creates a complete plot with given data, geom, and mappings. Supplies many useful defaults.

last_plot()

Returns the last plot

ggsave("plot.png", width = 5, height = 5)

Saves last plot as 5' x 5' file named "plot.png" in working directory. Matches file type to file extension.

Geoms - Use a geom to represent data points, use the geom's aesthetic properties to represent variables. Each function returns a layer.

Graphical Primitives

a <- ggplot(seals, aes(x = long, y = lat))
b <- ggplot(economics, aes(date, unemploy))

a + geom_blank()
(Useful for expanding limits)

a + geom_curve(aes(yend = lat + delta_lat, xend = long + delta_long, curvature = z))
x, xend, y, yend, alpha, angle, color, curvature, linetype, size

b + geom_path(lineend="butt", linejoin="round', linemitre=1)
x, y, alpha, color, group, linetype, size

b + geom_polygon(aes(group = group))
x, y, alpha, color, fill, group, linetype, size

a + geom_rect(aes(xmin = long, ymin = lat, xmax= long + delta_long, ymax = lat + delta_lat))
xmax, xmin, ymax, ymin, alpha, color, fill, linetype, size

b + geom_ribbon(aes(ymin=unemploy - 900, ymax=unemploy + 900))
x, ymax, ymin, alpha, color, fill, group, linetype, size

a + geom_segment(aes(yend=lat + delta_lat, xend = long + delta_long))
x, xend, y, yend, alpha, color, linetype, size

a + geom_spoke(aes(yend = lat + delta_lat, xend = long + delta_long))
x, y, angle, radius, alpha, color, linetype, size

One Variable

Continuous

c <- ggplot(mpg, aes(hwy))

c + geom_area(stat = "bin")
x, y, alpha, color, fill, linetype, size
a + geom_area(aes(y = ..density..), stat = "bin")

c + geom_density(kernel = "gaussian")
x, y, alpha, color, fill, group, linetype, size, weight

c + geom_dotplot()
x, y, alpha, color, fill

c + geom_freqpoly()
x, y, alpha, color, group, linetype, size
a + geom_freqpoly(aes(y = ..density..))

c + geom_histogram(binwidth = 5)
x, y, alpha, color, fill, linetype, size, weight
a + geom_histogram(aes(y = ..density..))

Discrete

d <- ggplot(mpg, aes(fl))

d + geom_bar()
x, alpha, color, fill, linetype, size, weight

Two Variables

Continuous X, Continuous Y

e <- ggplot(mpg, aes(cty, hwy))

e + geom_label(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE)
x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

e + geom_jitter(height = 2, width = 2)
x, y, alpha, color, fill, shape, size

e + geom_point()
x, y, alpha, color, fill, shape, size, stroke

e + geom_quantile()
x, y, alpha, color, group, linetype, size, weight

e + geom_rug(sides = "bl")
x, y, alpha, color, linetype, size

e + geom_smooth(method = lm)
x, y, alpha, color, fill, group, linetype, size, weight

e + geom_text(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE)
x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

Discrete X, Continuous Y

f <- ggplot(mpg, aes(class, hwy))

f + geom_bar(stat = "identity")
x, y, alpha, color, fill, linetype, size, weight

f + geom_boxplot()
x, y, lower, middle, upper, ymax, ymin, alpha, color, fill, group, linetype, shape, size, weight

f + geom_dotplot(binaxis = "y", stackdir = "center")
x, y, alpha, color, fill, group

f + geom_violin(scale = "area")
x, y, alpha, color, fill, group, linetype, size, weight

Discrete X, Discrete Y

g <- ggplot(diamonds, aes(cut, color))

g + geom_count()
x, y, alpha, color, fill, shape, size, stroke

Continuous Bivariate Distribution

h <- ggplot(diamonds, aes(carat, price))

h + geom_bin2d(binwidth = c(0.25, 500))
x, y, alpha, color, fill, linetype, size, weight

h + geom_density2d()
x, y, alpha, colour, group, linetype, size

h + geom_hex()
x, y, alpha, colour, fill, size

Continuous Function

i <- ggplot(economics, aes(date, unemploy))

i + geom_area()
x, y, alpha, color, fill, linetype, size

i + geom_line()
x, y, alpha, color, group, linetype, size

i + geom_step(direction = "hv")
x, y, alpha, color, group, linetype, size

Visualizing error

df <- data.frame(grp = c("A", "B"), fit = 4:5, se = 1:2)
j <- ggplot(df, aes(grp, fit, ymin = fit-se, ymax = fit+se))

j + geom_crossbar(fatten = 2)
x, y, ymax, ymin, alpha, color, fill, group, linetype, size

j + geom_errorbar()
x, ymax, ymin, alpha, color, group, linetype, size, width (also geom_errorbarh())

j + geom_linerange()
x, ymin, ymax, alpha, color, group, linetype, size

j + geom_pointrange()
x, y, ymin, ymax, alpha, color, fill, group, linetype, shape, size

Maps

data <- data.frame(murder = USArrests$Murder,
 state = tolower(rownames(USArrests)))
map <- map_data("state")
k <- ggplot(data, aes(fill = murder))

k + geom_map(aes(map_id = state), map = map) + expand_limits(x = map$long, y = map$lat)
map_id, alpha, color, fill, linetype, size

Three Variables

seals$z <- with(seals, sqrt(delta_long^2 + delta_lat^2))
l <- ggplot(seals, aes(long, lat))

l + geom_contour(aes(z = z))
x, y, z, alpha, colour, group, linetype, size, weight

l + geom_raster(aes(fill = z), hjust=0.5, vjust=0.5, interpolate=FALSE)
x, y, alpha, fill

l + geom_tile(aes(fill = z))
x, y, alpha, color, fill, linetype, size, width

Learn more at docs.ggplot2.org • ggplot2 2.0.0 • Updated: 12/15