DataFest 2017 Introduction to R and RStudio

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Outline

- Download and Install R and RStudio
- RStudio layout
- Loading data
- R packages
- Exploratory data analysis ("EDA")
    - Working with subsets of the data
- Basic statistics functionality
- Where to get help

Downloading/Installing R and RStudio

1. **R (the programming language)** - `http://cran.r-project.org/`
2. **RStudio (the IDE)** - `http://www.rstudio.com/`

RStudio layout

RStudio layout

Rstudio layout: the 4 panes.

- Lower-left: **Console** (where the action happens):
  - Shows a one-line “command prompt” as well as a line-by-line history of recently-executed commands.
- Upper-right: **Environment (or Workspace)** and **History**
  - **Environment** - names/properties of variables, datasets, etc.
  - **History** - shows previously-executed commands
  - The important button **“import dataset”** is also shown in the upper-right.
- Lower-right: Any plots that you generate will appear here in under **Plots**.
  - This is also where you can access your **files**, view/install **packages**, and view **help**.
- Upper-left: **Scripts**. Write and save scripts here. Scripts are sequences of commands you can easily re-run all at once, share with a teammate, etc.

RStudio layout: Console

Lower-left:

- Where the action happens:
  - Shows a one-line command prompt as well as a line-by-line history of recently-executed commands.
  - Press “Up” to cycle through previously-entered commands.

RStudio layout: Environment / History

Upper-right:

- Your **Environment** shows names/properties of variables, datasets, etc.
- The **History** tab shows the commands that you've previously executed
- The important button **“import dataset”** is also shown in the upper-right.

RStudio layout: The viewer

Lower-right:

- Any plots that you generate will appear here in the **Plots** tab.
- You can also access your **Files**, view/install R **packages**, and view R **help**.

RStudio layout: Script Window

Upper-left:

- Write and save scripts here. Scripts are sequences of commands you can easily re-run all at once, share with a teammate, etc.
- “**Start** in the console, **save** in a script.”

Loading datasets into R

What is a .csv file?

"Comma separated values", i.e. commas are the **delimiter**.

Getting this dataset / presentation

- The `DFworkshop.csv` dataset used in this presentation is available at

`http://tinyurl.com/DF17IntroToR-Data`

- All other files (R script, source code, presentation, etc.) can be found at

`http://tinyurl.com/DF17IntroToR`

Loading a large .csv dataset Method 1

By point-and-click

Datasets in R are stored as follows:

- Each of the **n** rows is an individual case, i.e. an observation.
- Each of the **p** columns is a variable which was recorded for each observation.

Save the .csv file to a directory on your computer (e.g. your Dropbox). Then, to load the data into a variable called `myData`:

- use the Import Dataset button in the upper-left pane.
  - [DEMO]

Loading a large .csv dataset Method 2

By read.csv()

Datasets in R are stored as follows:

- Each of the **n** rows is an individual case, i.e. an observation.
- Each of the **p** columns is a variable which was recorded for each observation.

Save the .csv file to a directory on your computer (e.g. your Dropbox). Then, to load the data into a variable called `myData`:

- execute `read.csv()` with the following arguments:

```
myData = read.csv("~/Dropbox/DFworkshop.csv", comment.char
                       quote = "",stringsAsFactors = FALSE)
```

- **TIP**: Write your commands in the **script** window so they're easily accessible.

A quick look at the data we loaded

```
dim(myData)    # "dimension"
```

```
## [1] 99  9
```

```
names(myData)
```

```
## [1] "ID"       "date"     "var3"     "state"    "type"
## [7] "location" "var6"     "var7"
```

- `dim()` shows us the data has 99 rows (observations) and 9 columns (variables).
- `names()` shows us the dataset's variable names

More on read.csv()

The function `read.csv()` has lots of optional arguments.

- The DataFest data should be readable using the `read.csv()` command listed earlier, with similar arguments. (Ask a DataFest consultant!)
- Get more info on the function by executing `?read.csv`; RStudio's Help window will appear.
- Examples of arguments for `myData = read.csv(...)` (e.g. for other datasets) are:
  - `file = 'data.csv', header = TRUE, sep = "|", stringsAsFactors = FALSE, nrows = 5`
  - `file = 'data.csv', header = FALSE, stringsAsFactors = FALSE, sep = ",")`

Using R packages

- Lots of R's capabilities aren't available in the basic download.
- Often, external **packages** need to be **installed** and **loaded** first.

```
install.packages("mosaic")  # "" mandatory
library("mosaic")           # "" optional
```

IMPORTANT: These two commands must **both** be used, or the package's functions won't be accessible to you.

- You would learn about the most common and useful packages in the remaining workshops.

EDA Summary statistics

categorical variables

```
table(myData$state)
```

```
##
## CA CO CT FL GA IL IN LA MA MD MO NC NJ NV NY OH PA TN TX
## 30  1  2  6  2  4  1  1  4  4  1  4 10  1  4  2  6  1  9
```

```
table(myData$type)
```

```
##
##  1  2  3  4  5  6  7  8  9
## 13 13 13 13 11 10 10  9  7
```

continous variables

```
summary(myData$var6)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      25    9638   32640   50880   77620  184800
```

```
summary(myData$var7)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    7.00   31.00   55.00   55.44   79.00  106.00
```

EDA Some basics

Basics

Most basic functionality is available standard – i.e. without having to install a package

```
mean(myData$var6)  # mean
```

```
## [1] 50877.92
```

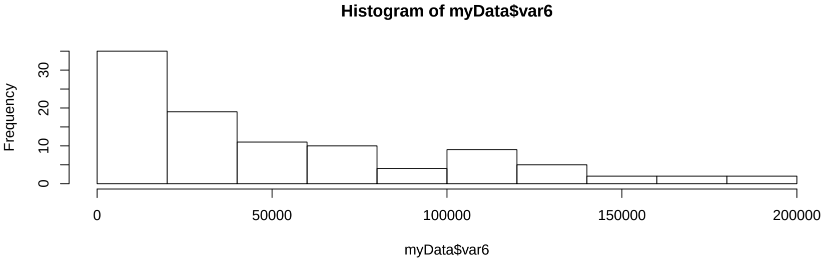
```
sd(myData$var7)    # standard deviation
```

```
## [1] 28.71898
```

Histogram of a continous variable

Plotting histogram with `hist()` function

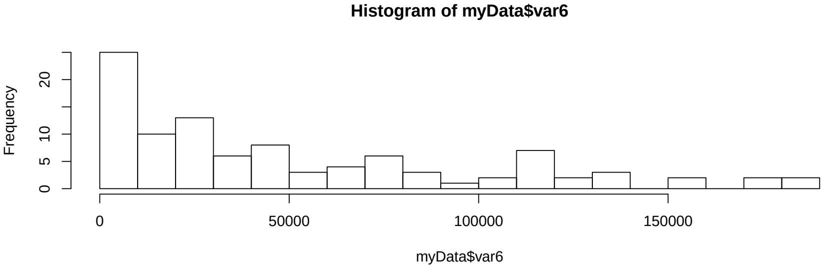
```
hist(myData$var6)
```



Histogram of a continous variable: var6

You can adjust the width of the bins by changing the `breaks` argument

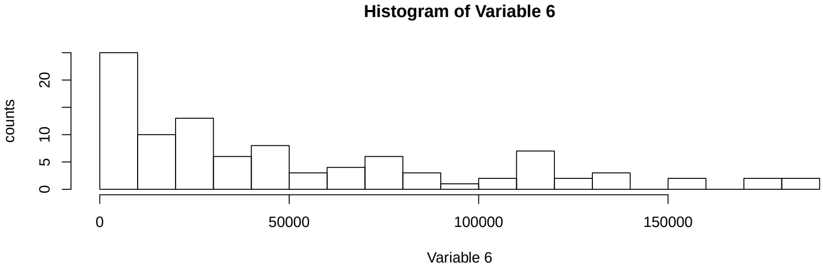
```
hist(myData$var6, breaks = 20)
```



Histogram of a continous variable: var6

Axis labels are controlled by `xlab` and `ylab`; the title by `main`

```
hist(myData$var6, xlab = "Variable 6", ylab = "counts",
     main = "Histogram of Variable 6", breaks = 20)
```

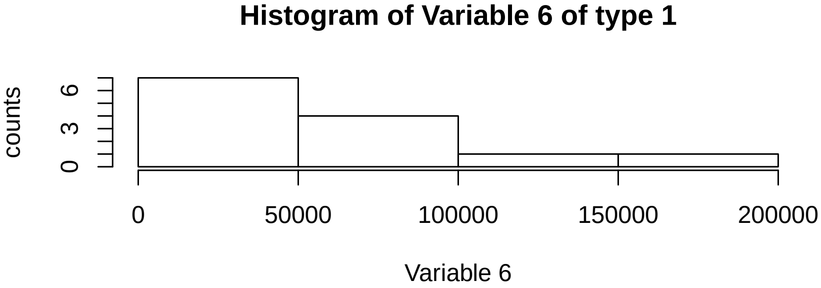


EDA Working with subsets of the data

Histograms with subsets

Here we access the `var6` variable in the dataset with `myData$var6`, and further refine the command by accessing only those elements where `type` is `1`:

```
hist(myData$var6[myData$type == 1], xlab = "Variable 6",
     ylab = "counts", main = "Histogram of Variable 6 of ty
```



This shows the important ability to access a particular index/indices of a 1-d **vector** using `vector[indices]`.

Comparing two categorical variables

Get a quick summary using a contingency table with the **table** command.

```
table(myData$type, myData$state)
```

```
##
##     CA CO CT FL GA IL IN LA MA MD MO NC NJ NV NY OH PA T
##   1  5  0  0  2  0  1  0  0  0  1  0  1  1  0  1  0  0
##   2  5  0  0  1  0  0  0  1  2  1  0  0  1  0  0  0  0
##   3  5  0  0  1  0  0  0  0  1  0  0  1  2  1  0  0  2
##   4  6  0  0  1  0  0  0  0  0  1  0  0  0  0  2  0  0
##   5  4  0  0  0  1  1  0  0  1  0  0  1  1  0  0  0  1
##   6  3  0  1  1  0  1  0  0  0  1  0  1  1  0  0  0  1
##   7  0  1  0  0  0  0  0  0  0  0  0  0  2  0  0  2  1
##   8  1  0  1  0  1  1  0  0  0  0  0  0  0  0  1  0  1
##   9  1  0  0  0  0  0  1  0  0  0  1  0  2  0  0  0  0
```

So, for example, the number of observations (rows of the dataset) with `type == 7` and `state == 'TX'` is 3.

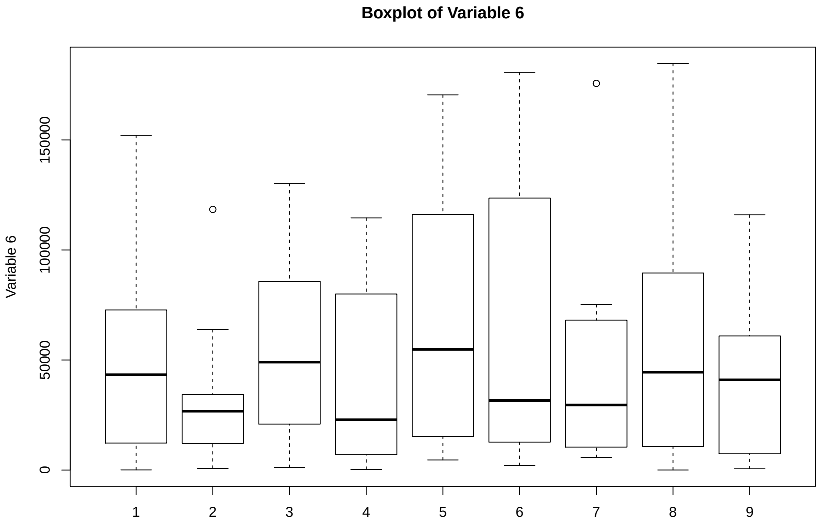
Comparing a continous variable across different groups

```
boxplot(myData$var6 ~ myData$type, ylab = "Variable 6",
        main = "Boxplot of Variable 6")
```

- Get a quick summary using side-by-side boxplots. Here we compare the continuous `var6` variable of `myData` by making a boxplot for those data points belonging to each level of `type`.
- For clarity, consider the above command without the extra label and title arguments: `boxplot(myData$var6 ~ myData$type)`. This just says "boxplot the continous `var6` variable of `myData`, breaking out the data by levels of the categorical `type` variable."

Comparing a continous variable across different groups

```
boxplot(myData$var6 ~ myData$type, ylab = "Variable 6",
        main = "Boxplot of Variable 6")
```



More on basic statistical functionality

t-test for a difference between means

```r
t.test(var6 ~ group, data = myData, na.rm = TRUE)
```

```
##
##  Welch Two Sample t-test
##
## data:  var6 by group
## t = -8.7669, df = 51.424, p-value = 8.761e-12
## alternative hypothesis: true difference in means is not
## 95 percent confidence interval:
##  -87631.44 -54980.37
## sample estimates:
## mean in group production    mean in group testing
##                 21347.19                 92653.10
```

The `na.rm = ...` argument ignores the NA values in the dataset.

t-test for a difference between means

Instead of

```
t.test(var6 ~ group, data = myData)
```

we could have executed

```
t.test(myData$var6 ~ myData$group)
```

- The first command is easier to read thanks to the `data =` argument.
- The `data =` argument can be used in many R functions, **but not all**!
- So give it a try, but if you get errors remember that the longer way of referring to variables, `data$variable`, is always available.

Correlation

Let's calculate the correlation between two variables.

```
# requires "mosaic" package
cor(var6, var7, data = myData)
```

Again, we could have also written

```
# will work regardless of whether "mosaic" is loaded
cor(myData$var6, myData$var7)
```

```
## [1] 0.7191304
```

Regression

Regression is performed by passing a regression formula to the `lm()` function. The formula will look like:

```
dependVar ~ indepVar1 + indepVar2 + [etc]
```

where [etc] is whatever other variables you want to regress on.

1. Store the result of `lm()` in a variable. Below we call it `regression.fit`.
2. View the results by using the `summary()` command on the variable you just created.

```
regression.fit = lm(var7 ~ var6, data = myData)  # perform
```

Regression (cont'd)

View the results of a linear regression with `summary()`

```
summary(regression.fit)  # view the results
```

Regression (cont'd)

```
## 
## Call:
## lm(formula = var7 ~ var6, data = myData)
## 
## Residuals:
##     Min      1Q  Median      3Q     Max 
## -29.261 -13.674  -4.059  12.080  60.365 
## 
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.440e+01  2.886e+00   11.92   <2e-16 ***
## var6        4.136e-04  4.058e-05   10.19   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
## 
## Residual standard error: 20.06 on 97 degrees of freedom
## Multiple R-squared:  0.5171, Adjusted R-squared:  0.5122
## F-statistic: 103.9 on 1 and 97 DF,  p-value: < 2.2e-16
```

Regression (cont'd)

- Often, related R commands can be combined to make code more concise, but harder to read depending on your experience.
- Here's how to perform and view a regression in one line of code:

```
summary(lm(var7 ~ var6, data=myData))
```

Note that if we use the latter command, the `regression.fit` variable wouldn't exist (so we can't refer to it later).

Regression (cont'd) and code completion

If you stored the results of a regression as in

```
regression.fit = lm(var7 ~ var6, data=myData)
```

you can easily exploit RStudio's code-completion feature.

- Don't remember what's in variable? Easy. . .
- . . . just type the **variable name** (into the **command prompt** or a **script window**) followed by a $ sign and press **TAB**.

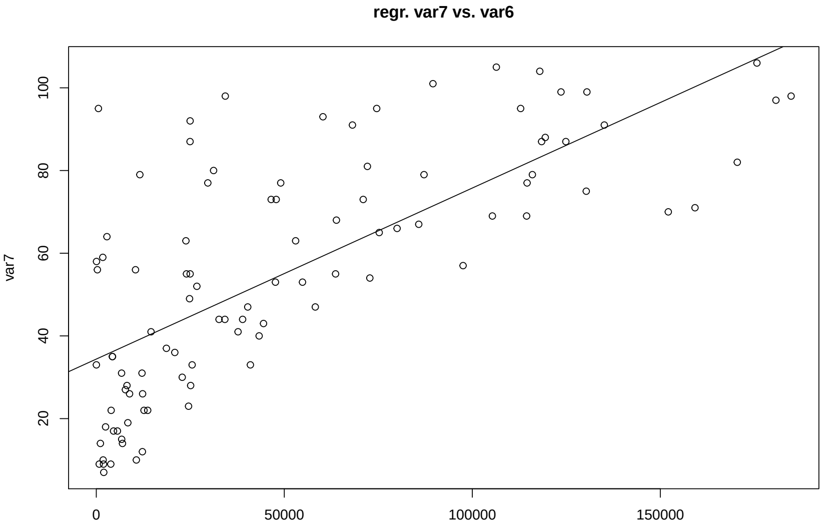
Basic plotting

```
plot(myData$var6, myData$var7, xlab = "var6", ylab = "var7"
     main = "regr. var7 vs. var6")
abline(regression.fit)
```

Earlier arguments like `xlab`, `ylab`, etc. can also be used with the `plot()` command.

Basic plotting

```
plot(myData$var6, myData$var7, xlab = "var6", ylab = "var7'
     main = "regr. var7 vs. var6")
abline(regression.fit)
```



Where to get help

1. To view documentation on any **function**, execute `?plot`, `?lm`, etc.
2. R command summaries and cheat sheets are all over the internet:
   e.g. `https://www.zoology.ubc.ca/~schluter/R/data/` is a good one.
3. Of course, also ask a DataFest participant / helper!
4. If all else fails, listen to your heart . . . Google it.