Topic 0: Introduction and R tutorial

8/28/2018

Administrative

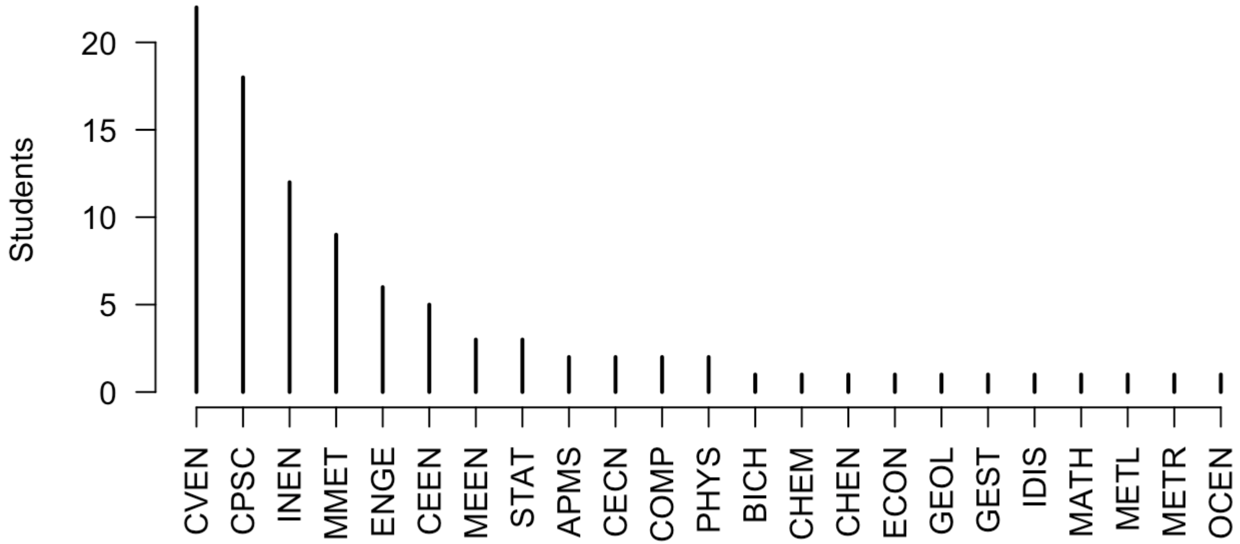
1. Get webassign
2. Accept Piazza invite
3. Read syllabus
4. Download R and Rstudio

What is Statistics?

> Statistics is the science of learning from data, and of measuring, controlling, and communicating uncertainty; and it thereby provides the navigation essential for controlling the course of scientific and societal advances.

-- Marie Davidian and Thomas A. Louis, *Why Statistics?*, Science 2012.

Why should you care



- Computer science/software engineering
    - A/B Testing
    - Recommendation
- Civil engineering
    - Traffic management
    - Risk and reliability
- Industrial engineering
    - Statistical process control
    - Queuing theory
- Mechanical engineering
    - Optimal control

- Biology
  - Genome-wide association study
  - Phylogeny
- Meteorology
  - Model output statistics
  - Ensemble forecasts
- Economics
  - Dynamic stochastic general equilibrium models
  - Factor investing
- Chemistry
  - Multivariate calibration

- Humanities
  - Topic modeling
  - Distant reading
- Psychology
  - Personality testing
  - Standardized testing
- Politics
  - Polling
  - Ideal point models
- Marketing
  - Market basket analysis

Motivating example

In the 2015 season of the National Football League (NFL), the Houston Texans won 9 of their 16 games.

- Win percentage: (9 / 16) x 100% = 56.25%.
- Is "real" win percentage better than chance (50%)?
- What is the probability of 9 or more wins out of 16 if real win percentage is 50%?

Simulate result of a season

```
p <- 0.5
season <- sample(c(0, 1), size = 16, replace = TRUE, prob = c(1 - p, p))
win_total <- sum(season)
season
```

```
##  [1] 1 1 0 0 1 0 0 0 0 1 1 1 0 1 0 1
```

```
win_total
```

```
## [1] 8
```

Run simulation 1000 times

```
n <- 1000
win_total <- replicate(n, {
  season <- sample(c(0, 1), size = 16, replace = TRUE, prob = c(1 - p, p))
  sum(season)
})
```

Frequencies of win totals:

```
table(win_total)
```

```
## win_total
##   2   3   4   5   6   7   8   9  10  11  12  13  14 
##   4  12  27  67 113 158 206 184 115  72  31   8   3 
```

Win probabilities

```r
table(win_total) / n
```

```
## win_total
##     2     3     4     5     6     7     8     9    10    11    12    13 
## 0.004 0.012 0.027 0.067 0.113 0.158 0.206 0.184 0.115 0.072 0.031 0.008 
##    14 
## 0.003
```

```r
sum(win_total >= 9) / n
```

```
## [1] 0.413
```

Learning R

Resources

- StackOverflow
- DataCamp introduction
- Rstudio cheatsheets

General Advice

- Just trying something has no cost; guess and check

Software can be chaotic, but we make it work

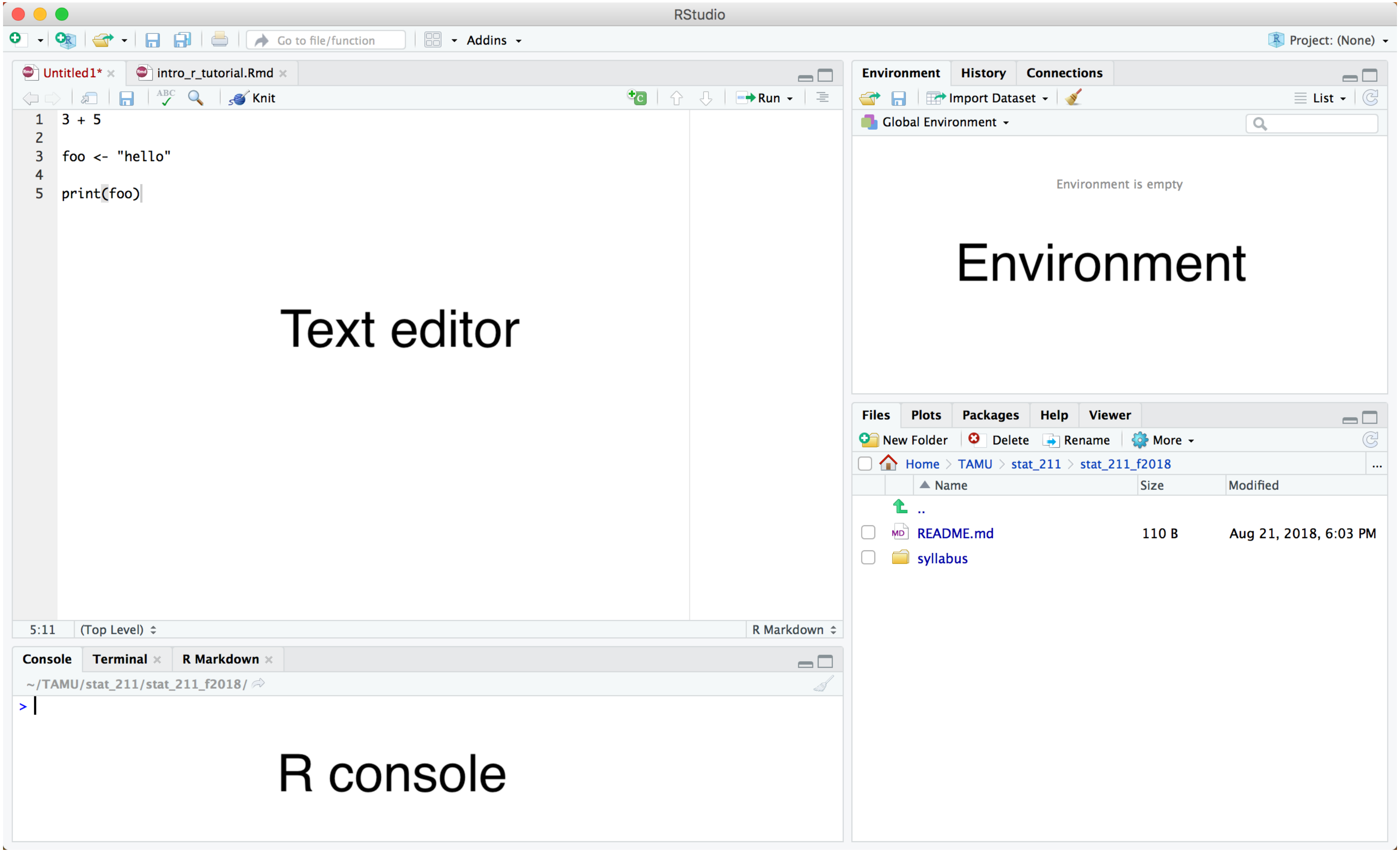
Expert

Trying Stuff Until it Works

O RLY?

The Practical Developer
@ThePracticalDev

Using R



```
3 + 5

foo <- "hello"

print(foo)
```

```
> 
```

~/TAMU/stat_211/stat_211_f2018/

Name	Size	Modified
..		
README.md	110 B	Aug 21, 2018, 6:03 PM
syllabus		

Suggested workflow

1. Open Rstudio
2. Change working directory: Ctrl + Shift + h
3. Create script: Ctrl + Shift + n
4. Write, save code in script
5. Run code
    1. source the script, or
    2. run line by line

R Syntax

```
# this is a comment

# use R as a calculator
3 * (5 + sqrt(2) + pi)
```

```
## [1] 28.66742
```

```
# assignment
a <- TRUE
b = 2
```

```
# comparison
10 > 20
```

```
## [1] FALSE
```

```
is.na(NA) & (5 > b)
```

```
## [1] TRUE
```

Control Flow

```r
# conditional
if (!a) {
  print("hello")
} else {
  print("goodbye")
}
```

```
## [1] "goodbye"
```

```r
# for loop
for (i in 1:10) {
  cat(i)
}
```

```
## 12345678910
```

```r
# while loop
x <- 4
while (x > 0) {
  cat(x ^ 2)
  cat(" ")
  x <- x - 1
}
```

```
## 16 9 4 1
```

Data Types

```
# vectors
vec1 <- c(1, 5, 4, 3)
vec2 <- 1:10
vec3 <- seq(from = -4, to = 2, by = 2)
```

```
# get first element
vec1[1]
```

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

```
# change 2nd element value
vec1[2] <- 1000
vec1
```

```
## [1]    1 1000    4    3
```

```
# get length
length(vec3)
```

```
## [1] 4
```

```r
# lists
list1 <- list(1, "a", 3)
list1
```

```
## [[1]]
## [1] 1
##
## [[2]]
## [1] "a"
##
## [[3]]
## [1] 3
```

```r
# get first element, not a list
list1[[1]]
```

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

```r
# get sublist, this is a list
list1[1]
```

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

```
# data frames
names <- c("Bob", "Fatima", "Pierre")
df <- data.frame(age = c(10, 15, 23),
                 name = names)
df
```

```
##   age   name
## 1  10    Bob
## 2  15 Fatima
## 3  23 Pierre
```

```
# get a column, 3 ways to do same thing
df[, "name"]
df$name
df[, 2]
```

```
## [1] Bob    Fatima Pierre
## Levels: Bob Fatima Pierre
## [1] Bob    Fatima Pierre
## Levels: Bob Fatima Pierre
## [1] Bob    Fatima Pierre
## Levels: Bob Fatima Pierre
```

```
colnames(df)
dim(df)
```

```
## [1] "age"  "name"
## [1] 3 2
```

Reading/writing data sets

```
# write df to csv, look at directory contents
write.csv(df, "demo_file.csv", row.names = FALSE)
dir()
```

```
##  [1] "demo_file.csv"                  "intro_r_tutorial_files"
##  [3] "intro_r_tutorial_slides.pdf"    "intro_r_tutorial.aux"
##  [5] "intro_r_tutorial.html"          "intro_r_tutorial.out"
##  [7] "intro_r_tutorial.pdf"           "intro_r_tutorial.Rmd"
##  [9] "roster_509_f2018.csv"           "rstudio_pic.png"
## [11] "tryingstuffuntilitworks-big.png"
```

```
# read df back in
df2 <- read.csv("demo_file.csv")
df
```

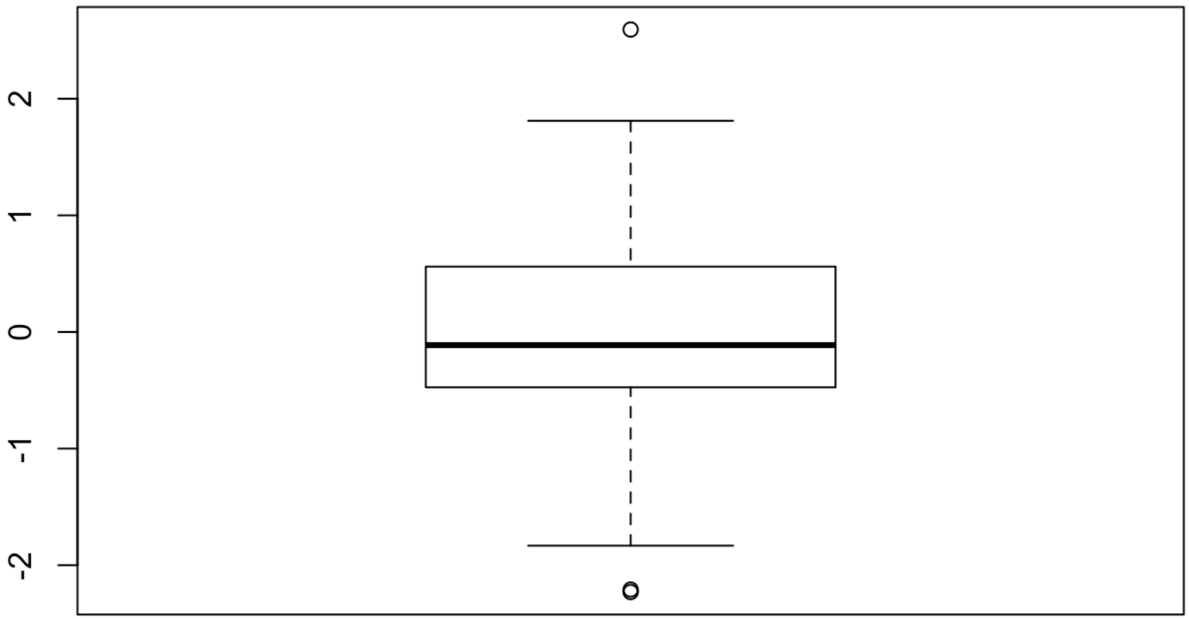
```
##   age   name
## 1  10    Bob
## 2  15 Fatima
## 3  23 Pierre
```

```
df2
```

```
##   age   name
## 1  10    Bob
## 2  15 Fatima
## 3  23 Pierre
```

Plotting

```
y_vals <- rnorm(100)
boxplot(y_vals)
```



Functions

```r
# define function
hello_func <- function(name, response = "hello") {
  paste0(name, " says ", response)
}

# call function
hello_func("Patrick")
```

```
## [1] "Patrick says hello"
```

```r
# see function
hello_func
```

```
## function(name, response = "hello") {
##   paste0(name, " says ", response)
## }
```

```r
# override default argument
hello_func("Patrick", response = "goodbye")
```

```
## [1] "Patrick says goodbye"
```

Getting help

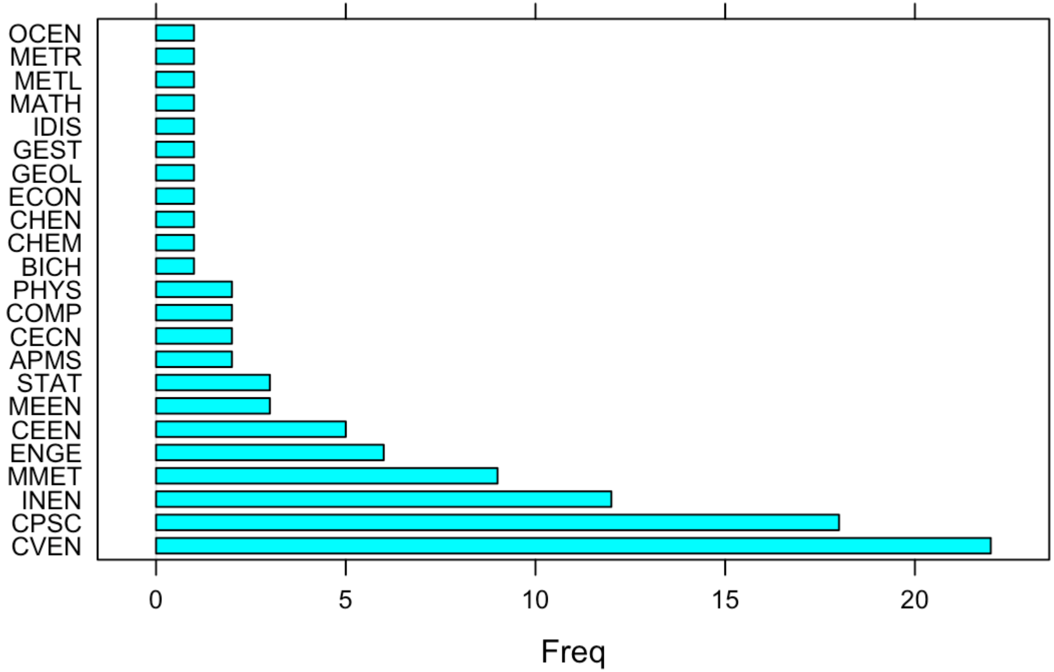
Use `?` or `help()`

```
?hist

help(read.csv)
```

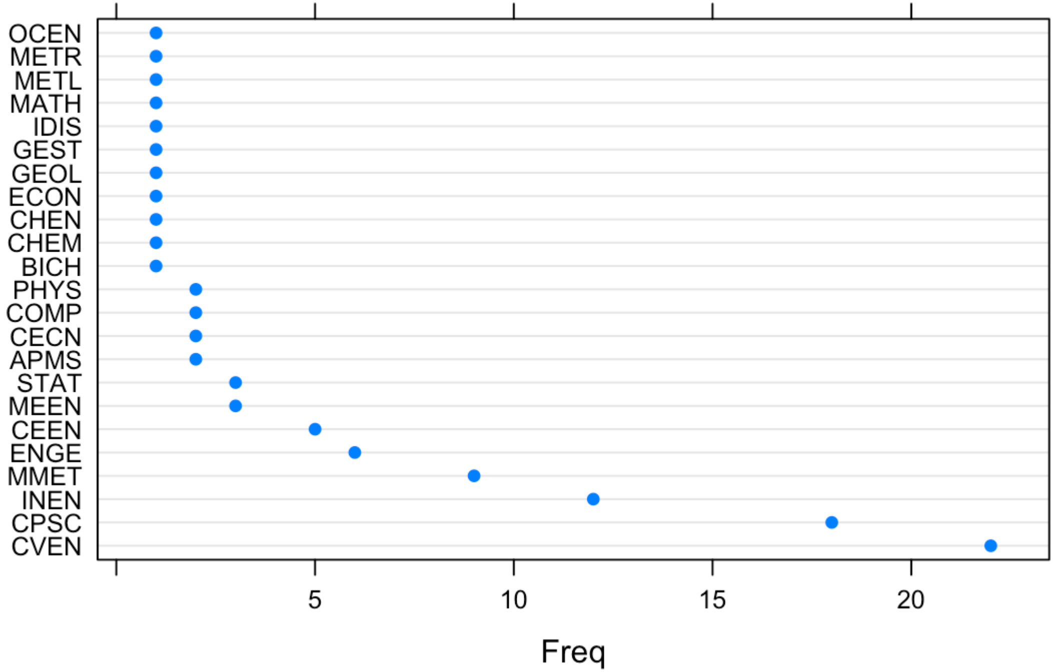
Packages

Stand on the shoulders of giants

```
# download a package, lattice
# install.packages(lattice)

# call a function from a package
lattice::barchart(roster_major)
```



```r
# load packages into environment, call function directly
library(lattice)
dotplot(roster_major)
```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METR
METL
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IDIS
GEST
GEOL
ECON
CHEN
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BICH
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COMP
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APMS
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MEEN
CEEN
ENGE
MMET
INEN
CPSC
CVEN
Freq