R: From Startup to Statistics

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Today's Workshop

- Presenters (GSU Psychology):
  - Matthew Turner, PhD, Research Scientist
  - Jessica Turner, PhD, Assoc. Professor of Psychology
- Teaching Assistants (GSU Neuroscience):
  - Amber Grant, B.S.
  - Kendrick King, B.S. (due spring 2018)
- All of the slides, R code, handouts, etc., are in the files you copied from the USB sticks and include web links for more information.
- For more information contact: mturner46@gsu.edu
- If you would like copies of the materials for use elsewhere, please contact me

My Background

- I started out years ago in physics, but quickly washed out of that and ended up doing things like Religious History, Art History, and Chemistry for a long while
- I eventually got my degrees in Social Science (MA), Mathematics (MA), Statistics (MS), and finally Psychology (PhD)
- All of this was with a lot of work in computing, simulation, and mathematical modeling
- This has given me an unusual perspective on statistics

Each of these fields has a very different approach!

Assumptions:

- You – *for some reason entirely of your own* – want to start using R
- You know some basic statistics at the graduate or advanced undergraduate level (for Psychology)
- You, very likely, know another system for doing statistics (at least a little)
  - This other system is, most likely, SPSS (and if not that, then it is SAS)
- If you tried it before, you may have had problems getting started

Oddities of R

Biggest Change/Challenge

If you are coming from SPSS, there is one huge change:
R is a programming language

- Almost everything you want to do requires what SPSS people call “syntax” (= code)
  - Good news! If you write SPSS syntax, you are already programming
  - Also **no one** outside of the SPSS community calls it “syntax”!
- Every analysis requires writing a program, although for simple analyses these may be a **single command**
  - Today’s workshop will be very simple analyses

Biggest Change/Challenge

- The main benefit is that these programs are **transferrable** and make a **permanent record** of the analysis

- This transferability is critically important!
  - Journals want people to share analyses which means sharing code
  - Funders expect a certain level of sharing of code with data

- If you are young:
  - Get used to this, **it is the future!**
  - "Reproducible research" requires code

Other stuff to get used to:

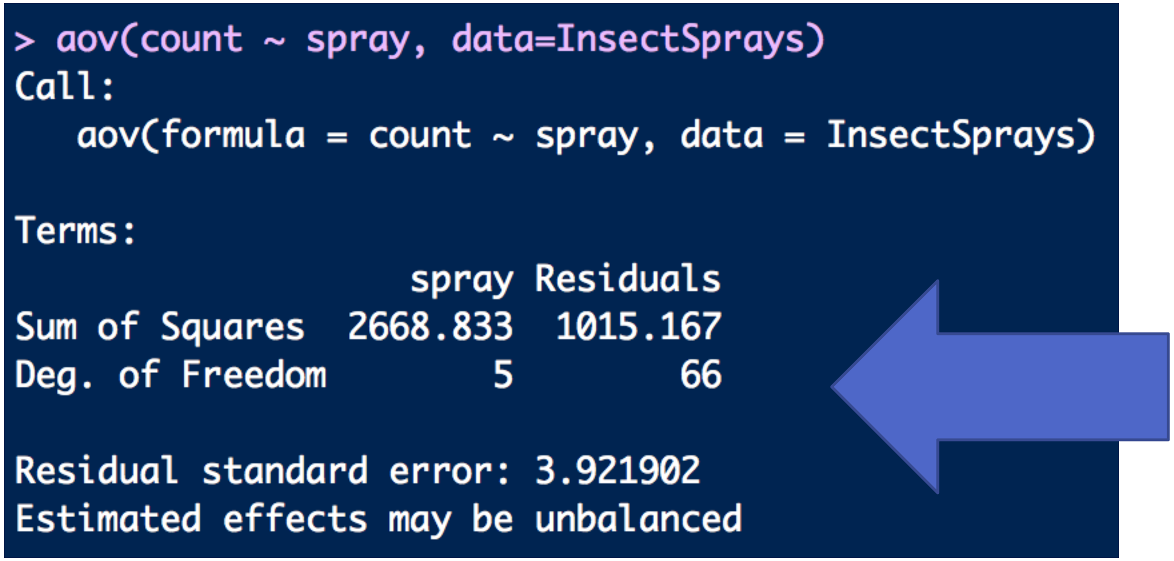
1. Updates require **fully reinstalling** R roughly every 12 months
    - Very little changes, I reinstall for every major new project
    - I have never had an old program not work due to an upgrade but YMMV
2. Most functionality has to be installed on demand with R packages (*discussed later*)
3. All of this indicates the need for the user to have "admin privileges" to their computer
    - There are ways around this if your IT department denies you this

Objects and Variables

- In R, we put many things into variables:
  - Data (numbers, factors, names, etc.)
  - The results (outputs) of computations (a linear model, a t-test, etc.)
    - Note that this is the actual test construction, not just the final results of the test!
    - We can often manipulate or continue the analysis with the stuff we stored in a name
  - Figures and graphics
- All of these things are "objects" which are essentially lists of things
- This probably seems weird to many of you who view variables as only data and all this other stuff as "output"

R is Taciturn

- SPSS returns reams of output for even the simplest commands
- R often responds with **no output** or just an acknowledgement that something happened
- R usually has the information you want, but it waits until you **ASK** for the information rather than forcing it on you



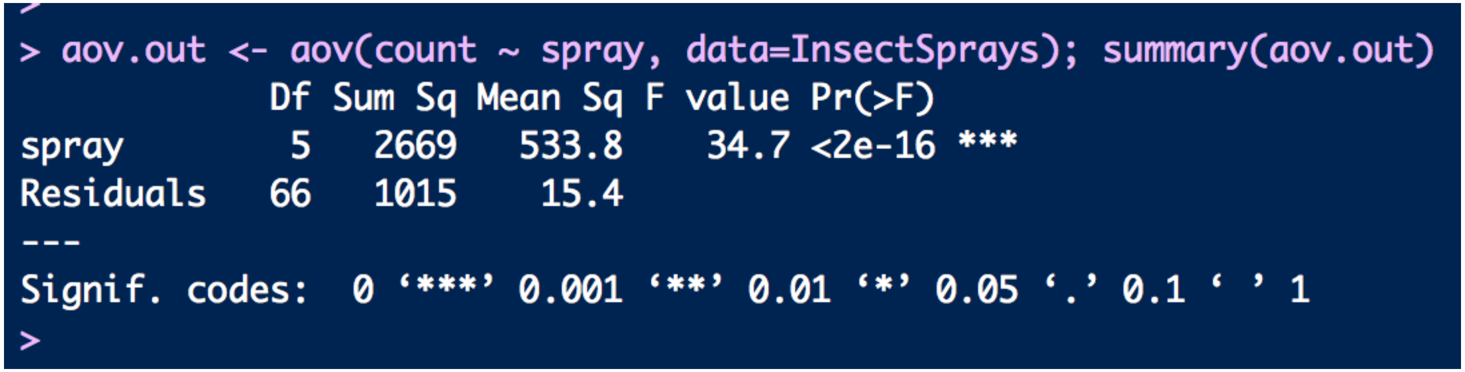
```
> aov(count ~ spray, data=InsectSprays)
Call:
   aov(formula = count ~ spray, data = InsectSprays)

Terms:
                   spray Residuals
Sum of Squares  2668.833  1015.167
Deg. of Freedom        5        66

Residual standard error: 3.921902
Estimated effects may be unbalanced
```

Do an ANOVA

Do an ANOVA and **print the table**



```
> aov.out <- aov(count ~ spray, data=InsectSprays); summary(aov.out)
            Df Sum Sq Mean Sq F value Pr(>F)    
spray        5   2669   533.8    34.7 <2e-16 ***
Residuals   66   1015    15.4                   
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
```

R is Taciturn

Generally this is a **good thing**:

- It forces you to know what you want and ask for it
- It encourages you to build up computations step-by-step
- It does not overwhelm you with details that you may not want

SPSS vs R: Packages

- Both R and SPSS come with some functions built in
  - Basic R is a little **sparser** than SPSS
  - But R with a few added packages added is vastly more powerful
- Both R and SPSS have “packages”
  - SPSS calls these **modules**
  - IBM wants **$$$** for these modules
  - R packages are free and open, at least in the main R ecosystem
  - There are companies that sell R packages, too!
  - Revolution Analytics (Mircosoft) makes a commercial R for high performance computing (“big data” applications)

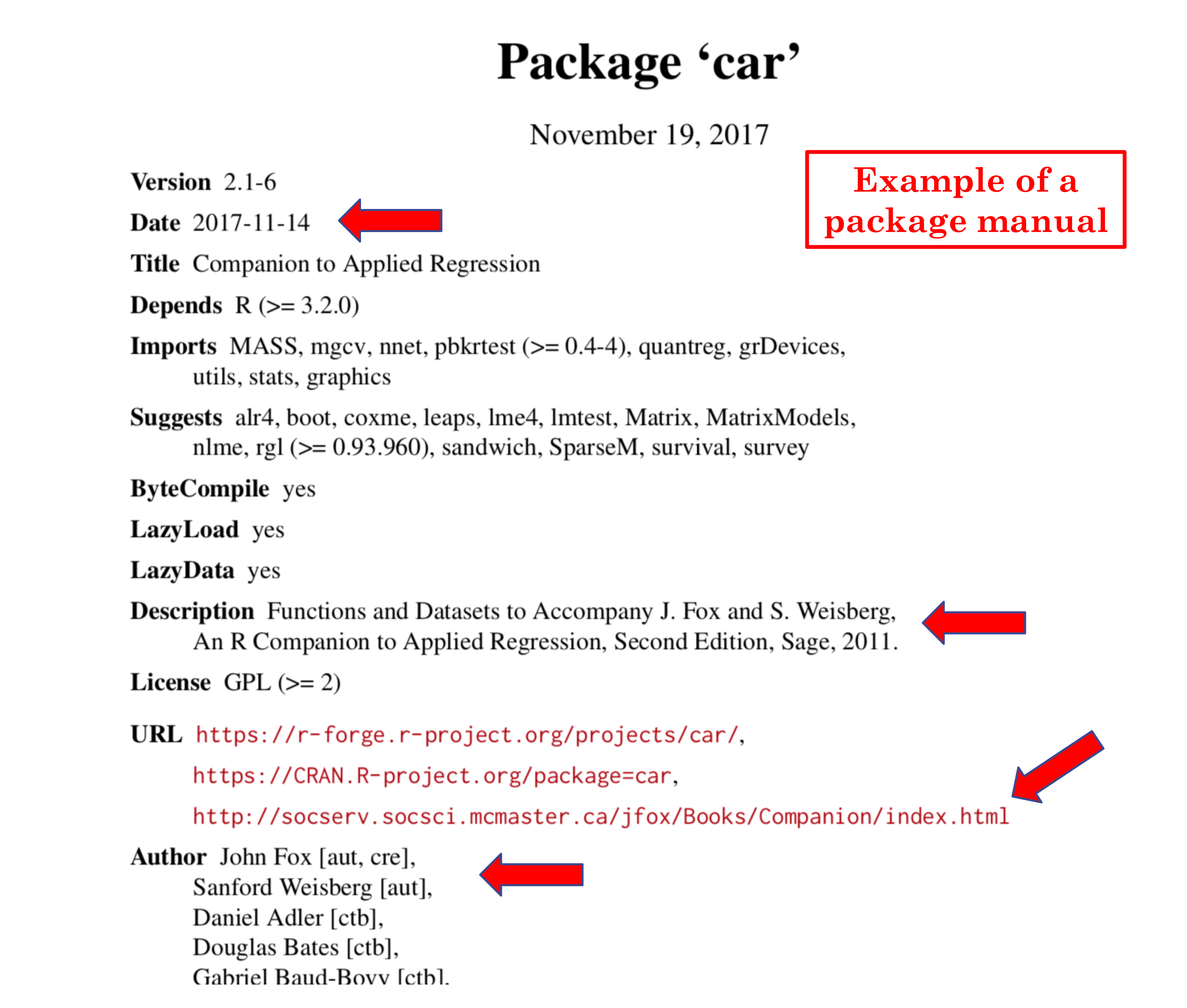
Packages

The best **and worst** thing about R is the package manager

- **Pros**:
  - **Allows anyone to release new statistical procedures to the world**
  - Almost every possible statistical procedure is out there *somewhere* you just have to find it (Google!)
  - All the main R packages are kept in one place (CRAN)
  - R is automatically connected to CRAN via the internet
- **Cons**:
  - **Allows anyone to release new statistical procedures to the world**
  - **Packages are managed independently**
    - Very uneven in how well-developed they are
    - **Inconsistent in terms of syntax**
  - Packages are **not** well-organized by topic (ex: **car**)

Packages

- How do you know if a package is good enough to use?
  - **Generally the answer is yes, use it!**
    - Most packages are written by statisticians and professional data analysts and are heavily tested
    - The more important they are, the better tested they are, and the larger the user community is…
  - **Biggest problems are odd syntax or inefficient computing (slow or need a lot of memory)**
    - For psychological research this likely does not matter
  - All packages have a manual that lists authors and contributors
    - Treat it like research papers and look up the authors/citations



Package ‘car’

November 19, 2017

Version 2.1-6

Date 2017-11-14

Title Companion to Applied Regression

Depends R (>= 3.2.0)

Imports MASS, mgcv, nnet, pbkrtest (>= 0.4-4), quantreg, grDevices, utils, stats, graphics

Suggests alr4, boot, coxme, leaps, lme4, lmtest, Matrix, MatrixModels, nlme, rgl (>= 0.93.960), sandwich, SparseM, survival, survey

ByteCompile yes

LazyLoad yes

LazyData yes

Description Functions and Datasets to Accompany J. Fox and S. Weisberg, An R Companion to Applied Regression, Second Edition, Sage, 2011.

License GPL (>= 2)

URL `https://r-forge.r-project.org/projects/car/`,
`https://CRAN.R-project.org/package=car`,
`http://socserv.socsci.mcmaster.ca/jfox/Books/Companion/index.html`

Author John Fox [aut, cre],
Sanford Weisberg [aut],
Daniel Adler [ctb],
Douglas Bates [ctb],
Gabriel Baud-Bovy [ctb],

Example of a package manual

Last Oddity: The Safety is Off

- R will let you do any analysis that is not strictly impossible for the data
  - SPSS, for instance, blocks some operations when you carefully set your variable types
  - However, SPSS, often guesses wrong and people don't set the types
- R has all the usual data types and they can be set
  - This will lead to some safety, but it is not strict like SPSS
  - The better developed packages will try to guide you to sensible results

Using R

Interface

- R has a very bad native interface
  - **No one** uses R directly
  - The R Project has basically ceded this to other teams
- You really need to use a different program to interface with R
  - The most common is **RStudio** (by RStudio, Inc.)
  - This is a free system, most of it is open source (but not all!)
- **There are GUI interfaces** (that look like SPSS or other software) but they are not very good!
  - I actively discourage students from using them

Finding Stuff Out

- Because R is command driven, you have to develop a sense of how to find things out:
  - The "?" operator – put ? in front of a command name to get some help printed out
  - The `help()` and `help.search()` functions open help text
  - The `apropos()` function looks for partial matches for command names
  - For all but ? you must put the search term in quotes
- However: the R native documentation can be hard to read!

Finding Stuff Out

- **Google:**
  - **How do I _____ in R?**
  - After about a week of this, your Google will start filling things in for you
- Rstudio's interface also has help functions:
  - Rstudio does a good job with help
  - It has a help browser off to the side that uses R's `help.search()` but looks nicer
  - It will **automatically show hints** as you type to remind you what is expected from a command

General Process for Data Analysis

- Read in the data
  - The linga franca of the data world is the CSV file
  - R can also read in SPSS, SAS, and XLS formatted data, among others, but sometimes this is hard to get to work right!
- Name, Edit, Subset, and Transform the variables
  - In the data science world this is called **"munging"**
- Apply a function to data (aov, lm, etc.)
- Ask for the results you want/need
- Repeat

R encourages a very interactive style of data analysis! Some psychologists seem distrustful of this!

Interactive Style

- R encourages an interactive style of data analysis
  - Load the data
  - Do analyses/make graphs quickly
  - Re-analyze the data once you understand it
  - Export results and publication quality results

- Reproducibility note:
  - **There are tools in R that allow it to export data, graphs, tables, and numbers directly into your research paper text**
  - **Not easy to use** (very steep learning curve)
  - But, once you do, you can write the paper and the analysis in a **single document**, with tables/numbers/figures updating automatically

Resources

- At the graduate level, a good high-level book on statistics with R is Maindonald and Braun's **Data Analysis and Graphics Using R**
- The Quick R website is full of short articles on R organized by method
- The Personality Project website has a good guide to R for psychological researchers
- Lynda.com is a courseware site that has basic R lessons and many universities have contracts for staff and students to use it without additional cost
- R for Cats is an introduction to programming in R (mostly R data structures)
- Finally, the R-Bloggers site is an aggregator of blog posts by 750 international R bloggers and has articles on lots of topics

Warning!

"Using R is a bit akin to smoking. The beginning is difficult, one may get headaches and even gag the first few times. But in the long run, it becomes pleasurable and even addictive. Yet, deep down, for those willing to be honest, there is something not fully healthy in it."

– Francois Pinard

https://www.johndcook.com/blog/2012/02/29/comparing-r-to-smoking/