



Dynamic Interactions

Empowering Educators and Researchers
with Interactive Quarto Documents Using
webR

James Balamuta
Remote Talk @ posit::conf(2023)

Before we begin, thank you ...



Core
Developers



George Stagg



Lionel Henry



[Source](#)

Early
Testers



E. Eli Holmes

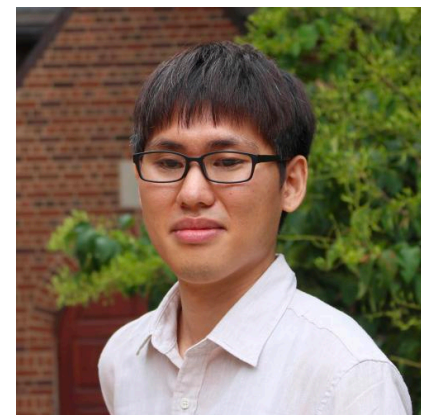


boB Rudis



[Source](#)

Contributors










JooYoung Seo



**J.J., Carlos, Charles,
Christophe, & Yihui**

Agenda

-  **of R Environment Setup** (i.e.  )
- **Breakthrough Technology**  (i.e. Quarto, WASM, webR)
- **Elevating Education**  (i.e. From Static to Dynamic)
- **Fueling Research**  (i.e. Reproducibility at Last?)
- **Unlocking New Possibilities**  (i.e. The Future)

R Environment Setup

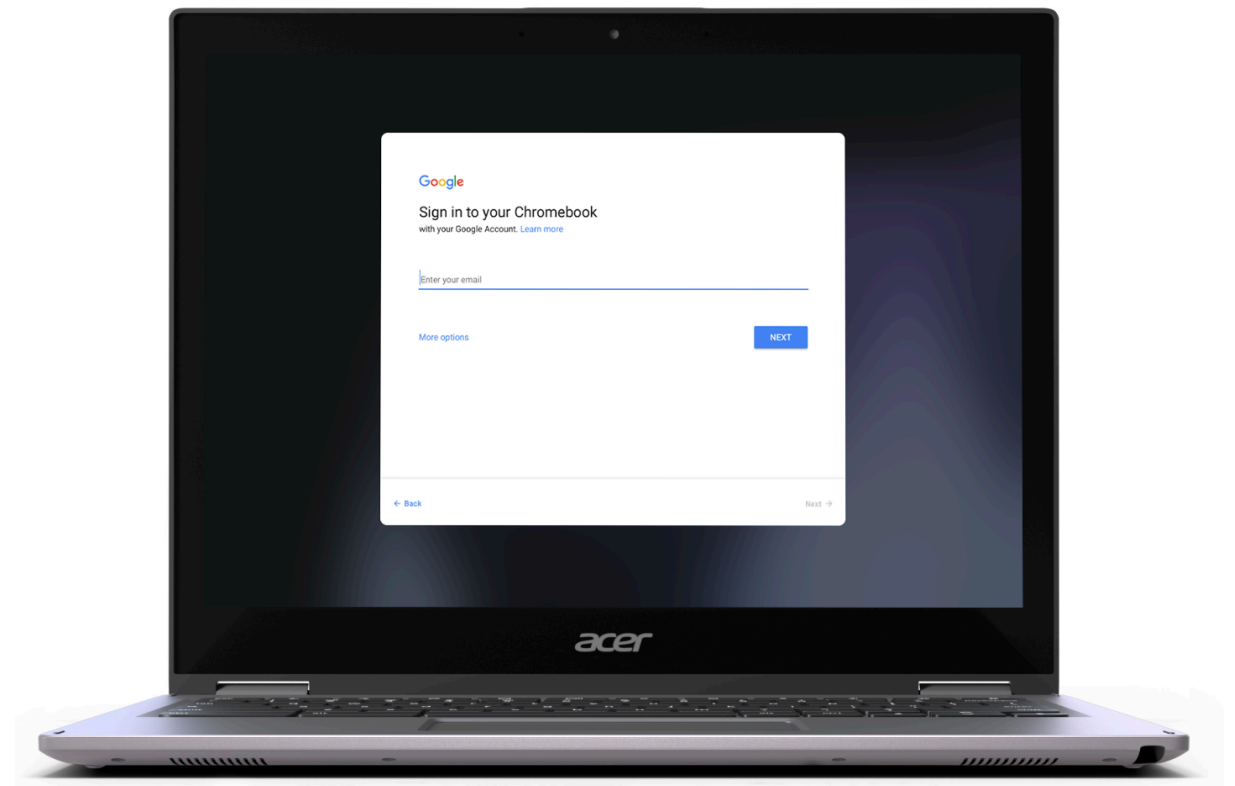


STAT 385 Statistics Programming Methods credit: 3 Hours.

Statisticians must be savvy in programming methods useful to the wide variety of analysis that they will be expected to perform. This course provides the foundation for writing and packaging statistical algorithms through the creation of functions and object oriented programming. Fundamental programming techniques and considerations will be emphasized. Students will also create dynamic reports that encapsulate their implemented algorithms. Students must have access to a computer on which they can install software.

Prerequisite: STAT 200 or STAT 212.

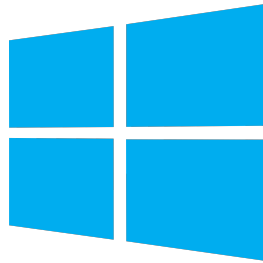
<http://catalog.illinois.edu/courses-of-instruction/stat/>



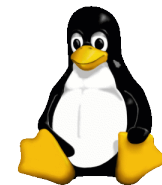
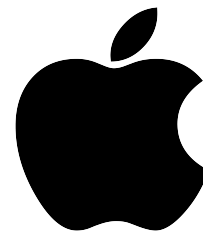
Day 0

3 Step Environment Re-Creation

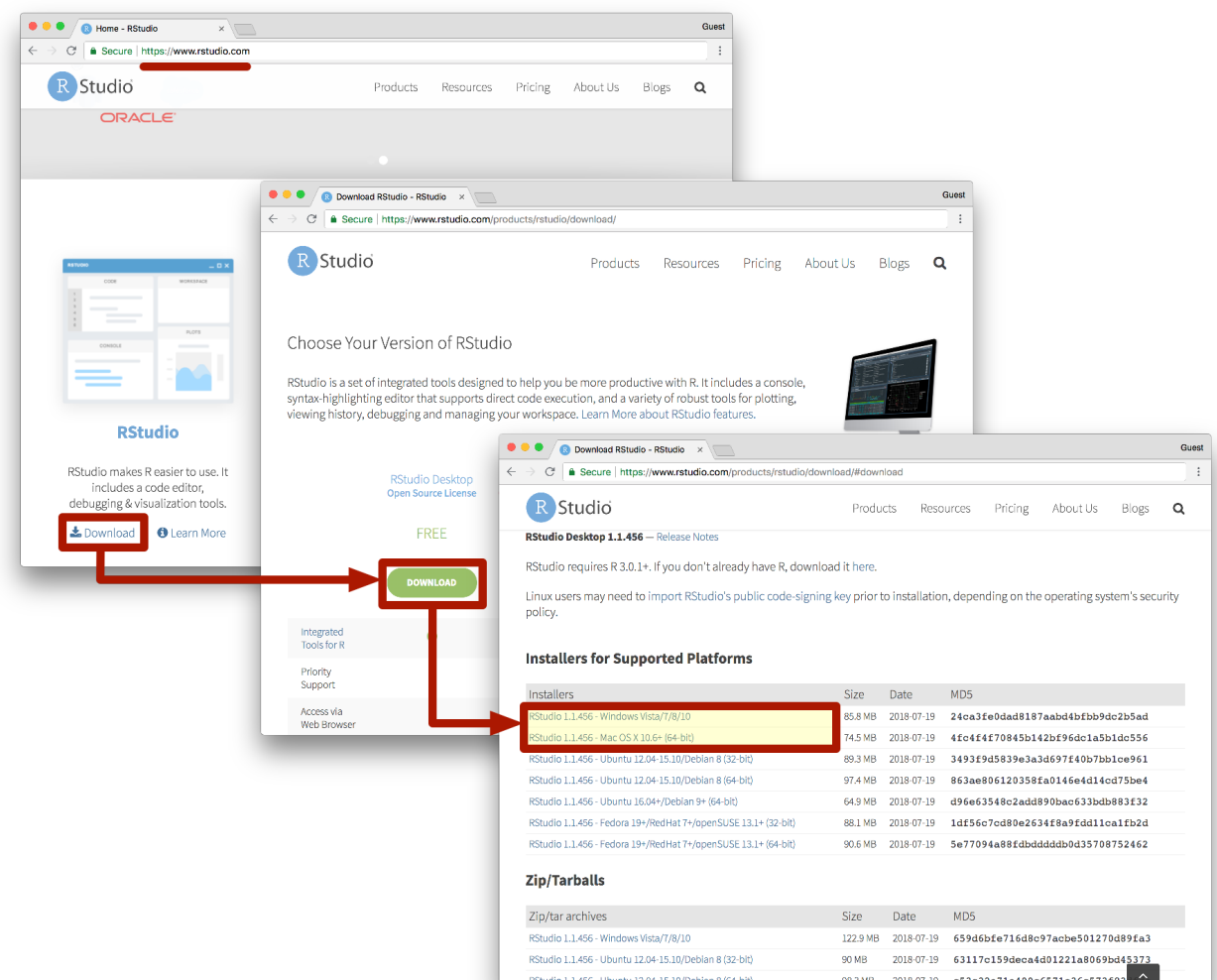
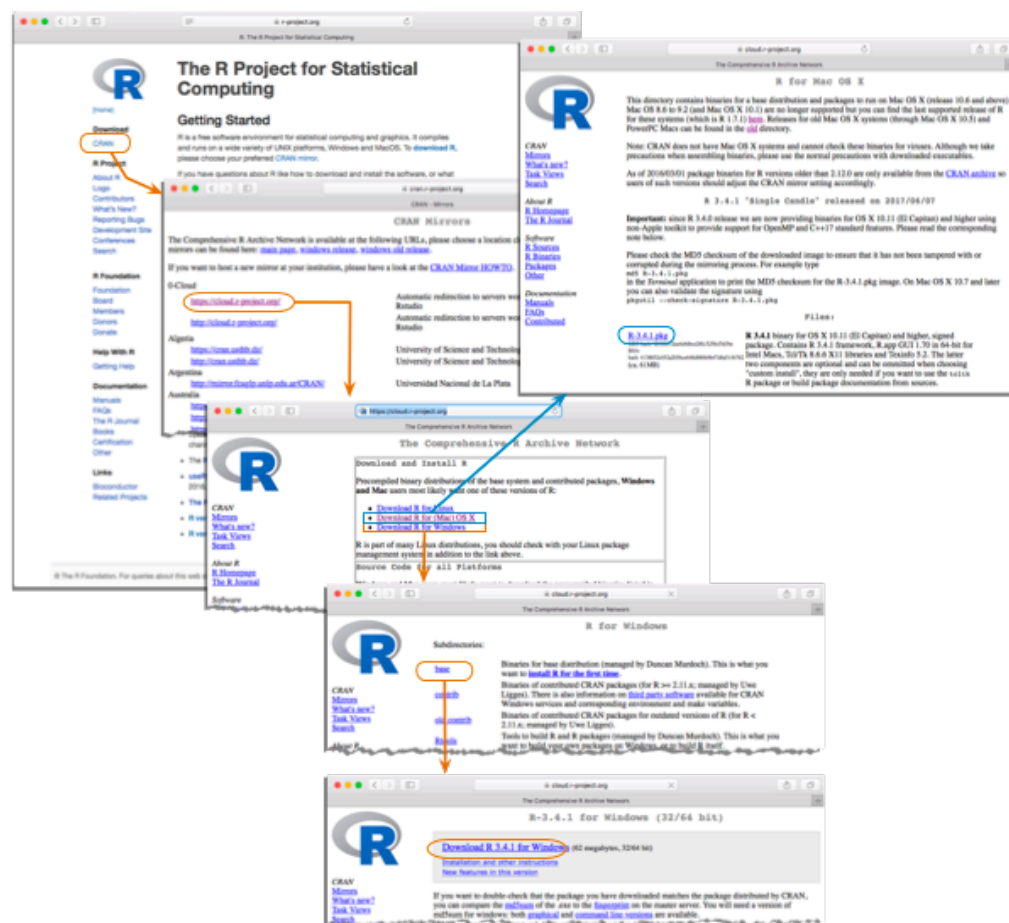
1. Identify OS



2. Install R

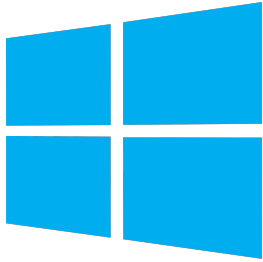


3. Install RStudio



Need Developer Tools?

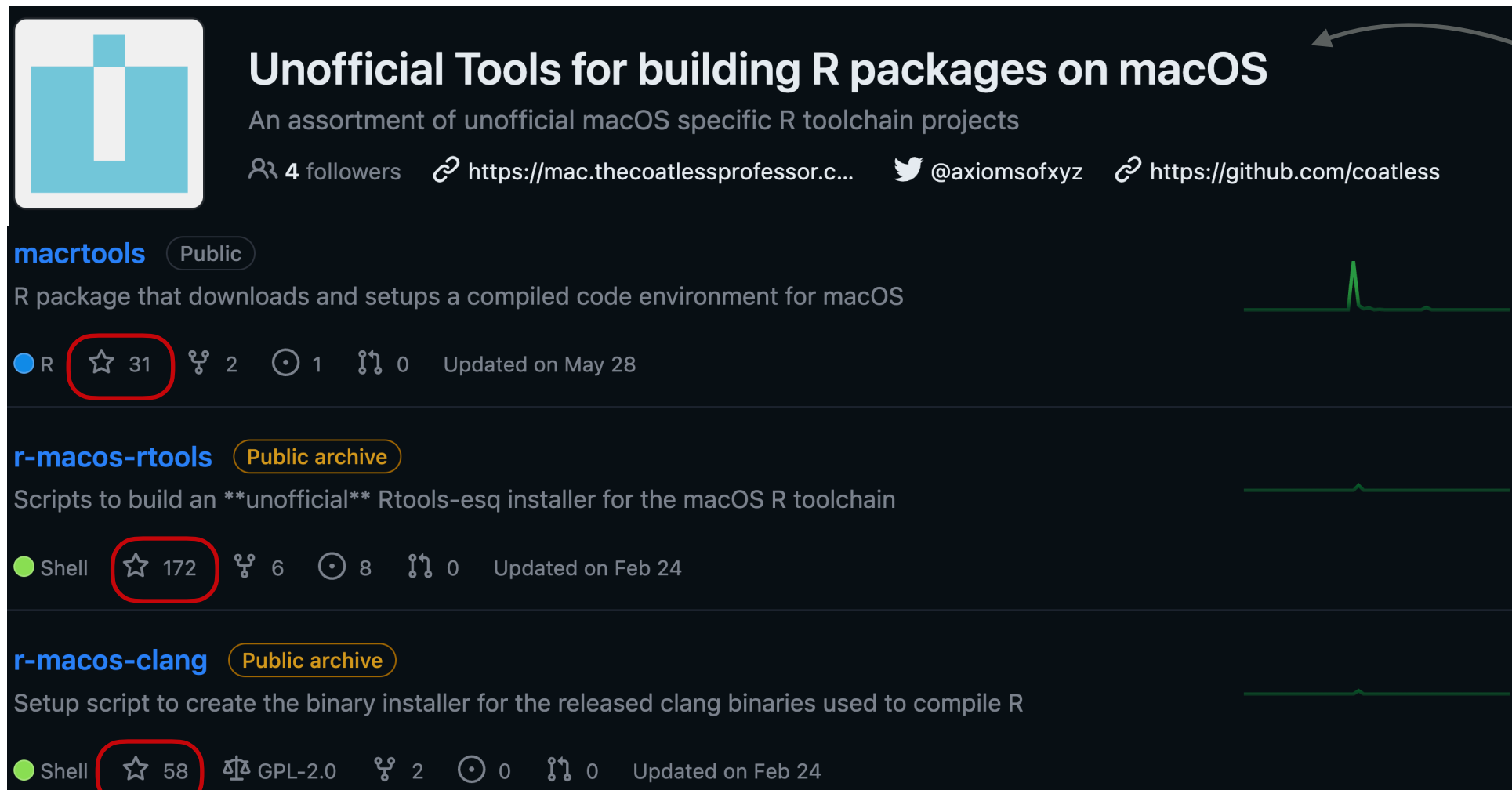
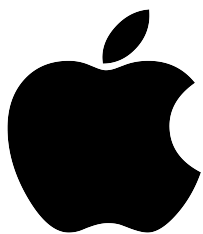
Installing Rtools43



Rtools43 is only needed for installation of R packages from source or building R from source. R can be installed from the R binary installer and by default will install binary versions of CRAN packages, which does not require Rtools43.

Moreover, online build services are available to check and build R packages for Windows, for which again one does not need to install Rtools43 locally. The [Winbuilder](#) check service uses identical setup as the CRAN incoming packages checks and has already all CRAN and Bioconductor packages pre-installed.

Rtools43 may be installed from the [Rtools43 installer](#). It is recommended to use the defaults, including the default installation location of `C:\rtools43`.

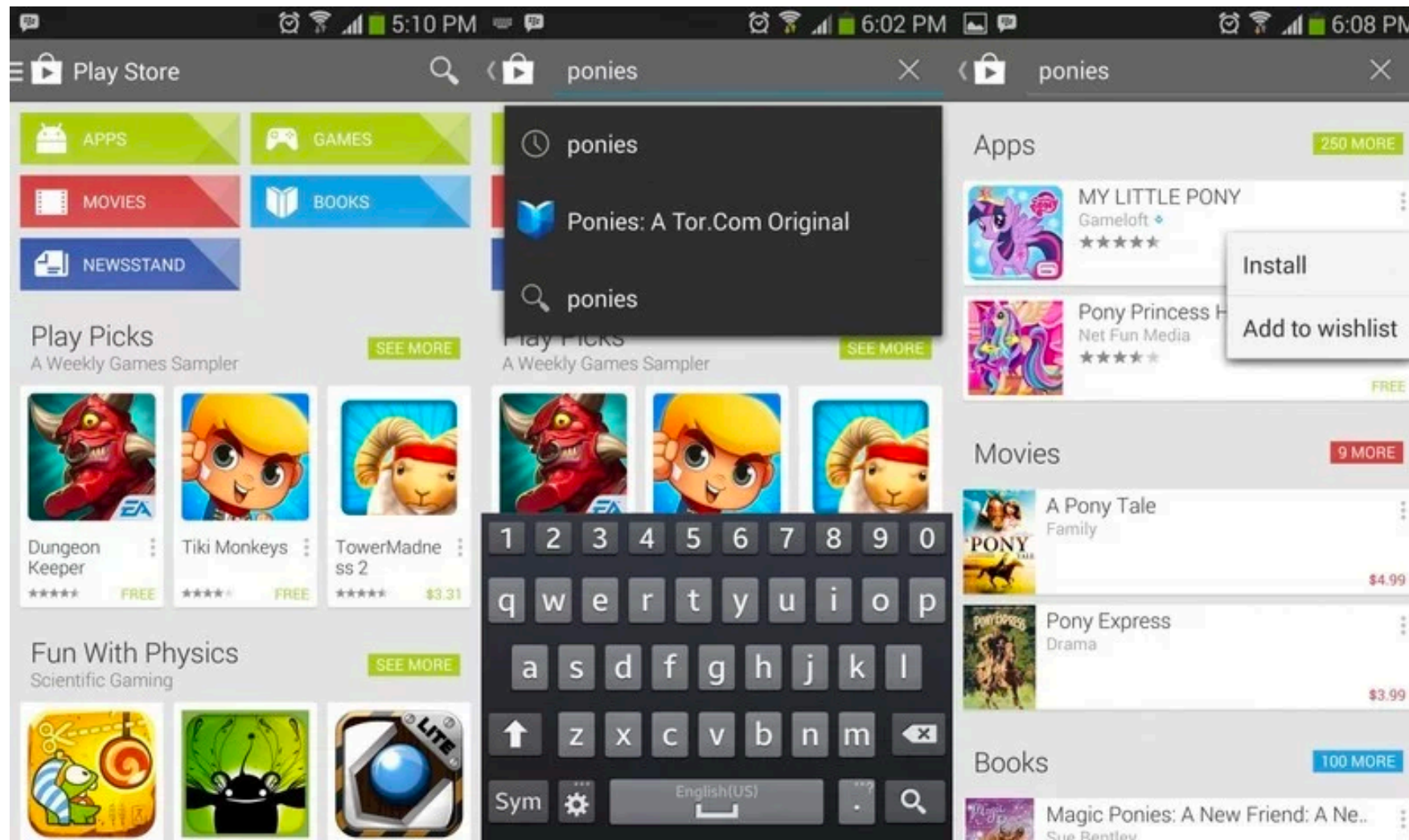


The screenshot shows a GitHub repository page for 'macrtools' and related projects. The repository 'macrtools' is public and has 31 stars, 2 forks, 1 issue, and 0 pull requests, updated on May 28. It is described as an 'R package that downloads and setups a compiled code environment for macOS'. Below it, the 'r-macos-rtools' repository is shown as a 'Public archive' with 172 stars, 6 forks, 8 issues, and 0 pull requests, updated on Feb 24. It is described as 'Scripts to build an **unofficial** Rtools-esq installer for the macOS R toolchain'. At the bottom, the 'r-macos-clang' repository is also shown as a 'Public archive' with 58 stars, 2 forks, 0 issues, and 0 pull requests, updated on Feb 24. It is described as a 'Setup script to create the binary installer for the released clang binaries used to compile R'. A green line graph is visible on the right side of the repository cards.

Community-run installer effort

Where's the App Store?

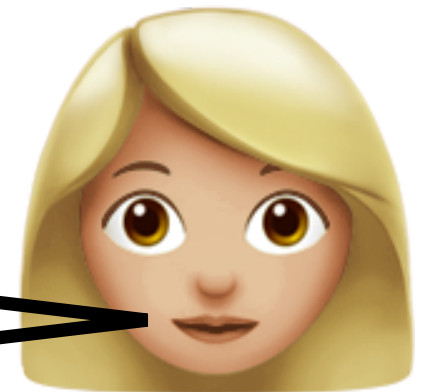
Not a simplified 1-Click Install



Day 1 - Class



How do we install R and RStudio?



Your code doesn't work!



Why do I need an administrator password?



I'm running on an ARM Mac ...



Day 1 - Reimagined

3 Steps to Explore Data

1. Login

netid@illinois.edu

.....

Log in

2. Select Project

STAT x85: Learning from Data

Projects Members Info

All Projects

ASSIGNMENT Day 1 - Example

JB James Balamuta

New Project

Delete Move

3. Start exploring!

STAT X85: Learning From Data / Day 1 - Example

File Edit Code View Plots Session Build Debug Profile Tools Help

01-intro-graph.R

```
1 ### Overview ----
2
3 # View RStudio Cloud Overview:
4 # https://github.com/stat385uiuc/rstudio-cloud-intro/raw/master/01-rstudio-cloud-
5
6 ### Required extensions ----
7
8 # Install packages or extensions to R language found on CRAN
9 # Uncomment to run the command by deleting the `#` before it.
10
11 # install.packages("ggplot2")
12
13 # Enable the package by loading
14 library("ggplot2")
15
16 ### Example Graphs ----
17
```

Console

R version 3.6.0 (2019-04-26) -- "Planting of a Tree"
Copyright (C) 2019 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (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.

> |

Environment History Connections

Global Environment

Environment is empty

Files Plots Packages Help Viewer

New Folder Upload Delete Rename More

Name	Size	Modified
..		
.Rhistory	55 B	
01-intro-graph.R	971 B	
02-interactive-heatmap-ny-accidents.R	2.5 KB	
03-class-profile-graphs.R	2.2 KB	
figures		
gadm36_USA_2_sp.rds	13.3 MB	
project.Rproj	205 B	
stat385-sp2019-day1.csv	9.9 KB	



Day 1 - Reimagined

3 Steps to Explore Data

1. Or use a badge!



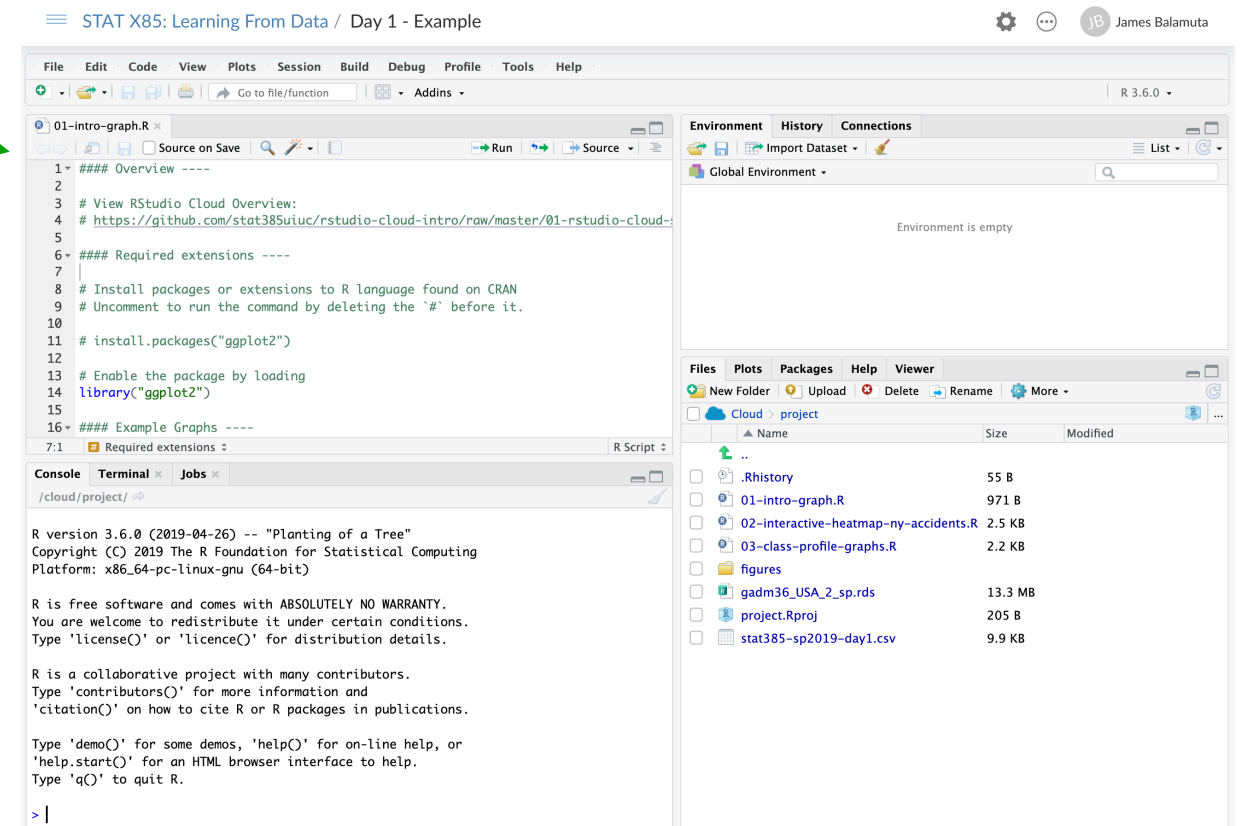
2. Login

netid@illinois.edu

.....

Log in

3. Start exploring!



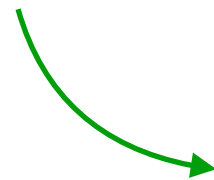
Reimagining Exploration

2 Steps to Explore Data



1. Or use a link!

2. Start exploring!



quarto-webr


Getting Started ▾

Your first webR-powered
Quarto document
Customization Options
Using R Packages
Hiding and Executing
Code

Support ▾

Troubleshooting
FAQ
Submit an issue

Demos ▾

README Example
Exploring Interactive
Code Cells
Community Examples

Greetings from quarto-webr Wonderland!

Empowering Your Quarto Documents with R through webR

WEBR STATUS

● Ready!

Welcome to the documentation portal for the [quarto-webr](#) extension – your key to unlocking the endless possibilities of [webR](#) within various [Quarto](#) formats, including [HTML](#), [Websites](#), and [Books](#).

Ready for an exciting journey into the world of webR's interactive code cells? Click the “Run Code” button below to experience it firsthand:

▶ Run Code

```
1 # Fit a linear model
2 model = lm(mpg ~ wt, data = mtcars)
3
4 # Obtain a summary
5 summary(model)
```



Breakthrough Technology



WEBASSEMBLY





- **Unify** and **extends** the **R Markdown** ecosystem



- **Switch** formats without hassle

HTML Document

```
analysis.qmd

title: "Analyzing Data"
format: html
```

Website

```
_quarto.yml

project:
  type: website

website:
  navbar:
    left:
      - analysis.qmd
```

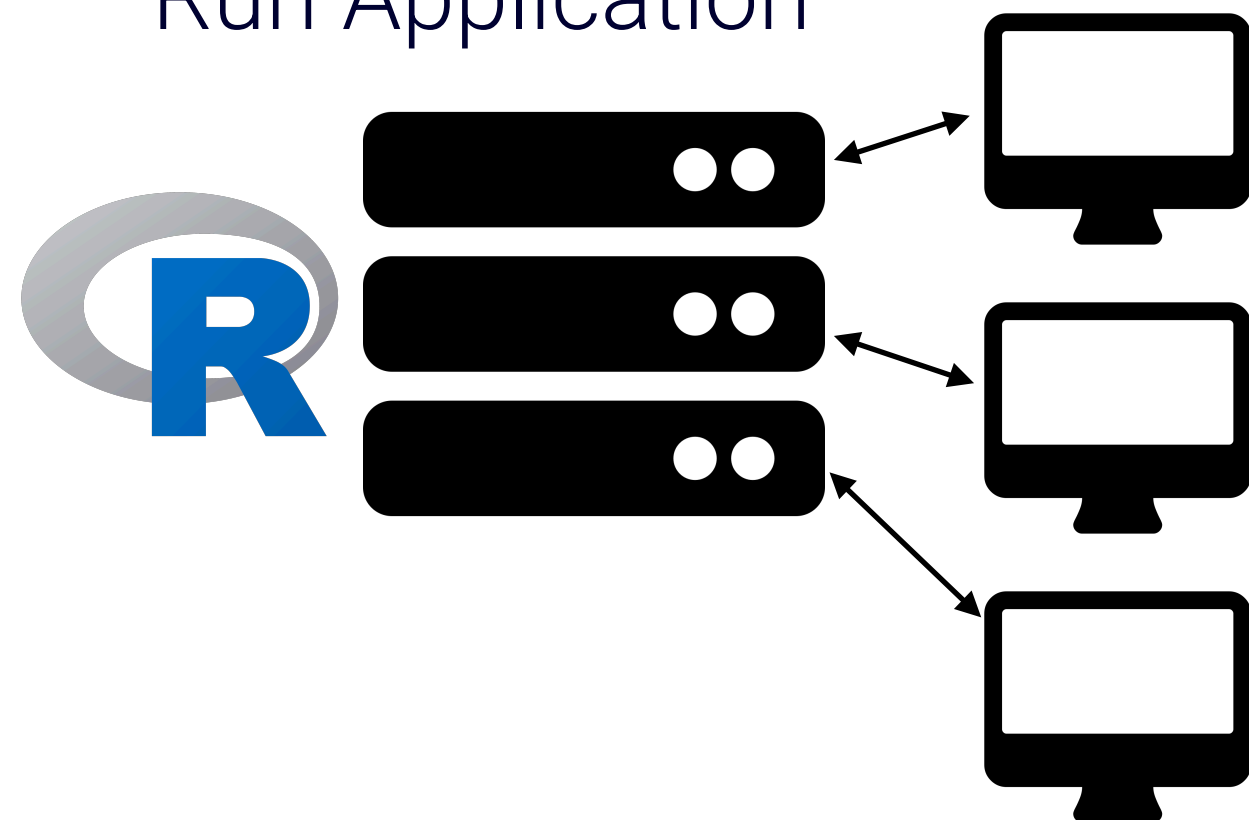


WEBASSEMBLY

Run applications “in-browser” at near native speed

Compute Server

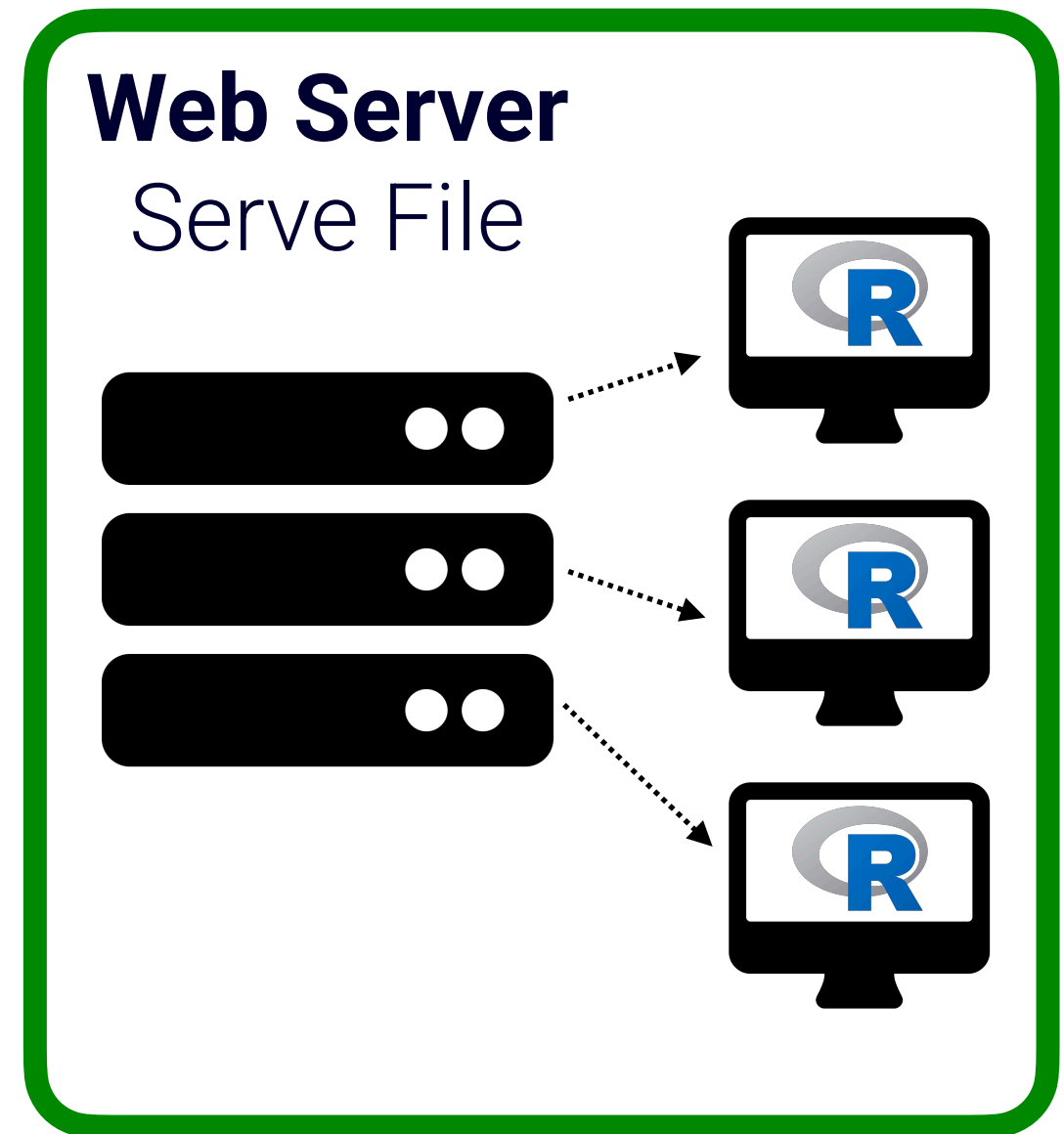
Run Application



e.g. Posit Workbench

Web Server

Serve File



e.g. GitHub Pages, Netlify



R running in your **Web Browser**

R

loop-list.R

```
# Explore looping of a list
my_list = list(1, 4, "abc")

for (i in my_list) {
  print(i)
}
# [1] 1
# [1] 4
# [1] "abc"
```

JavaScript

webr-loop-list.js

```
// Download from CDN and Import the webR class
import { WebR } from 'https://webr.r-wasm.org/v0.2.1/webr.mjs';

// Initialize a new instance of webR
// Available _everywhere_ in the document.
globalThis.webR = new WebR();
await globalThis.webR.init();

// Explore looping of a list
const my_list = await globalThis.webR.evalR(
  'list(1, 4, "abc")'
);

for (const i of my_list) {
  const out = await i.toJs();
  console.log(out);
}

// Output
// {type: 'double', names: null, values: [1]}
// {type: 'double', names: null, values: [4]}
// {type: 'character', names: null, values: ["abc"]}
```

Unification



```
demo-webr.qmd
Source Visual Outline
1 ---
2 title: webR in Quarto HTML Documents
3 format: html
4 engine: knitr
5 filters:
6   - webr
7 ---
8
9 This is a webR-enabled code cell in a Quarto HTML document.
10
11 ```{webr-r}
12 fit = lm(mpg ~ wt, data = mtcars)
13 summary(fit)
14 ```
```



quarto-webr



webR in Quarto HTML Documents

WEBR STATUS
● Ready!

This is a webR-enabled code cell in a Quarto HTML document.

Run code

```
1 fit = lm(mpg ~ wt, data = mtcars)
2 summary(fit)
```

Call:
lm(formula = mpg ~ wt, data = mtcars)

Residuals:

	Min	1Q	Median	3Q	Max
	-4.5432	-2.3647	-0.1252	1.4096	6.8727

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	37.2851	1.8776	19.858	< 2e-16 ***
wt	-5.3445	0.5591	-9.559	1.29e-10 ***

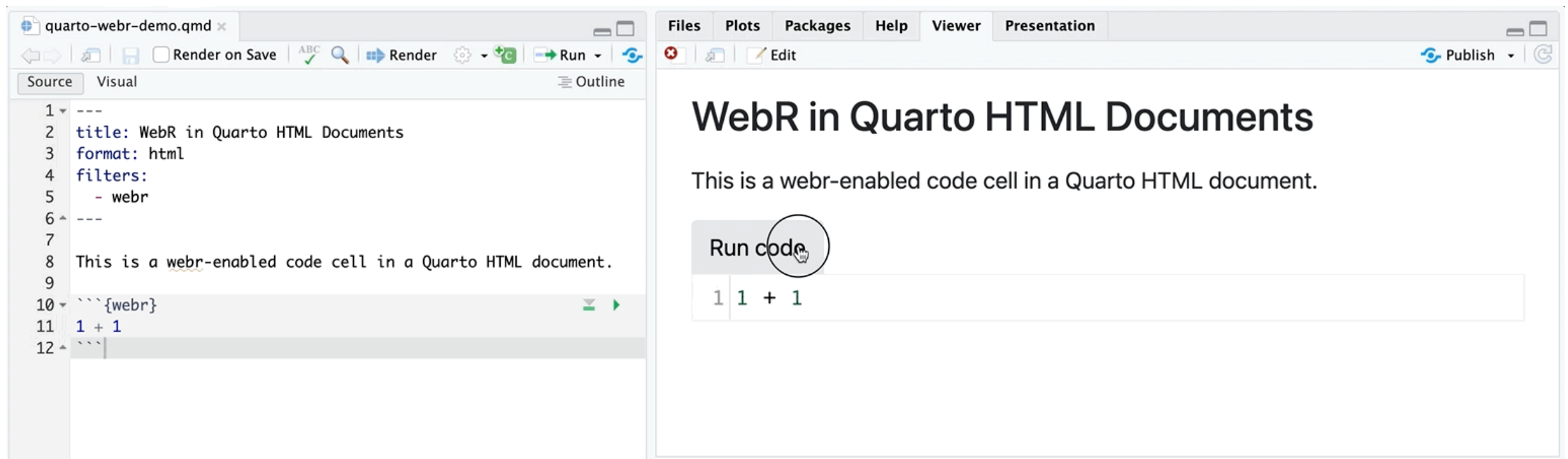
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.046 on 30 degrees of freedom
Multiple R-squared: 0.7528, Adjusted R-squared: 0.7446
F-statistic: 91.38 on 1 and 30 DF, p-value: 1.294e-10



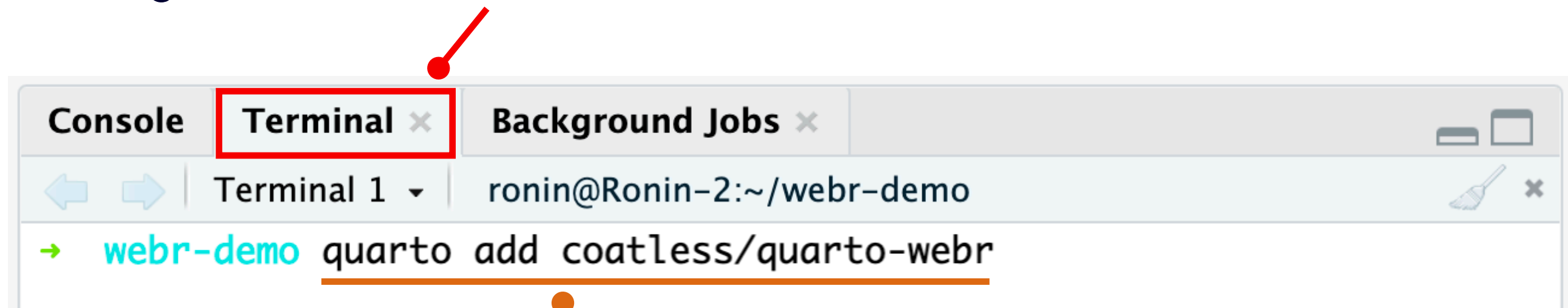
quarto-webr Extension

In Action



Install `quarto-webr` Extension

Navigate to the **Terminal** tab in lower left side of **RStudio**



Type the **install** command and press enter.

Making a Document Dynamic

Four Steps to Convert a Document

1. Add **engine: knitr**
2. Add the **webr** Filter
3. Use **{webr-r}** instead of **{r}**
4. Render the document!

 Render

```
webr-cell.qmd

---
title: Sample HTML Document
format: html
engine: knitr
filters:
  - webr
---

```{webr-r}
fit = lm(mpg ~ am, data = mtcars)
summary(fit)
```
```

Customize Document

Modifying webR and Native Extension Features

```
webr-option-demo.qmd

---
webr:
  show-startup-message: false # Status of webR initialization
  show-header-message: false # HTTP Header Check.
  packages: ['ggplot2', 'dplyr'] # Pre-install dependencies
  home-dir: "/home/rstudio" # Specify user directory
  channel-type: "post-message" # Change communication
filters:
  - webr
---
```

WEBR STATUS

● Loading...

WEBR STATUS

● Ready!

WEBR STATUS

● Installing package dependencies...

Learn more on the [Customization Options](#) page

Cell Option **context**

quarto-webr's Internal Cell

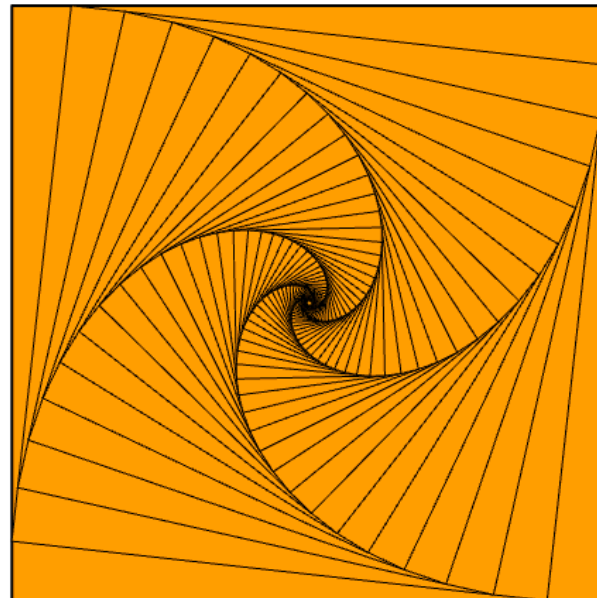
interactive

Run code

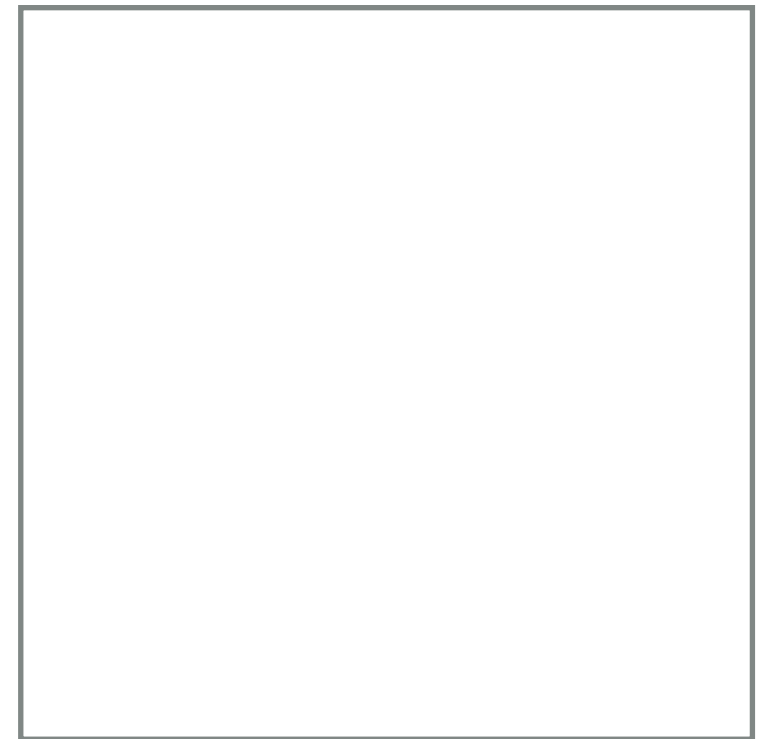
```
1 plot.new()
2 plot.window(
3   xlim = c(-1, 1),
4   ylim = c(-1, 1), asp = 1)
5 title(main = "Not Kansas Anymore")
6 x = c(-1, 1, 1, -1)
7 y = c( 1, 1, -1, -1)
8 polygon(x, y, col = "orange")
9 v1 = c(1, 2, 3, 4)
10 v2 = c(2, 3, 4, 1)
11 for(i in 1:50) {
12   x = 0.9 * x[v1] + 0.1 * x[v2]
13   y = 0.9 * y[v1] + 0.1 * y[v2]
14   polygon(x, y, col = "orange")
15 }
```

output

Not Kansas Anymore



setup



Purposely left empty

Elevating Education



Ready to Go Exercises

What If ...

For example, try changing the color from **blue** to **orange** and run the code again.

Run code

```
1 plot(  
2   mpg ~ wt,  
3   data = mtcars,  
4   col = "blue",  
5   xlab = "Miles/(US) gallon",  
6   ylab = "Weight (1000 lbs)",  
7   main = "Miles per Gallon and Weight of Cars",  
8   sub = "Source: 1974 Motor Trend US magazine."  
9 )
```

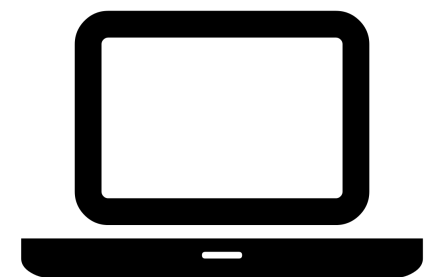
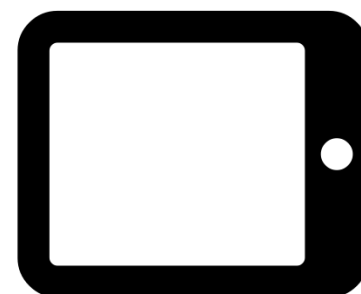
Fill-in-the-Blank ...

Fill in the blank to create an expression that adds up to **42**.

Run code

```
1 35 + _____
```

Works anywhere ...



Limits

- Internet connectivity is **required at the start**
- Not all packages are available.
- Not a replacement for RStudio/VS Code.



Learning Analytics

Understand Student Behavior Like Never Before



```
_quarto.yml

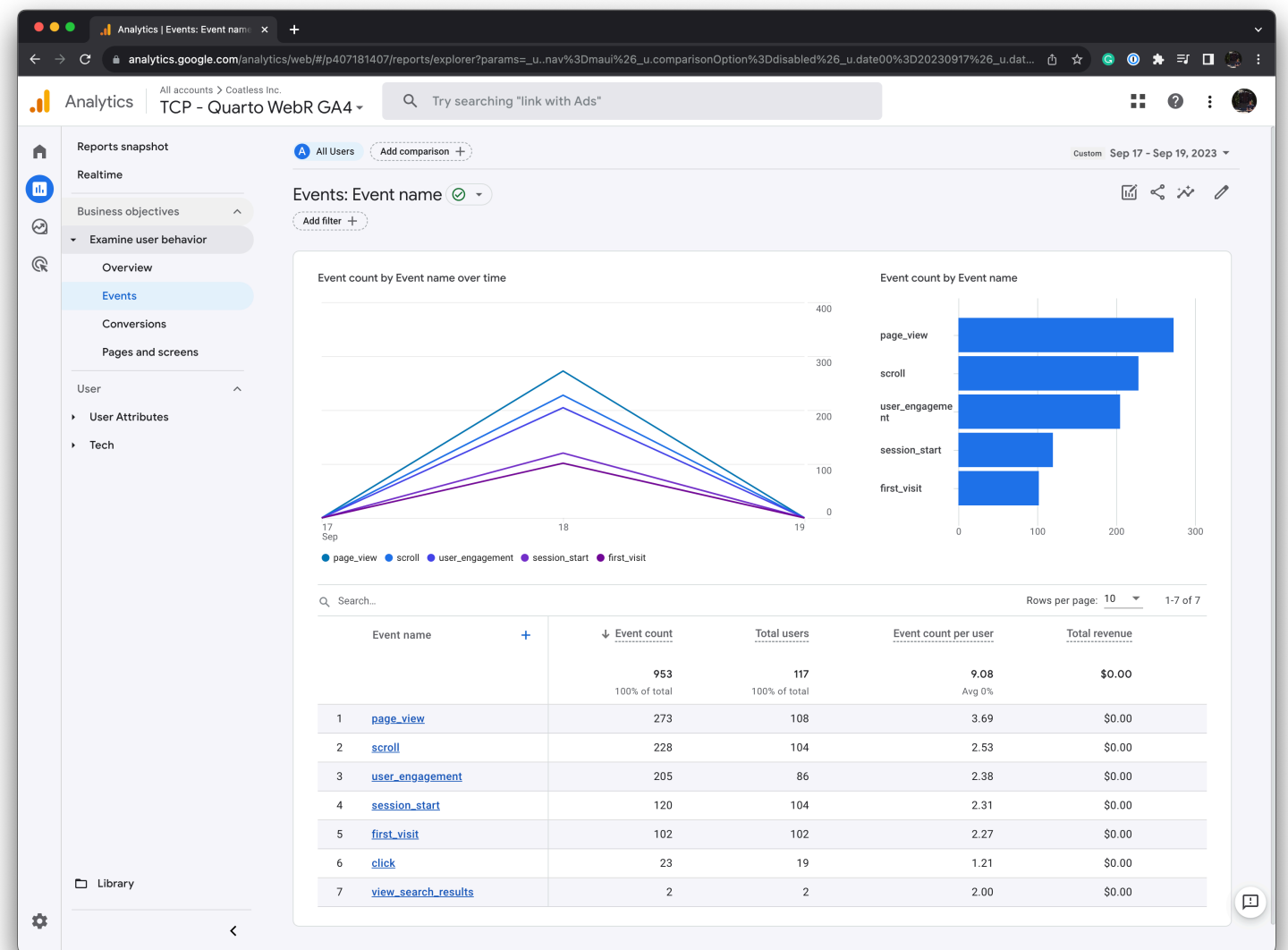
website:
  google-analytics: "UA-XXXXXXX"
```

Website Tools

Works with Books too!

HTML books are at their core [Quarto Websites](#) with some special navigational behavior built in. This means that all of the features described for enhancing websites are also available for books, including:

- [Navbars](#)
- [Social Metadata](#)
- [Full Text Search](#)
- [Google Analytics](#)



From Extension Website Launch

Student Data Says ...

- Spent an average of **1.5x longer** on a dynamic document.
- Code cells where **outcomes were not clear** were **explored more often**.
- Described as “**modern**” instead of “old-fashioned”



Fueling Research

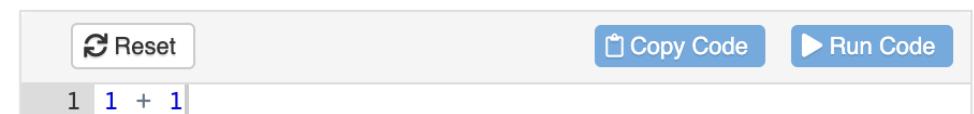
- **webR** has the **potential** to be an easier **distribution method** than **Docker**.
- It can be **customized** and **distributed**.
 - **R-universe** preloads packages with inside their version.
- **R-only** packages or scripts work great.
- Have compiled code?
 - Sit tight for more detailed instructions.
 - Stan is unlikely to be available in webR.



Source

Unlocking New Possibilities ✨

- Further work ([#14](#)) is required for **revealjs**
- Upstream [pandoc bug](#) and responsive issues.
- Improve the interface
- Implementing a Quarto Extension for [Pyodide](#) to bring **Python** into the mix.



quarto-pyodide Demo

Pyodide with Quarto HTML Standalone Document Proof of Concept

Experiments with an Interactive Quarto Document using Pyodide v0.24.3

AUTHOR
JJB

Demo

Background

The purpose of this document is to explore the [pyodide](#) WebAssembly interface to power interactive Quarto documents.

Setup

Sample Calculations

Let's start off with a quick calculation

Run code

```
1 1 + 1
```

Table of contents

- Demo
- [Background](#)
- Setup
- Sample Calculations
- Strings
- Retrieving prior objects
- Define and Call Functions
- Load a package

Want to learn more?






- **quarto-webR** Extension
 - [Extension Website](#) & [GitHub](#)
- **webR** Project
 - [Documentation](#) & [GitHub](#)
- **Community**
 - [boB Rudis' webR Experiments](#)
 - [Awesome List: webR](#)



[Extension Website](#)

Thank you! Questions?

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-  linkedin.com/in/jamesbalamuta/
-  @axiomsofxyz