Dynamic Interactions
Empowering Educators and Researchers with Interactive Quarto Documents Using webR

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Remote Talk @ posit::conf(2023)
Before we begin, thank you ...

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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
   - Windows
   - macOS
   - Linux

2. Install R
   - Download R from the official website.
   - Follow the installation instructions.

3. Install RStudio
   - Visit the RStudio website.
   - Choose the version that matches your operating system.
   - Download and 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](https://rtools43.com). It is recommended to use the defaults, including the default installation location of `C:\rtools43`.

![Unofficial Tools for building R packages on macOS](https://raw.githubusercontent.com/coatless/macOS-Rtoolchain-tools/master/Unofficial%20Tools%20for%20building%20R%20packages%20on%20macOS.md)

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
   - *********

2. Select Project
   - ASSIGNMENT
   - Day 1 - Example

3. Start exploring!
Day 1 - Reimagined
3 Steps to Explore Data

1. Or use a badge!

2. Login

3. Start exploring!
Reimagining Exploration

2 Steps to Explore Data

1. Or use a link!

2. Start exploring!
Breakthrough Technology

WEBASSEMBLY

webR

quarto®
• **Unify** and **extends** the R Markdown ecosystem

• **Switch** formats without hassle

**HTML Document**

```plaintext
project: blogdown
format: html
```

**Website**

```plaintext
project: website
website: html
- analysis.qmd
```
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**

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**R**

```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"
```

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**JavaScript**

```javascript
// 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: 'character', names: null, values: ["abc"] }
```
Unification
quarto-webr Extension

In Action

```r
1 + 1
```

```
WebR in Quarto HTML Documents

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

```
```
Install `quarto-webr` Extension

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

![Terminal Tab in RStudio](image)

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

```bash
webr-demo quarto add coatless/quarto-webr
```
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!
Customize Document

Modifying webR and Native Extension Features

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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

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

quarto-webr's Internal Cell

interactive

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

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 ...

![Devices](image)
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

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**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**

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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.
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
Want to learn more?

- **quarto-webr** Extension
  - [Extension Website](http://extensionwebsite.com) & [GitHub](http://github.com)
- **webR** Project
  - [Documentation](http://webrdocumentation.com) & [GitHub](http://github.com)
- **Community**
  - [boB Rudis' webR Experiments](http://webrexperiments.com)
  - [Awesome List: webR](http://awesomewebr.com)
Thank you! Questions?

Contact Info

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