# Interactive data visualization

Dr. Çetinkaya-Rundel

2018-04-16

# Announcements

- Great job answering each others' questions on Slack over the weekend!
- Ignore the license expiration notice on RStudio Cloud — it'll go away in a day or two
- Data Dialogue this week: Thursday at 11:45am at Gross Hall
  - Julia Silge - Understanding Principal Component Analysis Using Stack Overflow Data
  - Also R-Ladies RTP meetup Wed at 6:30pm: tidytext analysis with R
- HW 6 due Wed at noon
- All team members should be at lab this week
  - Review proposal feedback before lab
  - Schedule **all** team meetings between now and project presentation now
  - Set a goal for each of these team meetings, e.g. combine results, work on presentation slides, practice presentation, etc.

# Outline

- High level view
- Anatomy of a Shiny app
- Reactivity 101
- File structure

# Google Trend Index

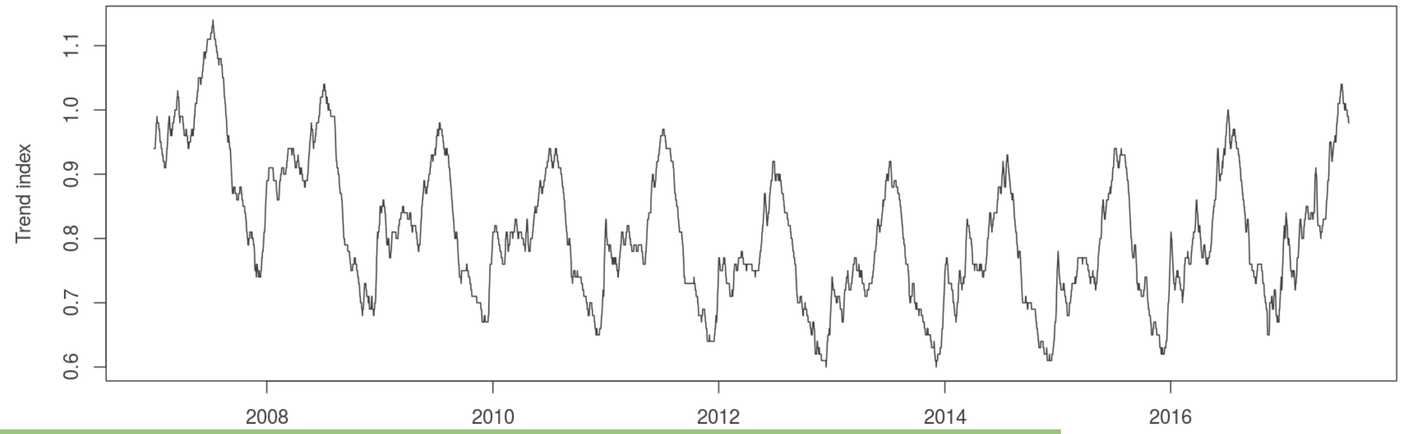
**Trend index**

Travel

**Date range**

2007-01-01 to 2017-07-31

**Overlay smooth trend line**




https://gallery.shinyapps.io/120-goog-index/

index is set to 1.0 on January 1, 2004

and is calculated only for US search traffic.

Source: Google Domestic Trends

Google Trend Index

by Mine Cetinkaya-Rundel <mine@rstudio.com>

A simple Shiny app that displays eruption data for the Google Trend Index app. Featured on the front page of the Shiny Dev Center.

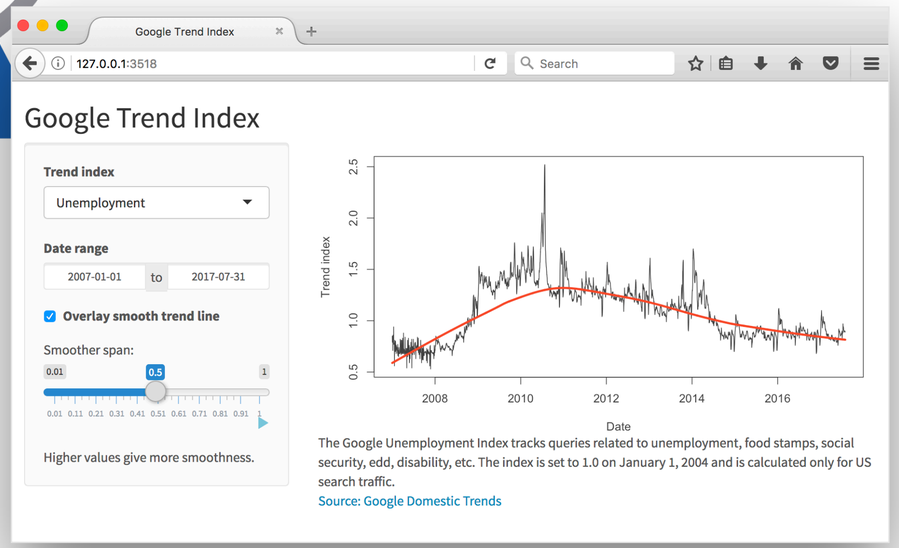
app.R

SHOW WITH APP

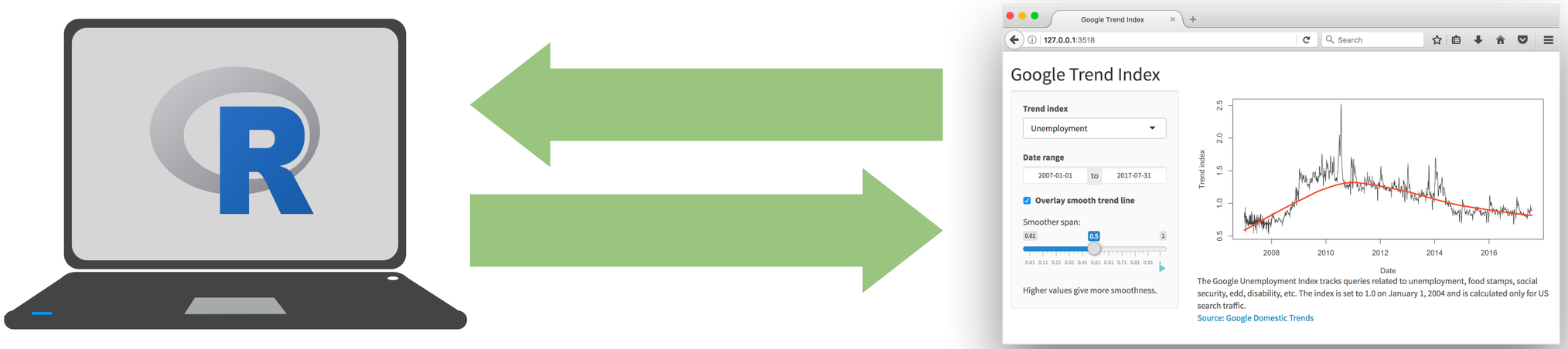
```
library(shiny)
library(shinythemes)
library(dplyr)
library(readr)

# Load data
trend_data <- read_csv("data/trend_data.csv")
trend_description <- read_csv("data/trend_description.csv")

# Define UI
```

# High level view

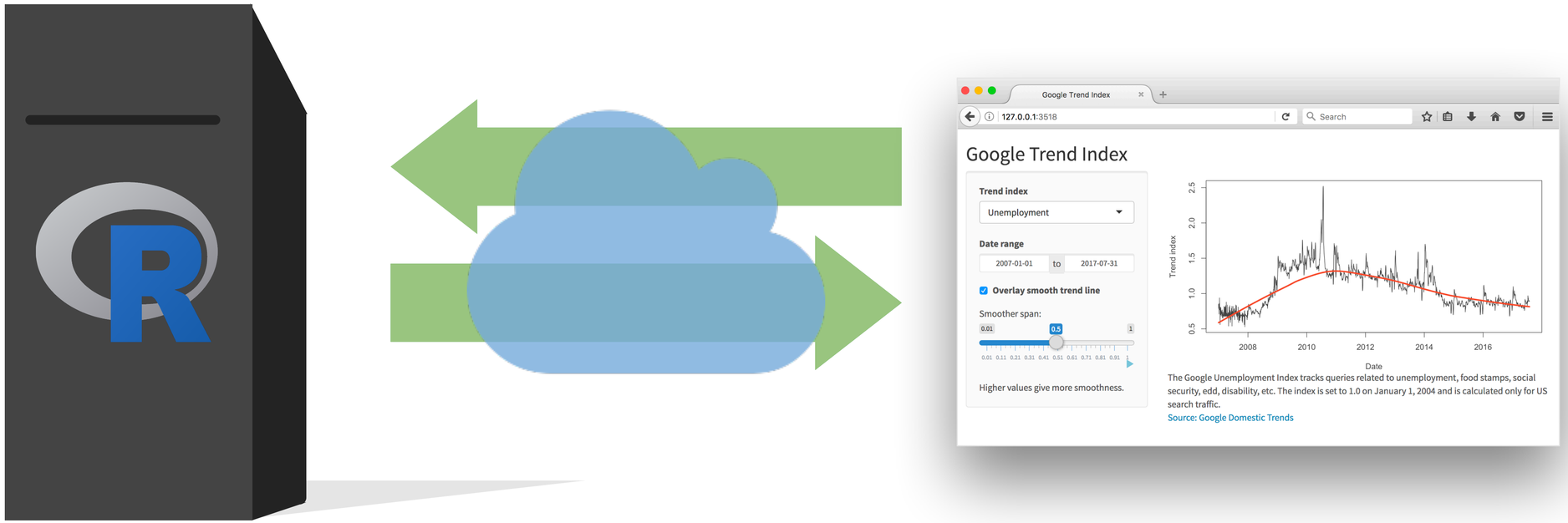
Every Shiny app has a webpage that the user visits, and behind this webpage there is a computer that serves this webpage by running R.

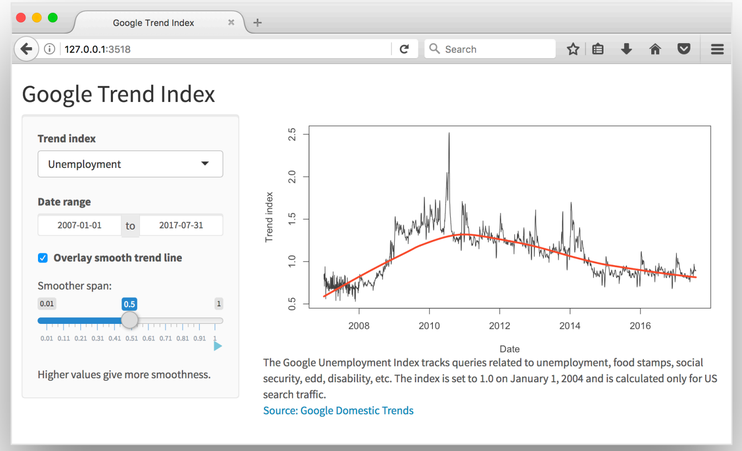


# When running your app locally, the computer serving your app is your computer.



# When your app is deployed,
# the computer serving your app is a web server.





Server instructions

User interface

# Interactive viz

goog-index/app.R

# Anatomy of a Shiny app

# What's in a Shiny app?

```
library(shiny)
ui <- fluidPage()

server <- function(input, output) {}

shinyApp(ui = ui, server = server)
```

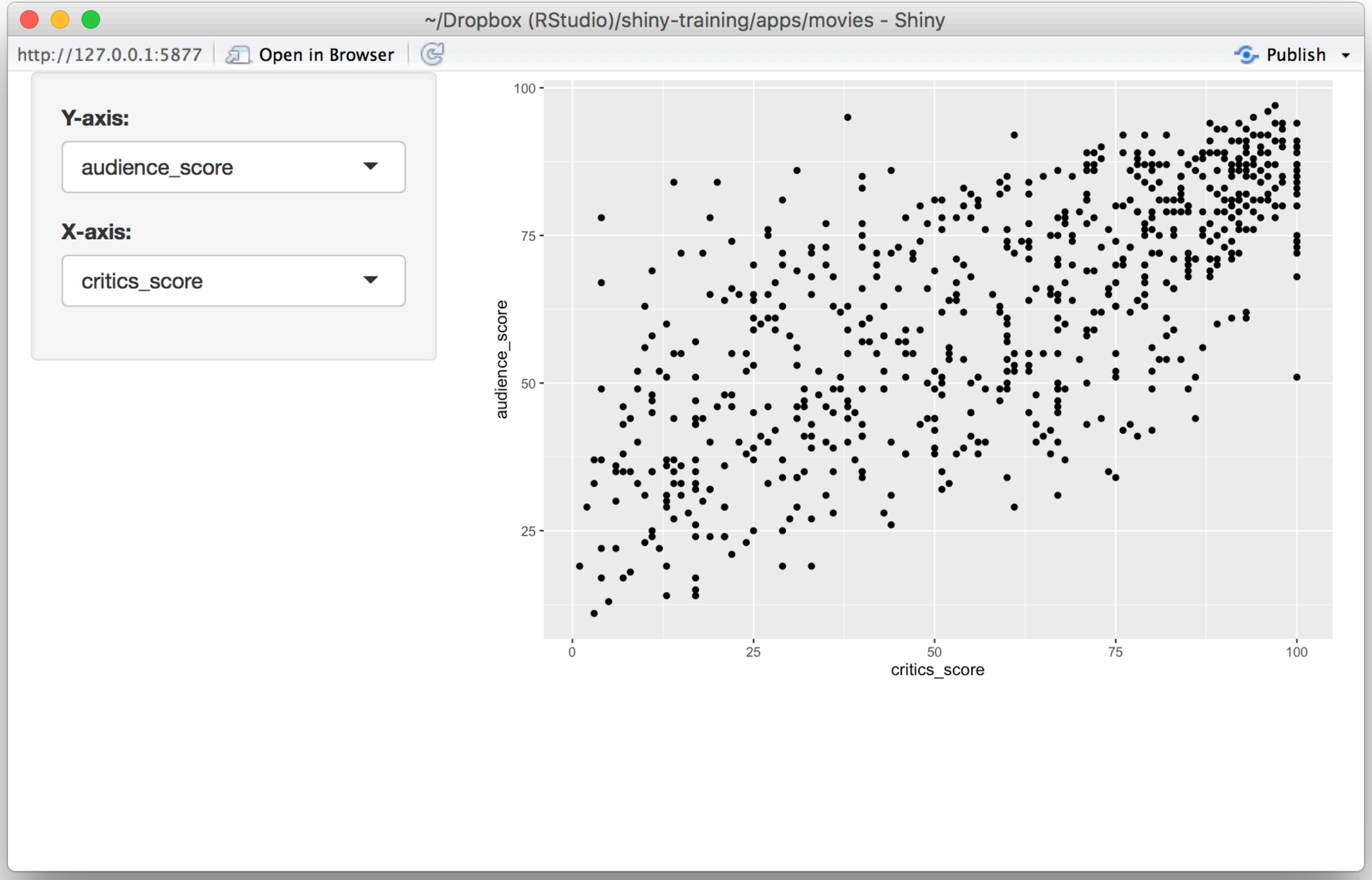
**User interface**
controls the layout and appearance of app

**Server function**
contains instructions needed to build app

# Let’s build a simple movie browser app!

`data/movies.Rdata`

Data from IMDB and Rotten Tomatoes on random sample of 651 movies released in the US between 1970 and 2014


~/Dropbox (RStudio)/shiny-training/apps/movies - Shiny
http://127.0.0.1:5877
Open in Browser
Publish
Y-axis:
audience_score
X-axis:
critics_score
100
75
50
25
audience_score
0
25
50
75
100
critics_score

# App template

```
library(shiny)
library(tidyverse)
load("data/movies.Rdata")
ui <- fluidPage()

server <- function(input, output) {}

shinyApp(ui = ui, server = server)
```

Dataset used for this app

# Anatomy of a Shiny app

## User interface

```
# Define UI
ui <- fluidPage(

  # Sidebar layout with a input and output definitions
  sidebarLayout(
    # Inputs: Select variables to plot
    sidebarPanel(
      # Select variable for y-axis
      selectInput(inputId = "y", label = "Y-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "audience_score"),
      # Select variable for x-axis
      selectInput(inputId = "x", label = "X-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "critics_score")
    ),

    # Output: Show scatterplot
    mainPanel(
      plotOutput(outputId = "scatterplot")
    )
  )
```

Create fluid page layout

```
# Define UI
ui <- fluidPage(

  # Sidebar layout with a input and output definitions
  sidebarLayout(
    # Inputs: Select variables to plot
    sidebarPanel(
      # Select variable for y-axis
      selectInput(inputId = "y", label = "Y-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "audience_score"),
      # Select variable for x-axis
      selectInput(inputId = "x", label = "X-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "critics_score")
    ),

    # Output: Show scatterplot
    mainPanel(
      plotOutput(outputId = "scatterplot")
    )
  )
```

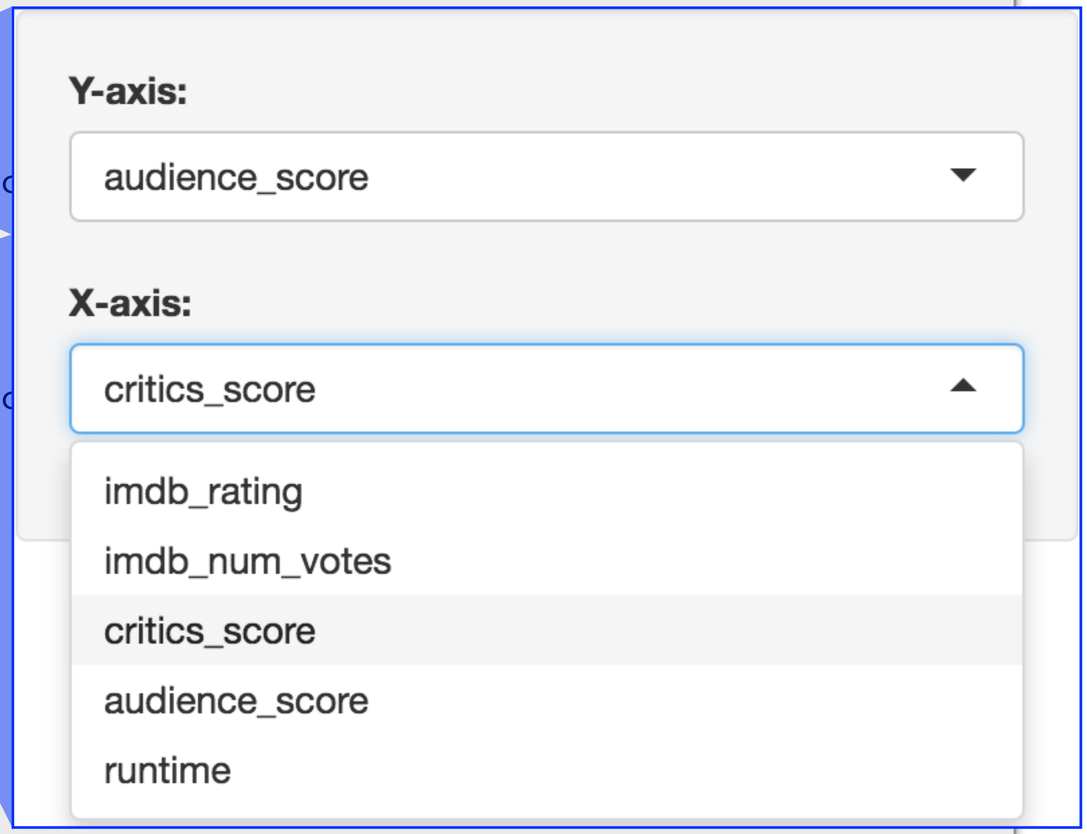
```r
# Define UI
ui <- fluidPage(

  # Sidebar layout with a input and output definitions
  sidebarLayout(
    # Inputs: Select variables to plot
    sidebarPanel(
      # Select variable for y-axis
      selectInput(inputId = "y", label = "Y-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "audience_score"),
      # Select variable for x-axis
      selectInput(inputId = "x", label = "X-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "critics_score")
    ),

    # Output: Show scatterplot
    mainPanel(
      plotOutput(outputId = "scatterplot")
    )
  )
```

Create a layout with a sidebar and main area

```r
# Define UI
ui <- fluidPage(

  # Sidebar layout with a input and output definitions
  sidebarLayout(
    # Inputs: Select variables to plot
    sidebarPanel(
      # Select variable for y-axis
      selectInput(inputId = "y", label = "Y-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "audience_score"),
      # Select variable for x-axis
      selectInput(inputId = "x", label = "X-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "critics_score")
    ),

    # Output: Show scatterplot
    mainPanel(
      plotOutput(outputId = "scatterplot")
    )
  )
```

Create a sidebar panel containing **input** controls that can in turn be passed to `sidebarLayout`

```r
# Define UI
ui <- fluidPage(

  # Sidebar layout with a input and output definitions
  sidebarLayout(
    # Inputs: Select variables to plot
    sidebarPanel(
      # Select variable for y-axis
      selectInput(inputId = "y", label = "Y-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "c
                  selected = "audience_score"),
      # Select variable for x-axis
      selectInput(inputId = "x", label = "X-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "c
                  selected = "critics_score")
    ),

    # Output: Show scatterplot
    mainPanel(
      plotOutput(outputId = "scatterplot")
    )
  )
```



```r
# Define UI
ui <- fluidPage(

  # Sidebar layout with a input and output definitions
  sidebarLayout(
    # Inputs: Select variables to plot
    sidebarPanel(
      # Select variable for y-axis
      selectInput(inputId = "y", label = "Y-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "audience_score"),
      # Select variable for x-axis
      selectInput(inputId = "x", label = "X-axis:",
                  choices = c("imdb_rating", "imdb_num_votes", "critics_score", "audience_score", "runtime"),
                  selected = "critics_score")
    ),

    # Output: Show scatterplot
    mainPanel(
      plotOutput(outputId = "scatterplot")
    )
  )
```

Create a main panel containing **output** elements that get created in the server function can in turn be passed to `sidebarLayout`

# Anatomy of a Shiny app

## Server

```
# Define server function
server <- function(input, output) {

  # Create the scatterplot object the plotOutput function is expecting
  output$scatterplot <- renderPlot({
    ggplot(data = movies, aes_string(x = input$x, y = input$y)) +
      geom_point()
  })
}
```

```
# Define server function
server <- function(input, output) {

  # Create the scatterplot object the plotOutput function is expecting
  output$scatterplot <- renderPlot({
    ggplot(data = movies, aes_string(x = input$x, y = input$y)) +
      geom_point()
  })
}
```

Contains instructions needed to build app

```
# Define server function
server <- function(input, output) {


  # Create the scatterplot object the plotOutput
  output$scatterplot <- renderPlot({
    ggplot(data = movies, aes_string(x = input$x,
      geom_point()
  })
}
```

Renders a **reactive** plot that is suitable for assigning to an output slot

```
# Define server function
server <- function(input, output) {

  # Create the scatterplot object the plotOutput function is expecting
  output$scatterplot <- renderPlot({
    ggplot(data = movies, aes_string(x = input$x, y = input$y)) +
      geom_point()
  })
}
```

Good ol' ggplot2 code, with **input**s from UI

# Anatomy of a Shiny app

## UI + Server

```
# Create the Shiny app object
shinyApp(ui = ui, server = server)
```

# Putting it all together…

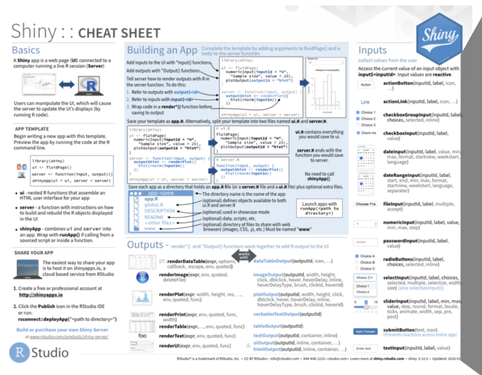
`movies/movies-01.R`

Add a `sliderInput` for alpha level of points on plot

`movies/movies-02.R`

# Inputs

www.rstudio.com/resources/cheatsheets/




## Inputs

collect values from the user

Access the current value of an input object with **input$<inputId>**. Input values are **reactive**.

Action — **actionButton**(inputId, label, icon, …)

Link — **actionLink**(inputId, label, icon, …)

Choice 1 / Choice 2 / Choice 3 — **checkboxGroupInput**(inputId, label, choices, selected, inline)

Check me — **checkboxInput**(inputId, label, value)

**dateInput**(inputId, label, value, min, max, format, startview, weekstart, language)

**dateRangeInput**(inputId, label, start, end, min, max, format, startview, weekstart, language, separator)

Choose File — **fileInput**(inputId, label, multiple, accept)

1 — **numericInput**(inputId, label, value, min, max, step)

•••••••• — **passwordInput**(inputId, label, value)

Choice A / Choice B / Choice C — **radioButtons**(inputId, label, choices, selected, inline)

Choice 1 (Choice 1 / Choice 2) — **selectInput**(inputId, label, choices, selected, multiple, selectize, width, size) (also selectizeInput())

0 5 10 (0 2 4 6 8 10) — **sliderInput**(inputId, label, min, max, value, step, round, format, locale, ticks, animate, width, sep, pre, post)

Apply Changes — **submitButton**(text, icon)
(Prevents reactions across entire app)

Enter text — **textInput**(inputId, label, value)

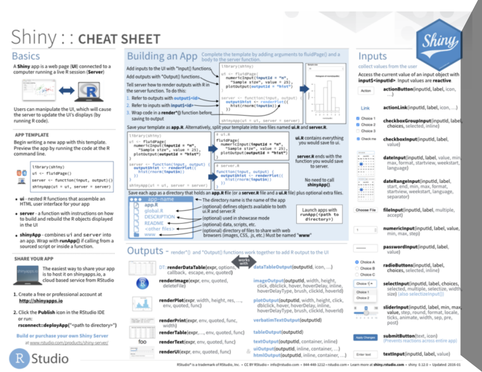
# Add a new widget to color the points by another variable

`movies/movies-03.R`

# Display data frame *if* box is checked

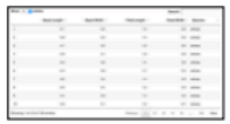
`movies/movies-04.R`

# Outputs




## Outputs - render*() and *Output() functions work together to add R output to the UI

works with

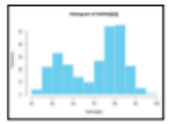


DT::**renderDataTable**(expr, options, callback, escape, env, quoted)

**dataTableOutput**(outputId, icon, …)

**renderImage**(expr, env, quoted, deleteFile)

**imageOutput**(outputId, width, height, click, dblclick, hover, hoverDelay, inline, hoverDelayType, brush, clickId, hoverId)

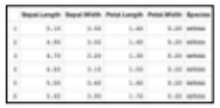


**renderPlot**(expr, width, height, res, …, env, quoted, func)

**plotOutput**(outputId, width, height, click, dblclick, hover, hoverDelay, inline, hoverDelayType, brush, clickId, hoverId)

**renderPrint**(expr, env, quoted, func, width)

**verbatimTextOutput**(outputId)



**renderTable**(expr,…, env, quoted, func)

**tableOutput**(outputId)

foo

**renderText**(expr, env, quoted, func)

**textOutput**(outputId, container, inline)

**renderUI**(expr, env, quoted, func)

& **uiOutput**(outputId, inline, container, …)
**htmlOutput**(outputId, inline, container, …)

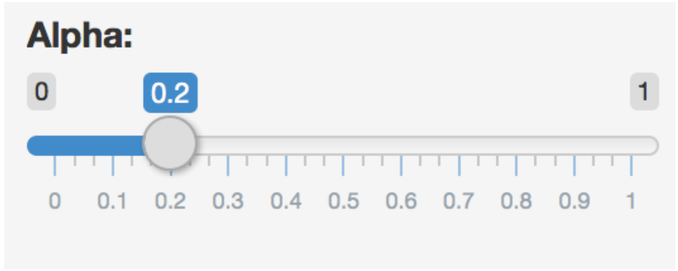
# Reactivity 101

# Reactions

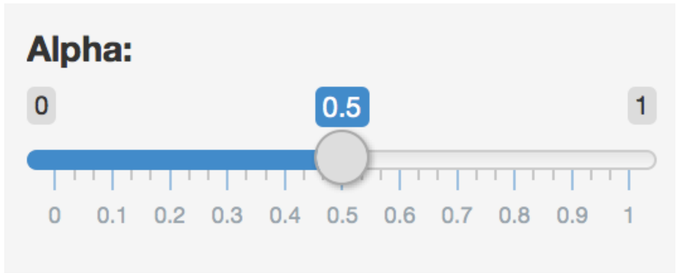
The **input$** list stores the current value of each input object under its name.

```
# Set alpha level
sliderInput(inputId = "alpha",
            label = "Alpha:",
            min = 0, max = 1,
            value = 0.5)
```

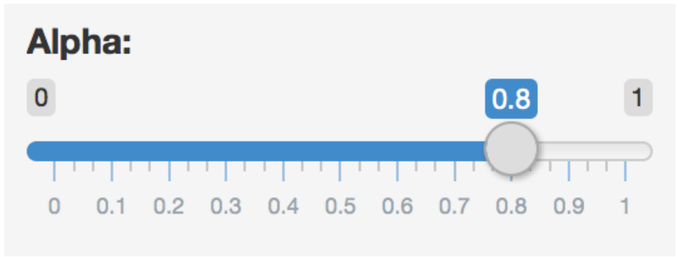
input$alpha




input$alpha = 0.2




input$alpha = 0.5




input$alpha = 0.8

# Reactions (cont.)

Reactivity automatically occurs
when an **input** value is used to render an **output** object.

```
# Define server function required to create the scatterplot
server <- function(input, output) {
   # Create the scatterplot object the plotOutput function is expecting
   output$scatterplot <- renderPlot(
    ggplot(data = movies, aes_string(x = input$x, y = input$y,
                                     color = input$z)) +
      geom_point(alpha = input$alpha)
   )
}
```

Suppose you want the option to plot only certain types of movies as well as report how many such movies are plotted:

1. Add a UI element for the user to select which type(s) of movies they want to plot
2. Filter for chosen title type and save as a new (reactive) expression
3. Use new data frame (which is reactive) for plotting
4. Use new data frame (which is reactive) also for reporting number of observations

1. Add a UI element for the user to select which type(s) of movies they want to plot

```
# Select which types of movies to plot
checkboxGroupInput(inputId = "selected_type",
                   label = "Select movie type(s):",
                   choices = c("Documentary", "Feature Film",
                               "TV Movie"),
                   selected = "Feature Film")
```

2. Filter for chosen title type and save the new data frame as a reactive expression

**server:**

```
# Create a subset of data filtering fo
movies_subset <- reactive({
  req(input$selected_type)
  filter(movies, title_type %in% input$selected_type)
})
```

Creates a **cached expression** that knows it is out of date when input changes

## 3. Use new data frame (which is reactive) for plotting

```
# Create scatterplot object plotOutput function is expecting
output$scatterplot <- renderPlot({
  ggplot(data = movies_subset(),
         aes_string(x = input$x, y = input$y,                    +
    geom_point(…) +
    …
})
```

**Cached** - only re-run when inputs change

4. Use new data frame (which is reactive) also for printing number of observations

**ui:**

```
mainPanel(
  …
  # Print number of obs plotted
  uiOutput(outputId = "n"),
  …
  )
```

**server:**

```
# Print number of movies plotted
output$n <- renderUI({
  types <- movies_subset()$title_type %>%
    factor(levels = input$selected_type)
  counts <- table(types)

  HTML(paste("There are",
             counts,
             input$selected_type,
             "movies in this dataset.
             <br>"))
})
```

# Putting it all together…

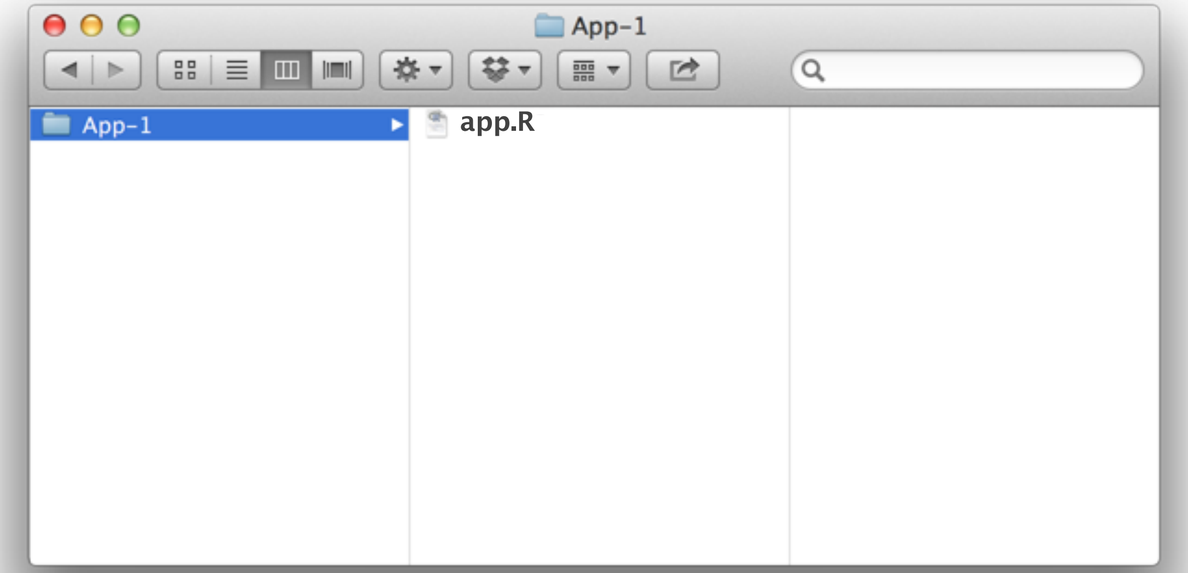
`movies/movies-05.R`

5. `req()`
6. App title
7. `selectInput()` choice labels
8. Formatting of x and y axis labels
9. Visual separation with horizontal lines and breaks

# When to use reactive

- By using a reactive expression for the subsetted data frame, we were able to get away with subsetting once and then using the result twice.
- In general, reactive conductors let you
  - not repeat yourself (i.e. avoid copy-and-paste code, which is a maintenance boon), and
  - decompose large, complex (code-wise, not necessarily CPU-wise) calculations into smaller pieces to make them more understandable.
- These benefits are similar to what happens when you decompose a large complex R script into a series of small functions that build on each other.

# File structure

# File structure

- One directory with every file the app needs:
- `app.R` (your script which ends with a call to `shinyApp()`)
- datasets, images, css, helper scripts, etc.