2018 Predictive Analytics Symposium

Session 31: AP - Developing Web Application With R Shiny

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Predictive Analytics Symposium

Ben Johnson

Session 31: Developing Web Applications With R Shiny

September 20, 2019

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Agenda

- Introduction to Shiny
  - Example applications
- Components of an app
  - User interface
  - Server code
- How to host Shiny applications online
- Tips & tricks
- Demo of building a Shiny application

What is Shiny?

- Web application framework
- Allows R programmers to create interactive web apps
  - Can be programmed exclusively in R
  - Augment code with HTML, CSS, and JavaScript
- Shiny is an R package developed and maintained by RStudio

I'd rather be shiny.

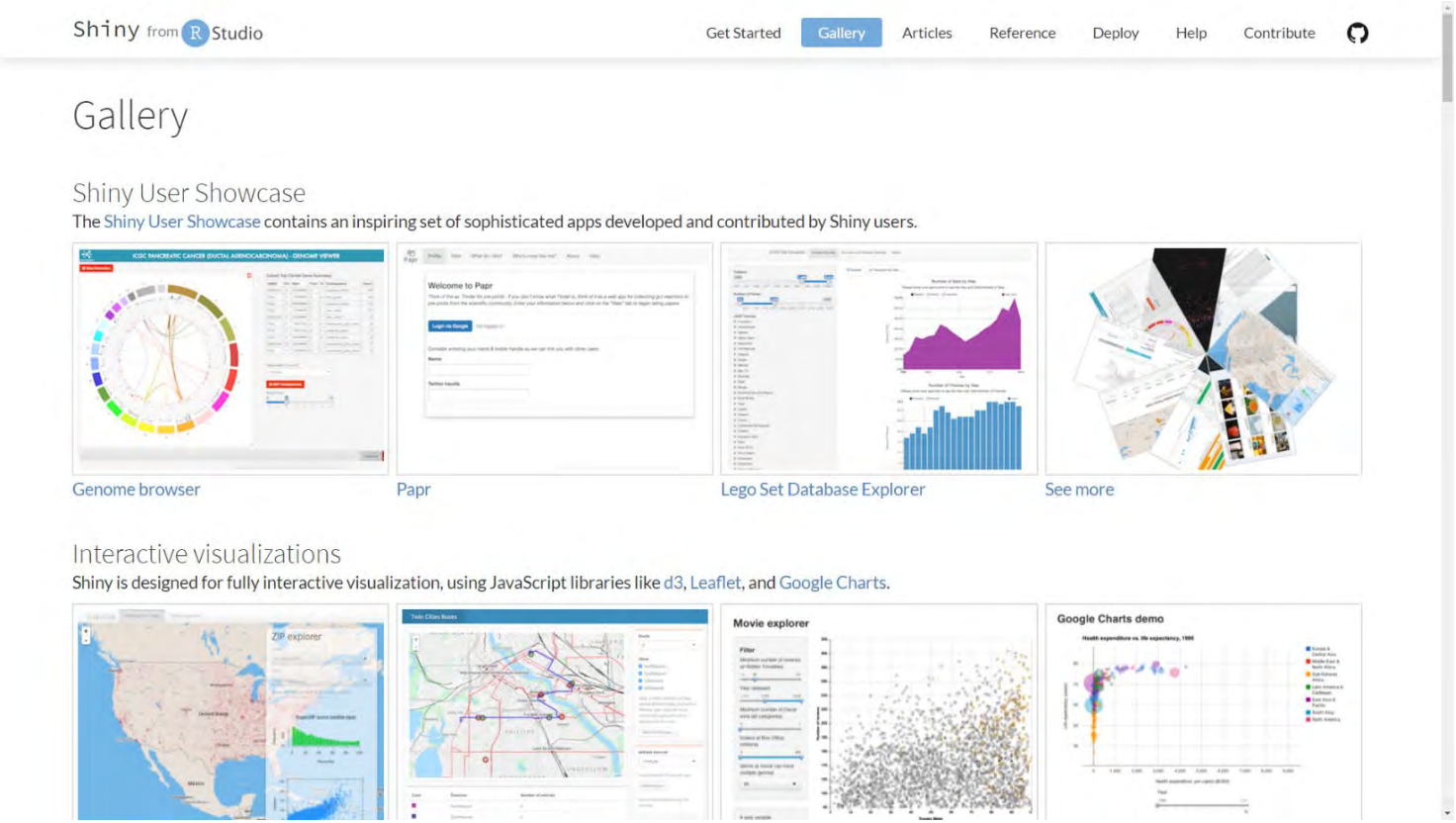
Tamatoa from Disney's Moana

Why use Shiny?

- You want to build web-apps but don't know the multitude of required programming languages
- Your analytics is already performed in R
- One person can accomplish what would otherwise have taken a full team of specialists
- It can be relatively inexpensive, or potentially free

← We tend to like this stuff

Shiny examples

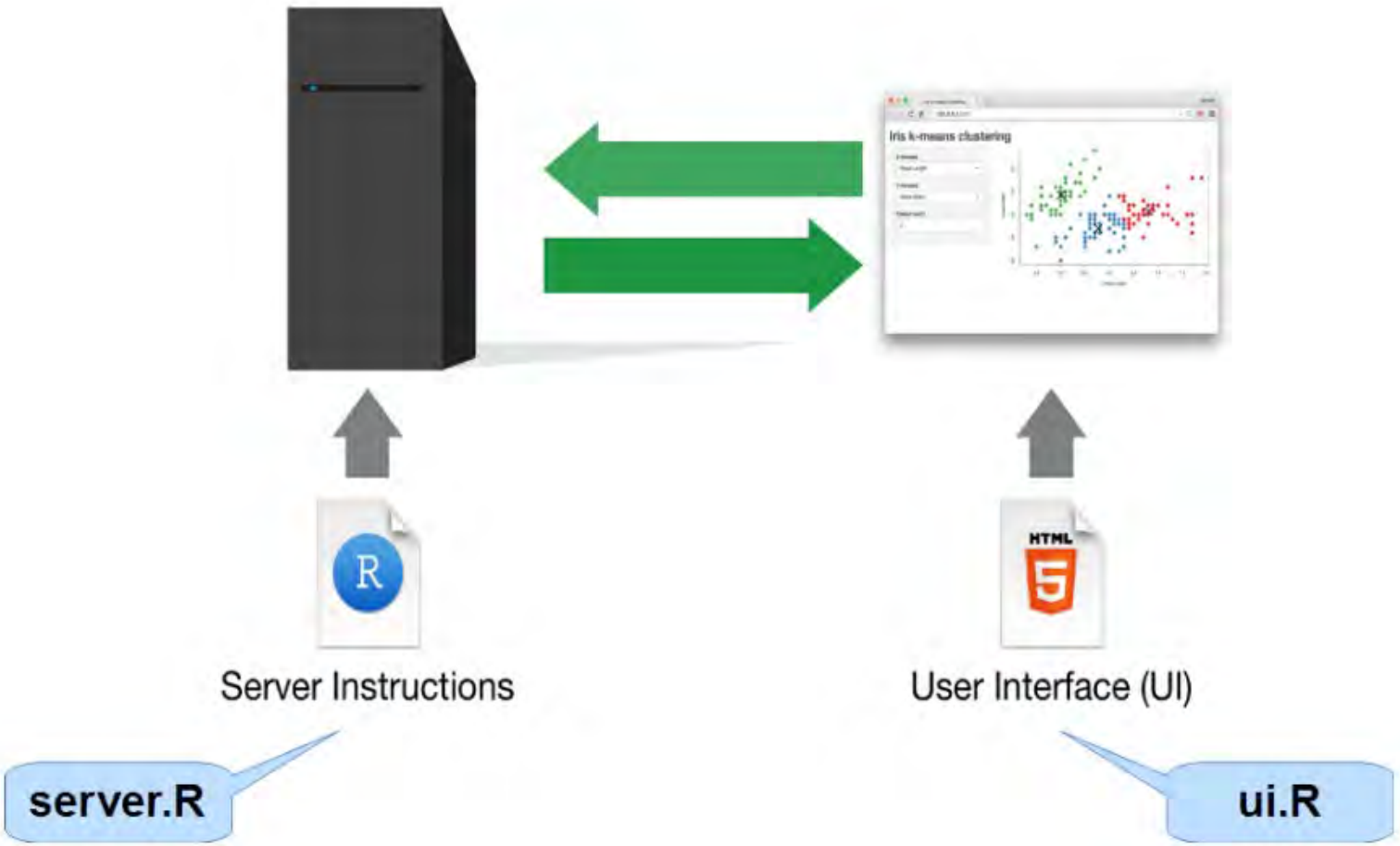


- https://shiny.rstudio.com/gallery/
- https://www.rstudio.com/products/shiny/shiny-user-showcase/

How does Shiny work?

- Employs an active R session to host the application
- The R session communicates with the browser in reactive context
  - Reactive context means that the session is actively listening for changes in user inputs
  - The R session reacts to changes in inputs by updating any corresponding outputs

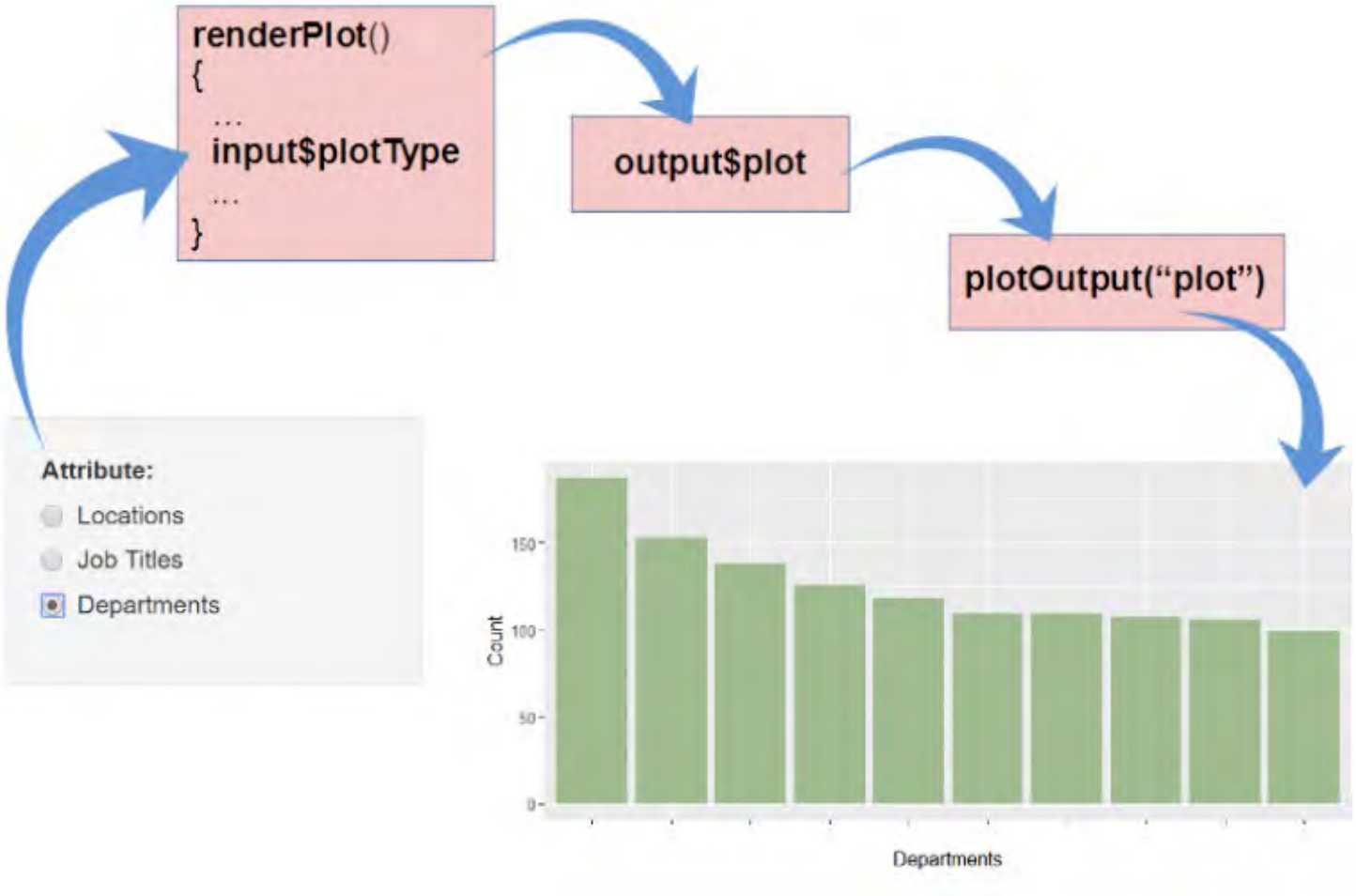
How does Shiny work?



What does Shiny code look like?

- User interface component
  - R code to build the structure and layout of the app
  - This dictates what the end user sees
- Server component
  - R code to process data and other objects
  - Defines relationships between inputs and outputs
- Supplementary files
  - Global file
  - www folder
  - Any additional scripts

Basic reactive flow chart example



User interface

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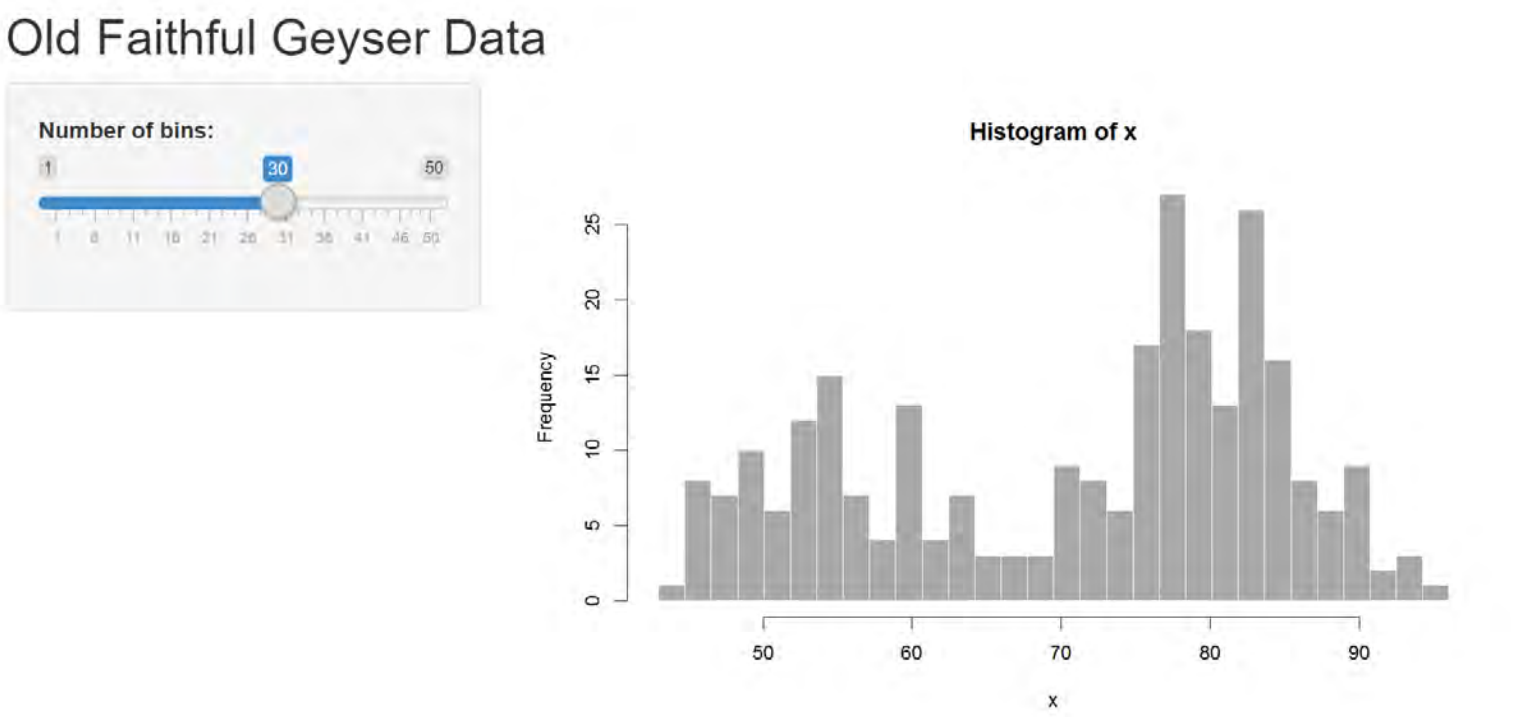
What the UI looks like in browser



UI code using Shiny

```
ui <- fluidPage(

   # Application title
   titlePanel("Old Faithful Geyser Data"),

   # Sidebar with a slider input for number of bins
   sidebarLayout(
      sidebarPanel(
         sliderInput("bins",
                     "Number of bins:",
                     min = 1,
                     max = 50,
                     value = 30)
      ),

      # Show a plot of the generated distribution
      mainPanel(
         plotOutput("distPlot")
      )
   )
)
```

UI code using HTML

```
<div class="container-fluid">
  <h2>Old Faithful Geyser Data</h2>
  <div class="row">
    <div class="col-sm-4">
      <form class="well">
        <div class="form-group shiny-input-container">
          <label class="control-label" for="bins">Number of bins:</la
bel>
          <input class="js-range-slider" id="bins" data-min="1" data-
max="50" data-from="30" data-step="1" data-grid="true" data-grid-num=
"9.8" data-grid-snap="false" data-prettify-separator="," data-prettif
y-enabled="true" data-keyboard="true" data-data-type="number"/>
        </div>
      </form>
    </div>
    <div class="col-sm-8">
      <div id="distPlot" class="shiny-plot-output" style="width: 100%
 ; height: 400px"></div>
    </div>
  </div>
</div>
```

Shiny input controls

Buttons

Action

Submit

`actionButton()`
`submitButton()`

Single checkbox

Choice A

`checkboxInput()`

Checkbox group

Choice 1
Choice 2
Choice 3

`checkboxGroupInput()`

Date input

2014-01-01

`dateInput()`

Date range

2014-01-24 to 2014-01-24

`dateRangeInput()`

File input

Choose File No file chosen

`fileInput()`

Numeric input

1

`numericInput()`

Password Input

`passwordInput()`

Radio buttons

Choice 1
Choice 2
Choice 3

`radioButtons()`

Select box

Choice 1

`selectInput()`

Sliders

`sliderInput()`

Text input

Enter text...

`textInput()`

Server

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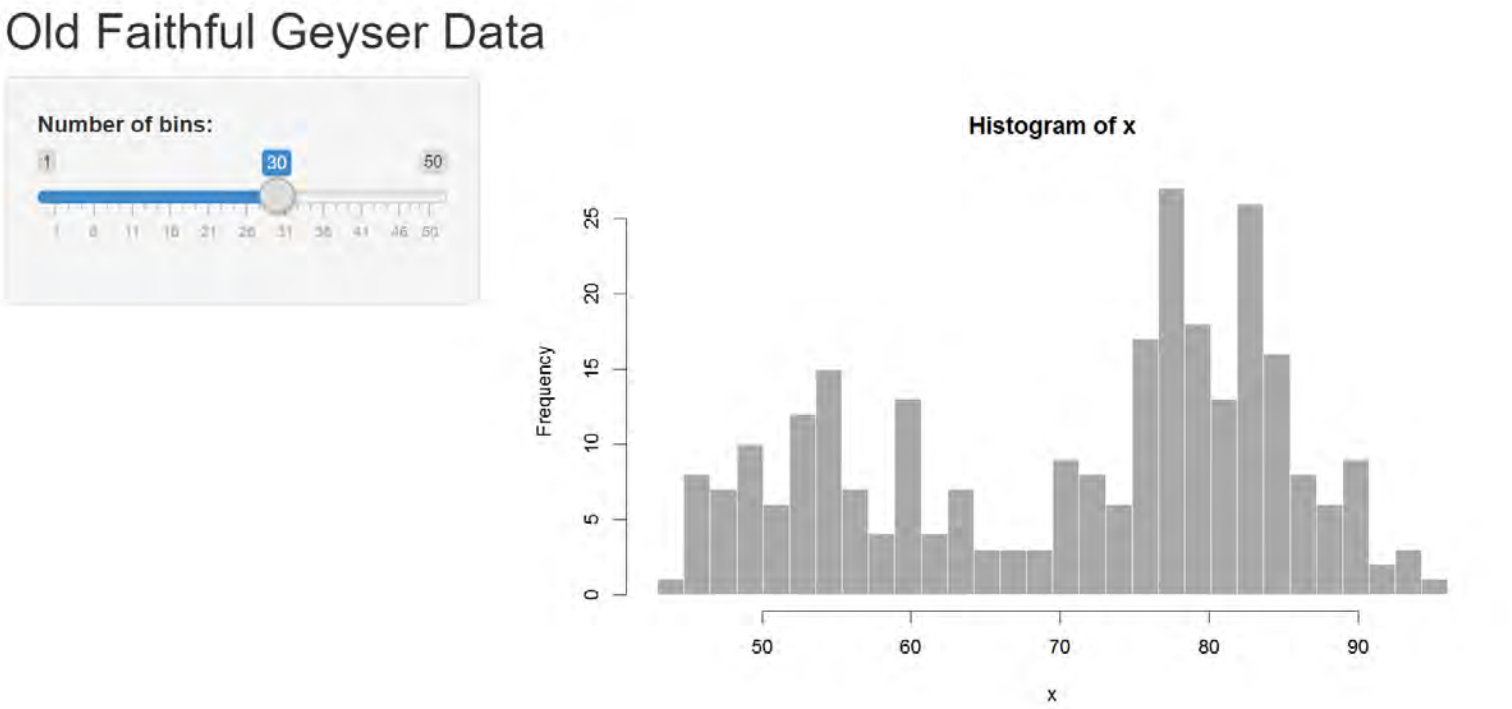
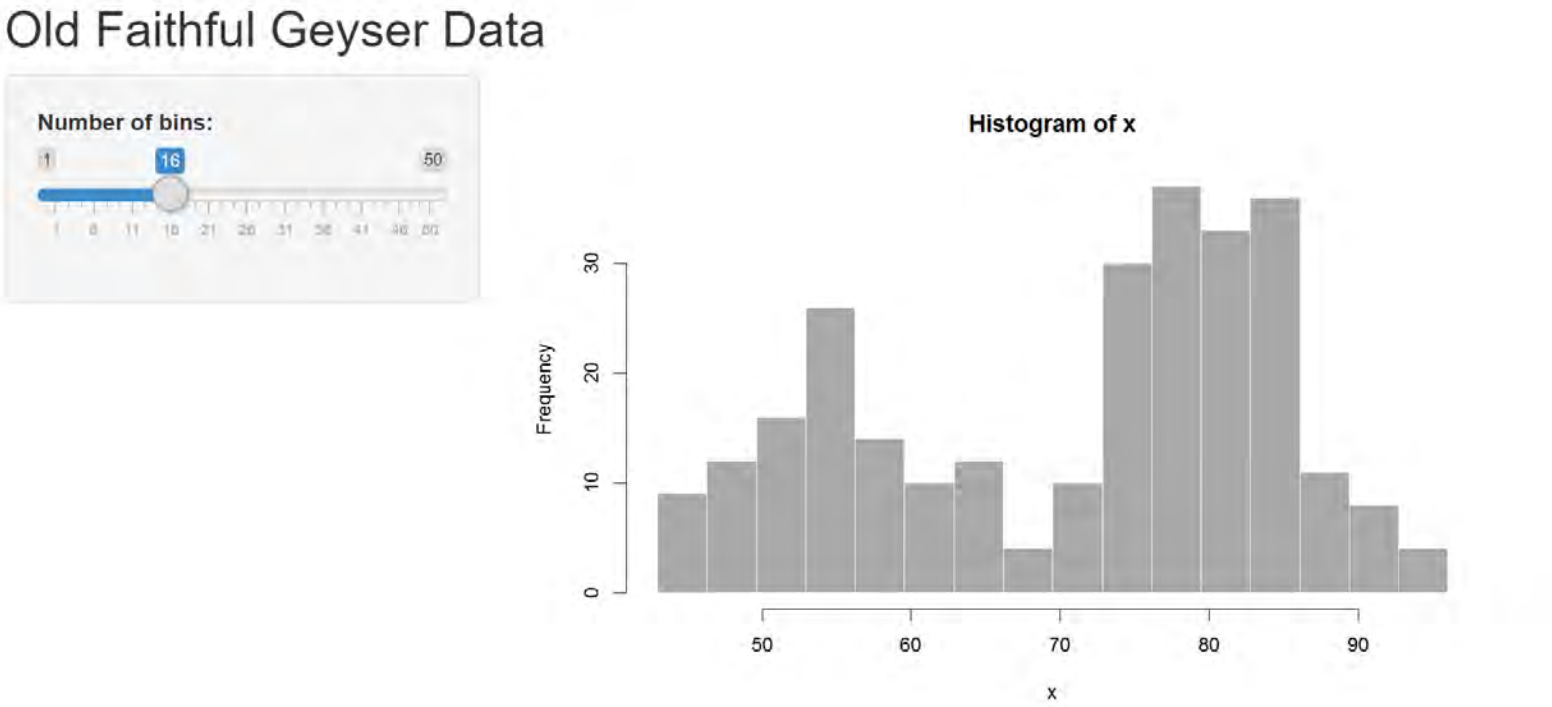
Shiny is interactive and reactive



Shiny is interactive and reactive



Server code using Shiny

```
# Define server logic required to draw a histogram
server <- function(input, output) {

   output$distPlot <- renderPlot({
      # generate bins based on input$bins from ui.R
      x    <- faithful[, 2]
      bins <- seq(min(x), max(x), length.out = input$bins + 1)

      # draw the histogram with the specified number of bins
      hist(x, breaks = bins, col = 'darkgray', border = 'white')
   })
}

# Run the application
shinyApp(ui = ui, server = server)
```

Input, Output, and Session

- Think of these as reactive lists
- Input – contains values for each user control
  - Values can refresh when the user interacts with browser
- Output – contains visuals that depend on inputs
  - Visuals are created by R code in the server
- Session – contains additional client information
  - E.g. pixelratio, namespace, user, group
  - Some aspects of the session object only exists if the user accesses app from internet

Hosting your application

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Shinyapps.io

Pros

- Quick and easy
- No server maintenance
- Security managed by RStudio
- Can be free

Cons

- Limited control over configuration
- Limited user authentication
- No local storage persistency
- If free, time of usage is limited

Shiny Server Pro

- Lots of control
- Deploy app behind firewalls
  - Helpful in testing
- Enterprise-grade user access and security features

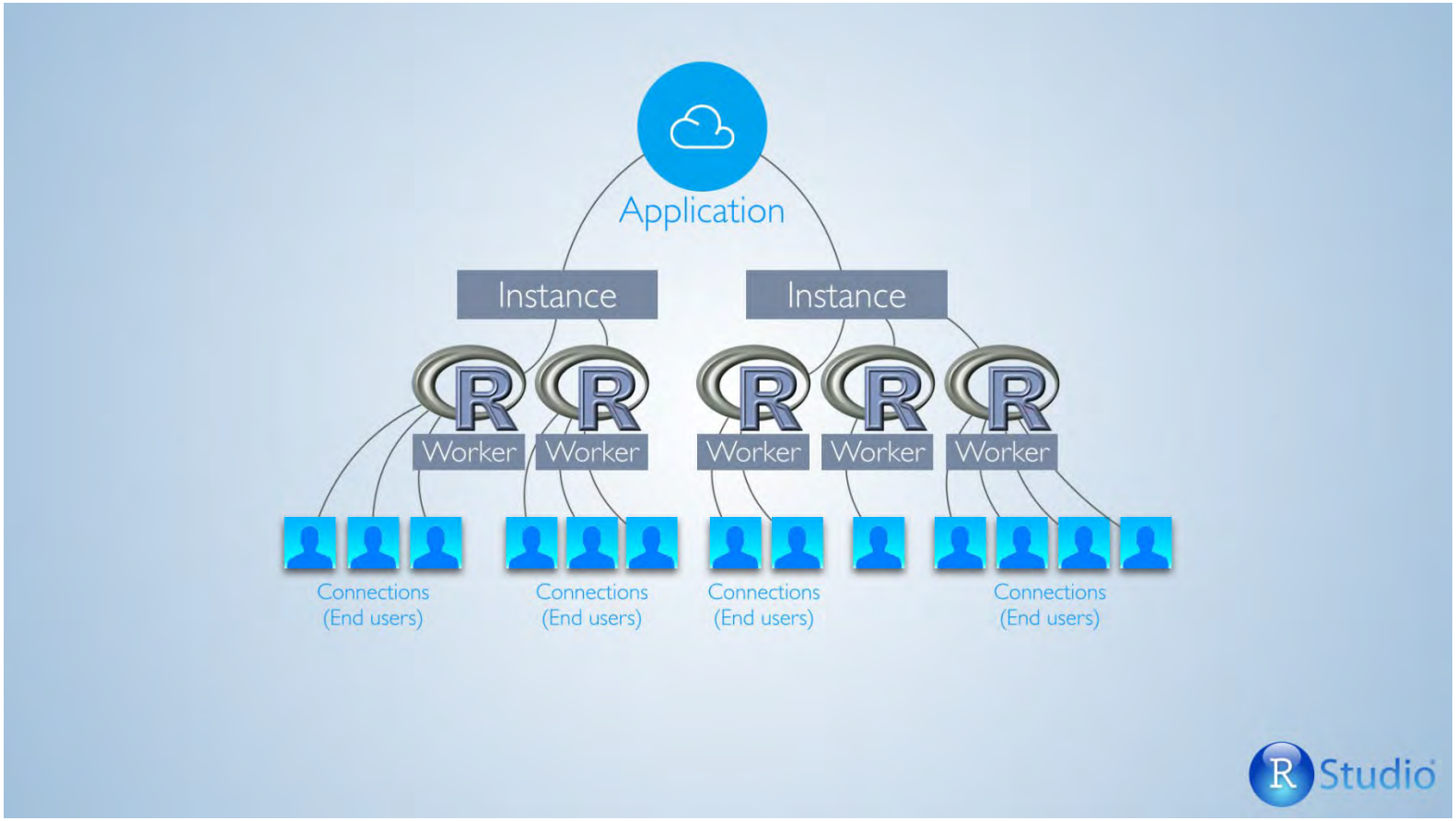
- Non-negligible cost
- Requires technical know-how to maintain

RStudio Connect

- Publishing platform for Shiny apps, markdown docs, dashboards, etc.
- Push-button publishing from RStudio IDE
- Ideal for sharing internally

- Very non-negligible cost
  - Can range from $15k-80k annually

How multiple users connect



Source: http://shiny.rstudio.com/articles/scaling-and-tuning.html

Why scaling optimization matters

- R is single-threaded
  - If two users share an R process, they compete for computational resources
  - Can result in the app becoming nonresponsive while it waits for other computations to finish
- When two users share an R process, if the application crashes then it will affect both users
- Limiting the number of users per R process also has negative consequences
  - Increases the time required to initialize the app
  - Will use more RAM on your server

Tips, tricks, and neat features

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Practical considerations

- Who is your intended audience?
  - How many users do you anticipate
  - Is your app external or internal

- Will the app serve as a demonstrative web page or an analytics tool
- Will Shiny fit into your workflow?
  - Do you need to save files to feed into external systems
  - Will users need to download from your server, or can files be written to the server

Practical considerations (continued)

- Do you need an audit trail
  - Build logging into your code
  - Build a report generating capability
- Can users start fresh every time they visit your application or does it need to “remember” their previous visits
  - Bookmarking in Shiny is great for this
- What user experience is sufficient for your use case
  - Creating a pleasant experience takes a lot of work

Downloading versus writing to disk

- Examples of writing to disk:
  - write.csv
  - saveRDS
- Examples of downloading
  - downloadHandler

- If your Shiny app is hosted online, writing to disk will save files to the server.
- You can transmit data to the end user by employing a downloadHandler
  - The user's internet browser handles this action

Bookmarking in Shiny

- Bookmarking allows you to save the active state of the shiny application so that it can be revisited later with identical input values
- enableBookmarking(store = “url”)
  - store = “server” saves the state data to the server
- bookmarkButton

Source: http://clipart-library.com

Use modularized code

- Shiny modules are essentially mini-applications
  - Modules have their own UI and server code
  - They use reactive context
- Using Shiny modules will streamline future updates
  - Changes to the current code can be made in one place
  - You can build new features quickly when they have commonalities with existing features
- Your code will be much easier to read when separated into distinct scripts

Use a global CSS file

- You can style your Shiny applications with CSS in three different ways
  - Inline CSS
  - In the HTML header
  - In a separate file
- Try to resist using inline CSS whenever possible
  - CSS in a single file will help increase development speed and be easier to maintain
- Implement your CSS code with the “addClass” function

Example Shiny-related packages

- shinyWidgets
  - Many additional input controls
- shinyBS
  - Useful for adding special alerts, buttons, modals, etc.
- shinyJS
  - Adds JavaScript functionality like show, hide, disable, etc.
- shinydashboard
  - Dashboard layout applications
- DT
  - Data tables

The shinyJS package

- This is my favorite helper package for Shiny applications
- One method for creating conditional UI is to use functions like “hide” or “show” to display the UI at the appropriate time
  - Those UI elements will technically exists but not be seen by the user
  - Contrast this to functions like “insertUI” which create UI elements dynamically
- https://deanattali.com/shinyjs/

Shiny resources

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- https://www.rstudio.com/products/shiny/shiny-user-showcase/
- https://shiny.rstudio.com/gallery/
- https://shiny.rstudio.com/tutorial/
  - Garrett Grolemund's video tutorial
  - Also includes written tutorials
  - Additional videos from RStudio's conferences related to shiny development
- https://deanattali.com/blog/building-shiny-apps-tutorial/
  - Dean Attali is unaffiliated with RStudio but well known in the Shiny community for his tutorials and Shiny-related R packages

Demo in R

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