Week 13: *Shiny Apps*

EMSE 4572: Exploratory Data Analysis

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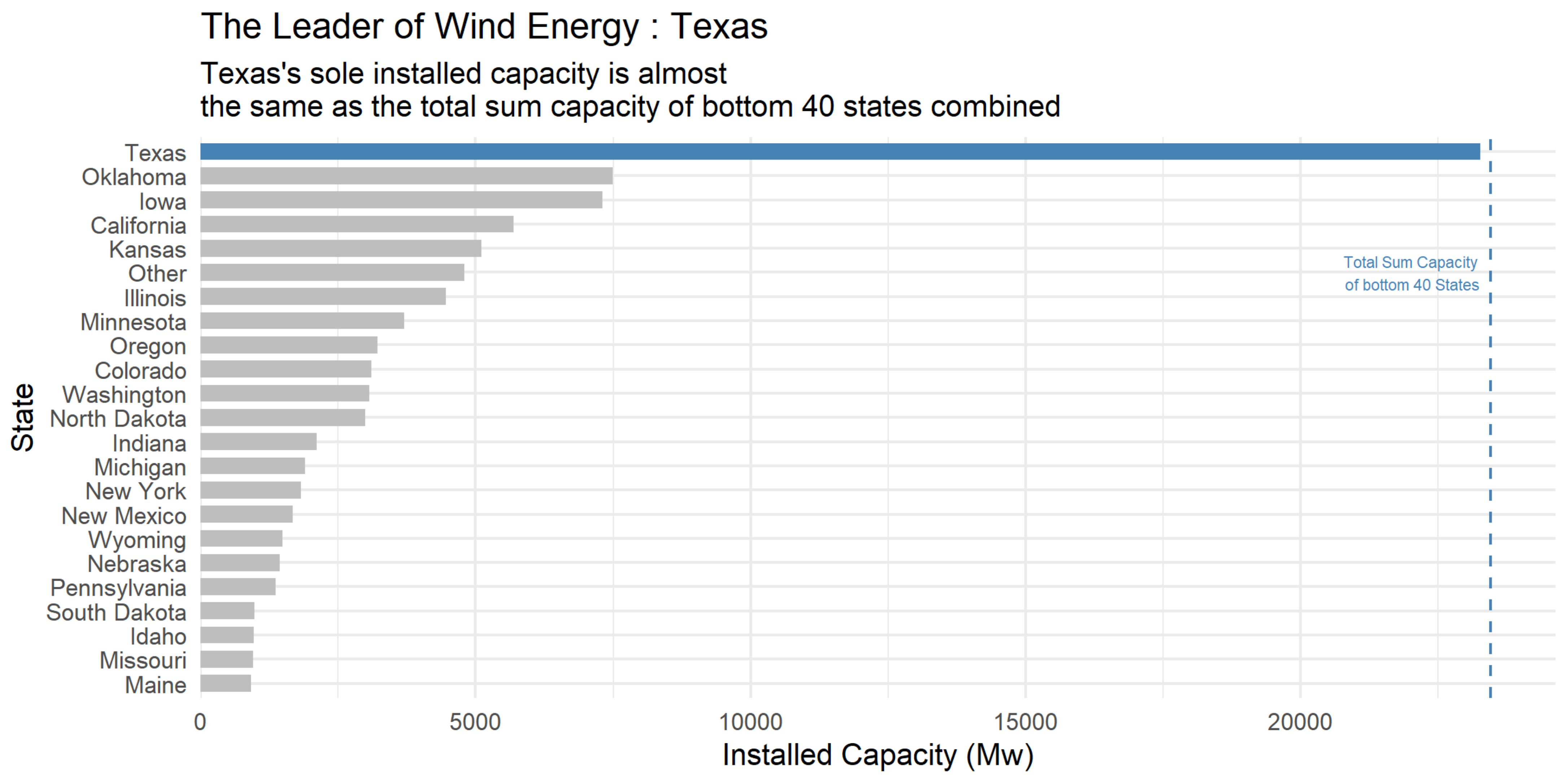
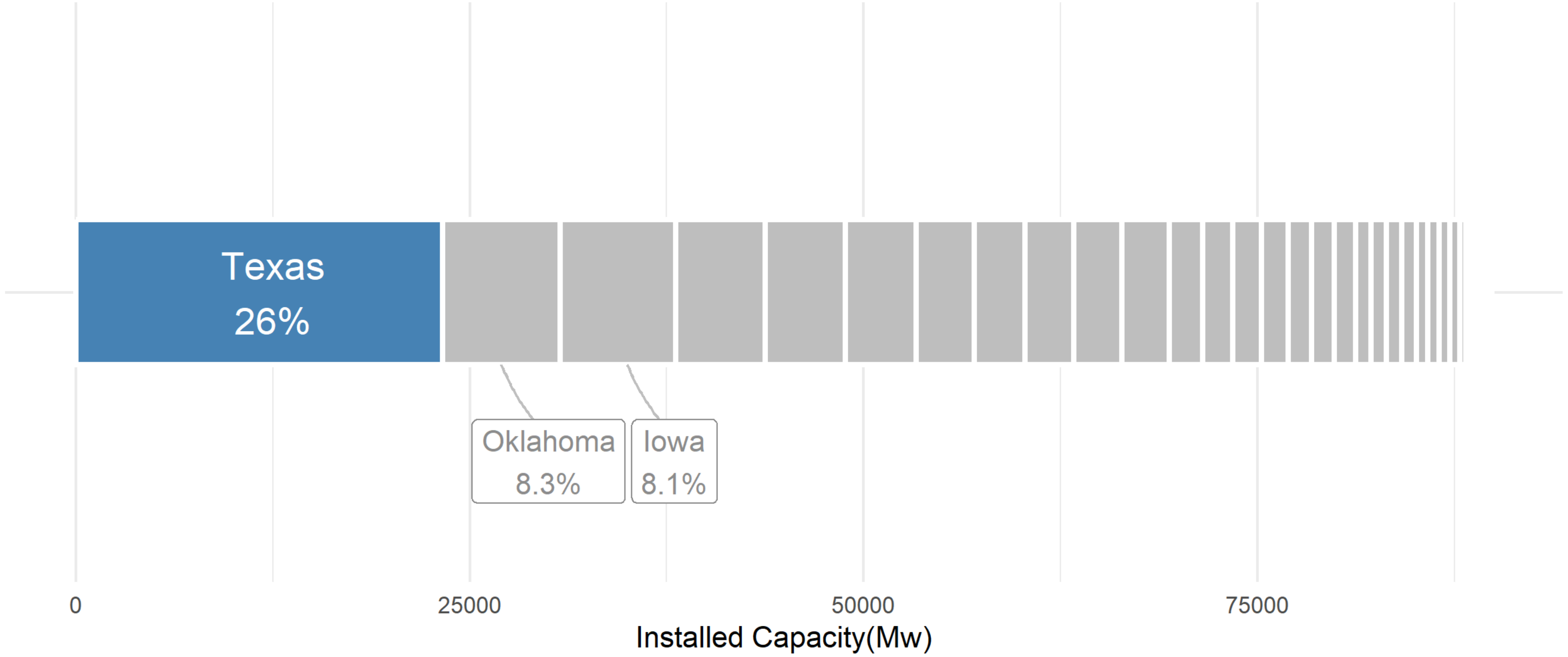
November 30, 2022


The Leader of Wind Energy : Texas
Texas's sole installed capacity is almost
the same as the total sum capacity of bottom 40 states combined
Texas
Oklahoma
Iowa
California
Kansas
Other
Illinois
Minnesota
Oregon
Colorado
Washington
North Dakota
Indiana
Michigan
New York
New Mexico
Wyoming
Nebraska
Pennsylvania
South Dakota
Idaho
Missouri
Maine
State
Total Sum Capacity
of bottom 40 States
0
5000
10000
15000
20000
Installed Capacity (Mw)

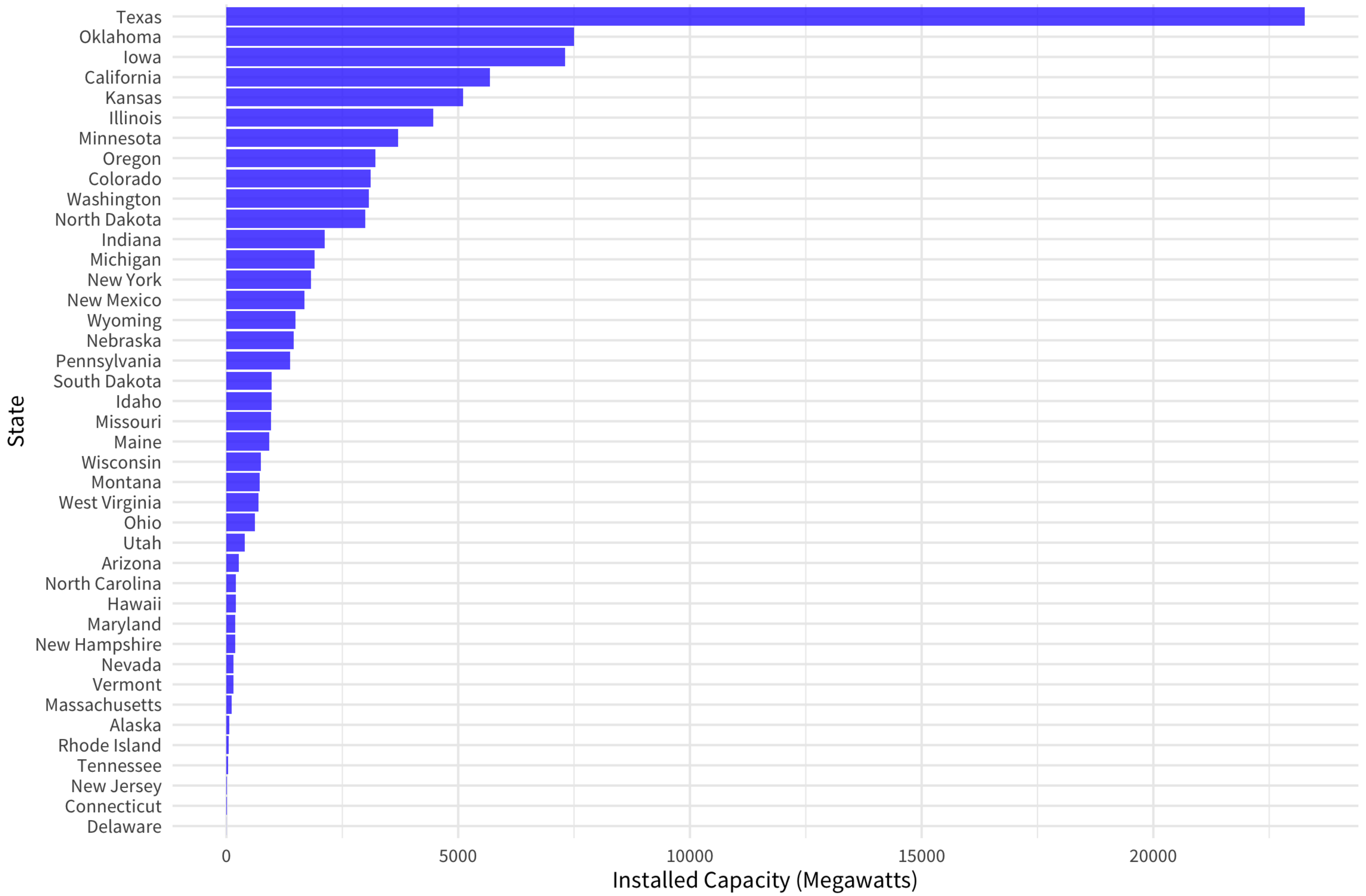
The Leader of Wind Energy : Texas

Texas accounts for 26% capacity followed by Oklahoma and Iowa



Installed Capacity By State

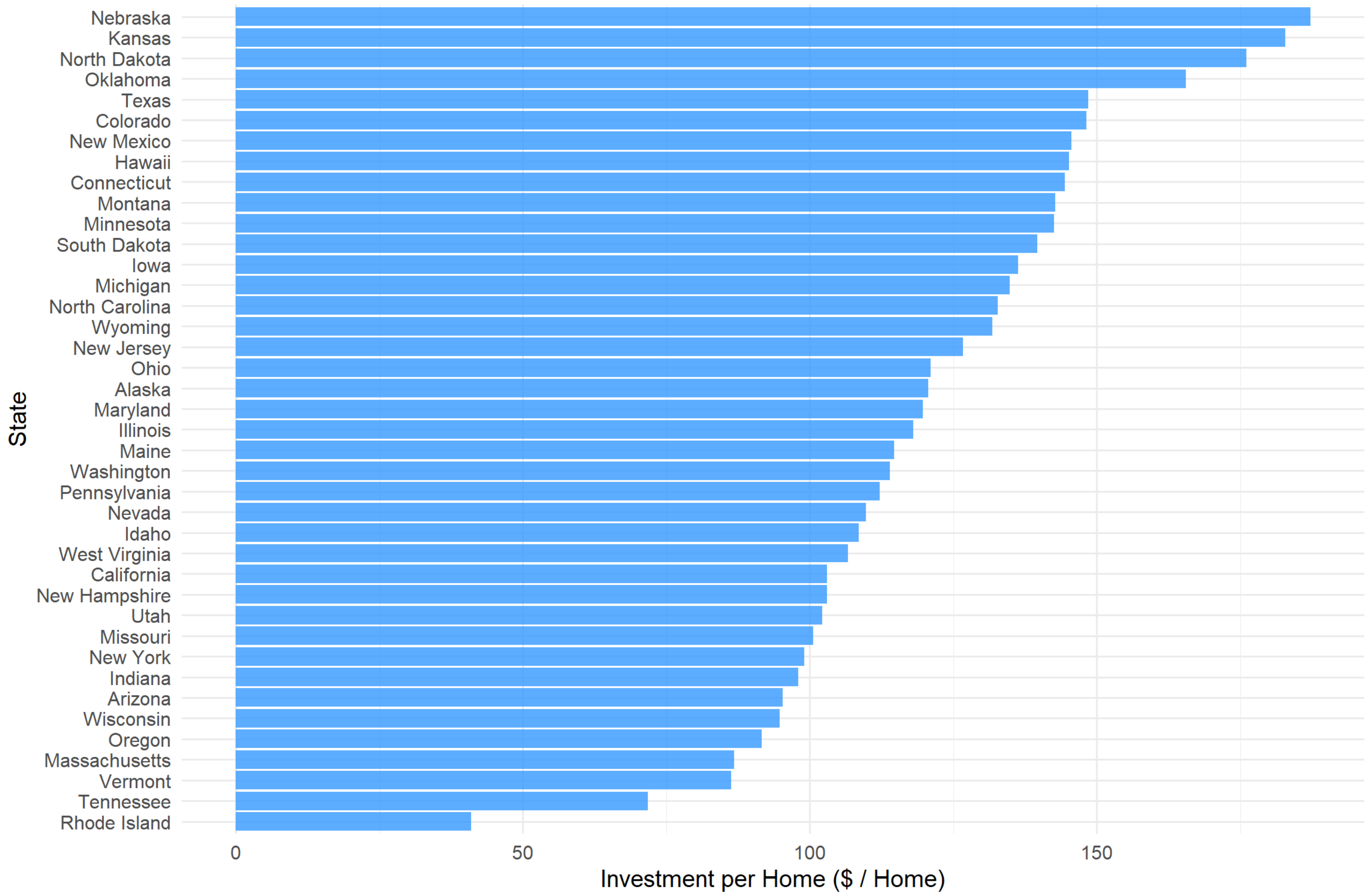
Improved Visualization



**States omitted from the graph due to having an installed capacity of 0 are the following: Virginia, South Carolina, Mississippi, Louisiana, Kentucky, Georgia, Florida, Arkansas, and Alabama

Total Investment Per Home Powered

2nd Improved Visualization

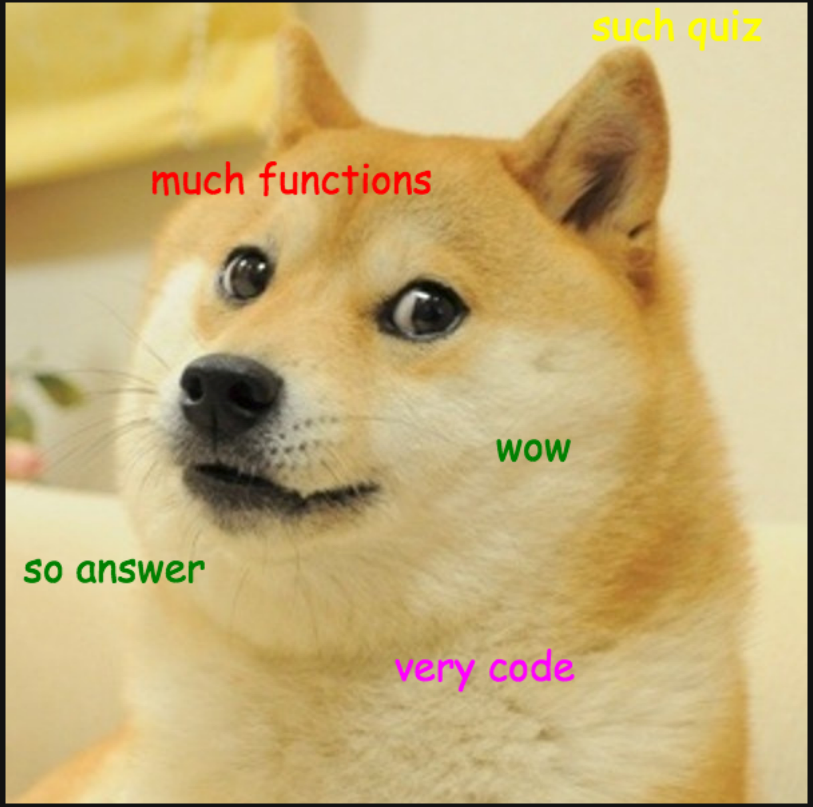


**States omitted from the graph due to having an installed capacity of 0 are the following:
Virginia, South Carolina, Mississippi, Louisiana, Kentucky, Georgia, Florida, Arkansas, and Alabama

Quiz 5

Instructions will be posted in the #class channel on slack

10:00



License

These slides were modified from Florencia D'Andrea's RLadies Shiny Meetup Slides

New libraries to install

```r
install.packages('shiny')
install.packages('shinyWidgets')
install.packages('rsconnect')
```

Interactive Webapps in R

Check out the Shiny Gallery

Week 13: *Shiny Apps*

1. Anatomy of a Shiny App

2. User Interface

3. Server

Intermission

4. Extras

5. Deploying your App

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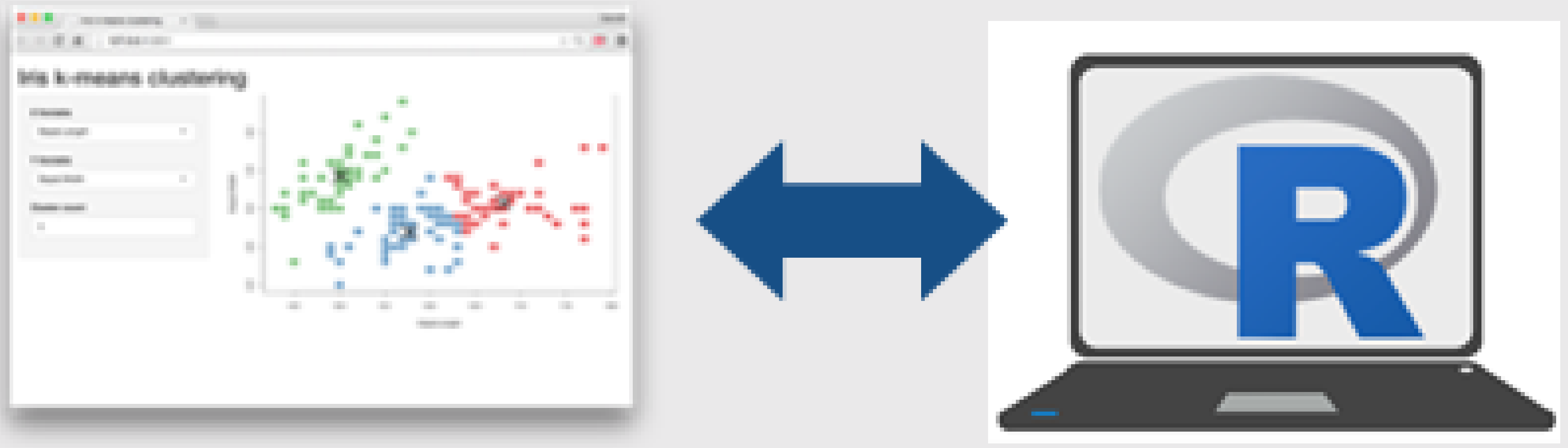
Anatomy of a Shiny App

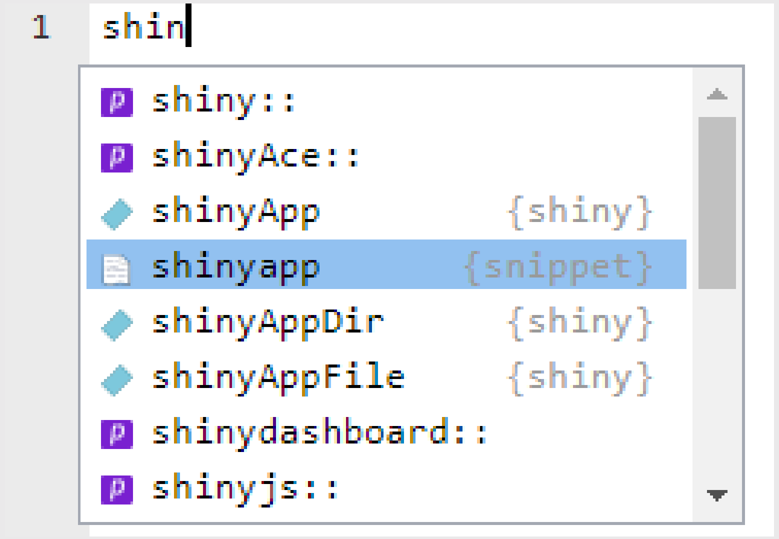
A Shiny app is a web page (UI) connected to a computer running a live R session (Server)



app.R

You can insert all the code at once with the shinyapp snippet!

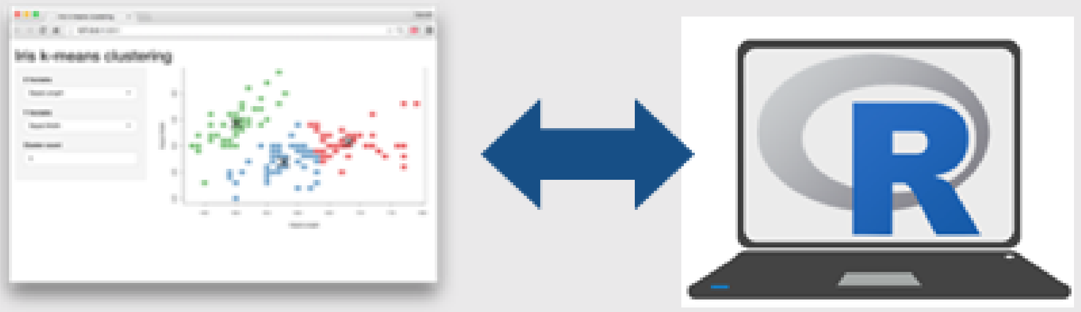
Just start typing `shiny`...



```
shin
```

```r
library(shiny)

ui <- fluidPage(

)

server <- function(input, output, session) {

}

shinyApp(ui, server)
```

Building a shiny app



`ui`

1. Pick a layout function

2. Add inputs widgets

3. Add `*Output()` functions

`server`

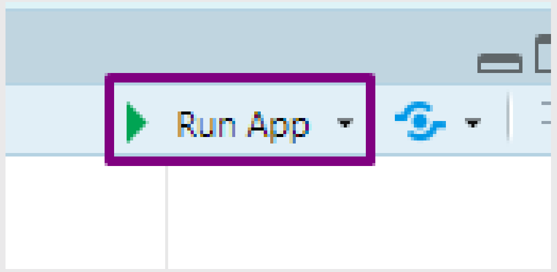
1. Use `render*()` functions to make outputs

2. Link outputs with `output$<id>`

3. Link inputs with `input$<id>`

Run the app 🎬

- **Option 1**: Click the "Run App" button in the toolbar:



- **Option 2**: Use a keyboard shortcut: Cmd/Ctrl + Shift + Enter.

- **Option 3**: `shiny::runApp()` with the path to the **app.R** file.

Your Turn

`hello_shiny.app`

File → New File → Shiny Web App...

```r
library(shiny)

# Define UI for application that draws a histogram
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")
        )
    )
)

# 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)
```

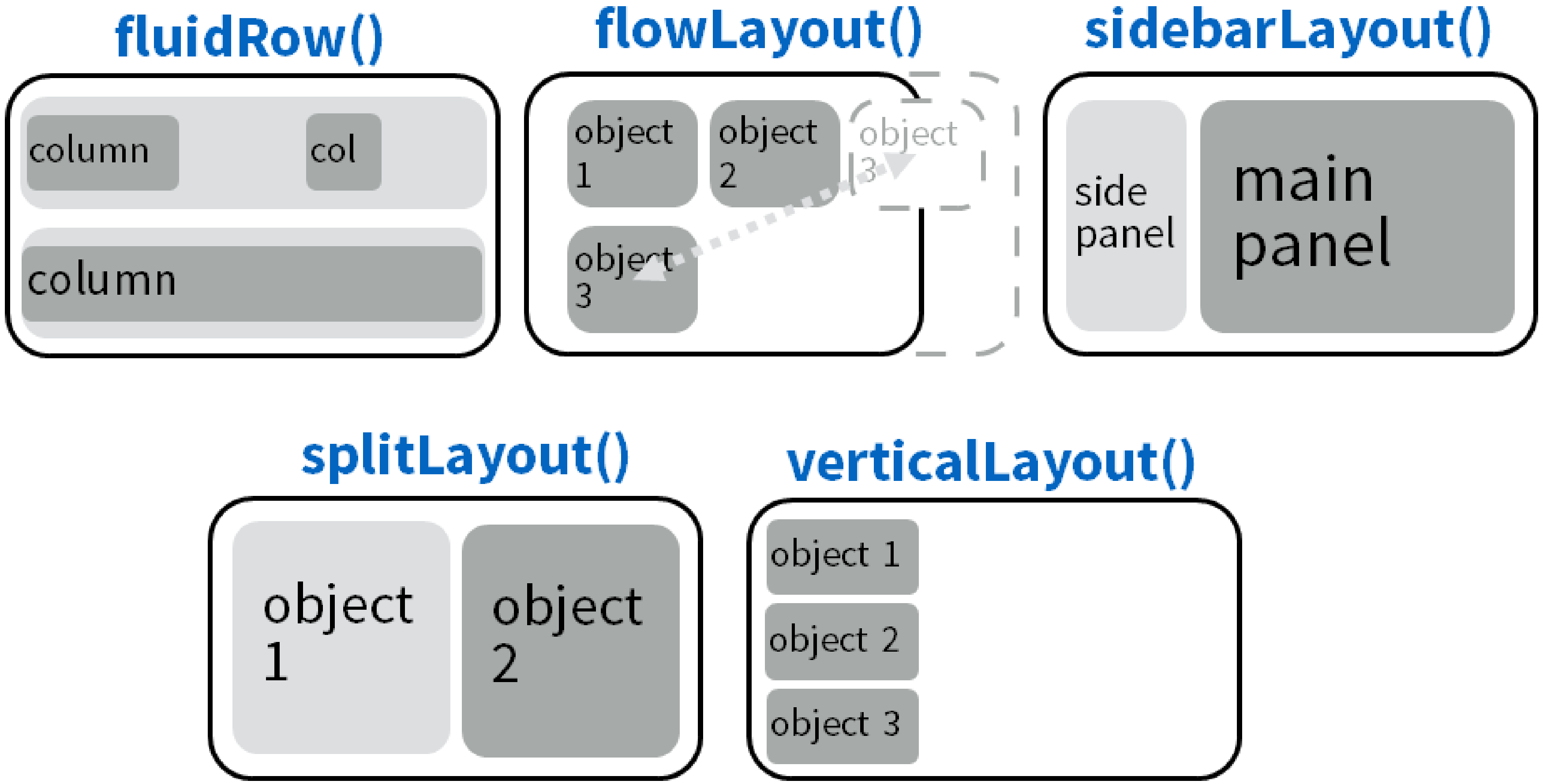
Week 13: *Shiny Apps*

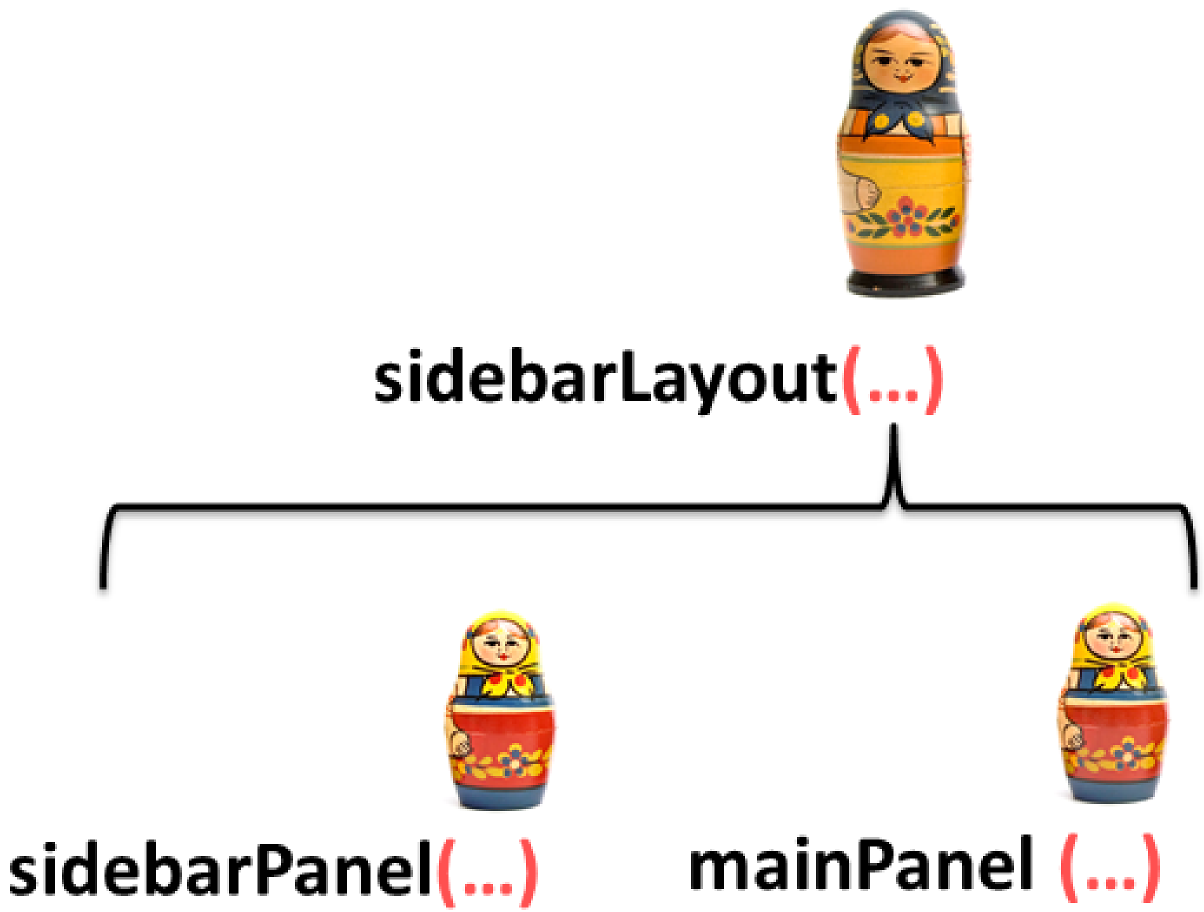
User Interface (UI)

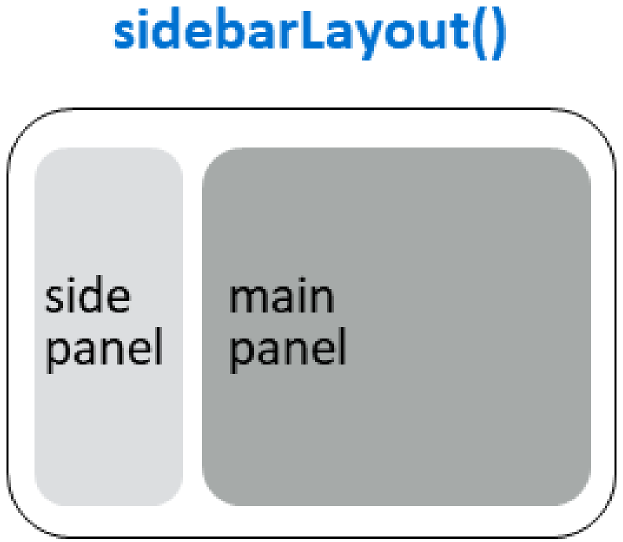
Matryoshka Dolls

Organize panels and elements into a layout with a **layout function**

Top level is usually `fluidPage()`

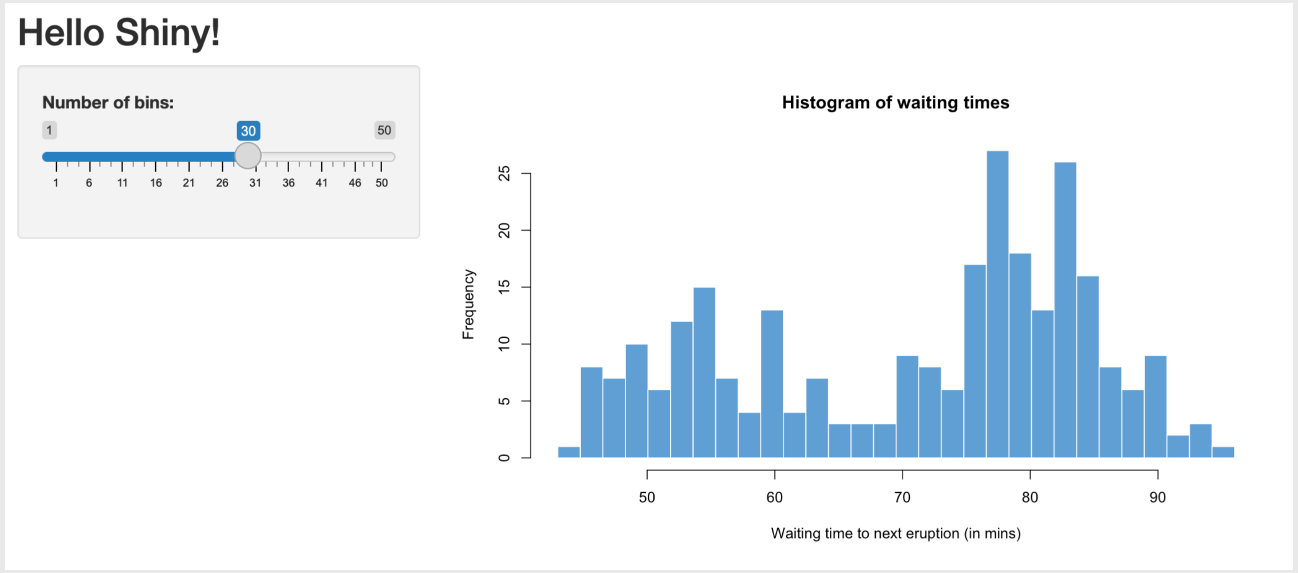



sidebarLayout(...)
sidebarPanel(...)
mainPanel (...)


sidebarLayout()
side panel
main panel

sidebarLayout()

```
ui <- fluidPage(

  titlePanel("Hello Shiny!"),

  sidebarLayout(

    sidebarPanel(
      sliderInput(
        "bins", label = "Number of
        min = 1, value = 30, max =
      )
    ),

    mainPanel(
      plotOutput("distPlot")
    )
  )
)
```

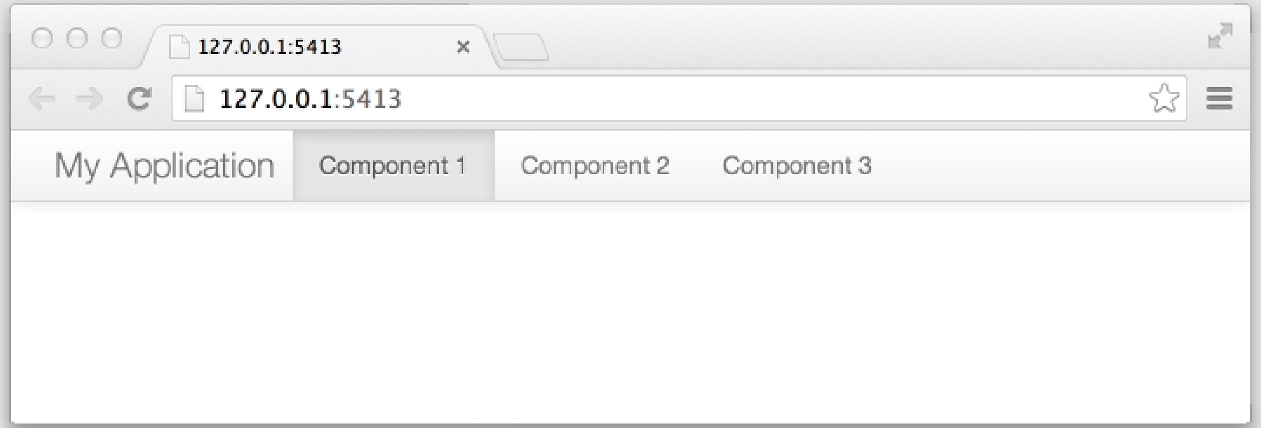

Hello Shiny!

Number of bins:

navbarPage(): An alternative to fluidPage()

Think of each tabPanel() as it's own fluidPage()

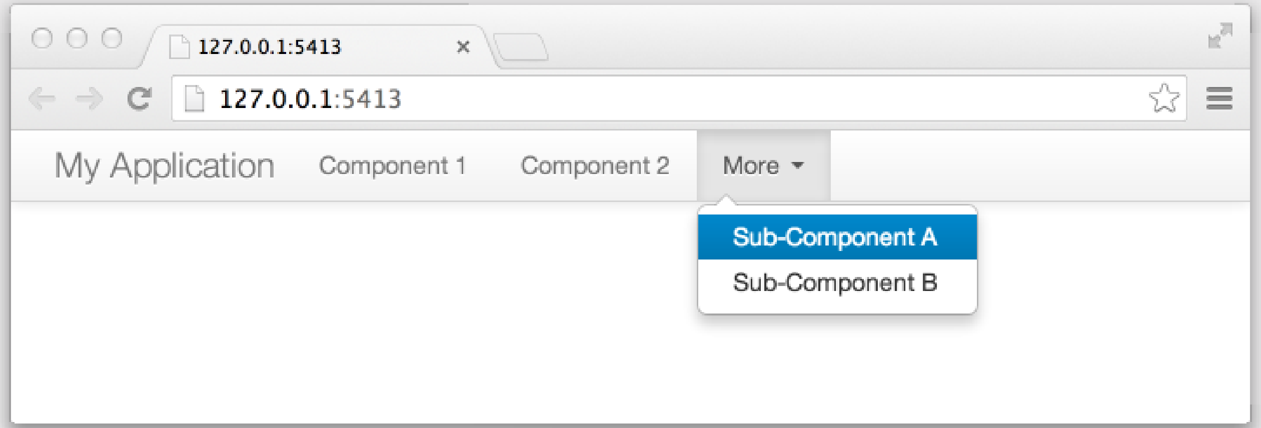
```
ui <- navbarPage("My Application",
  tabPanel("Component 1"),
  tabPanel("Component 2"),
  tabPanel("Component 3")
)
```



`navbarPage()`: An alternative to `fluidPage()`

Use `navbarMenu()` to create a nested menu item

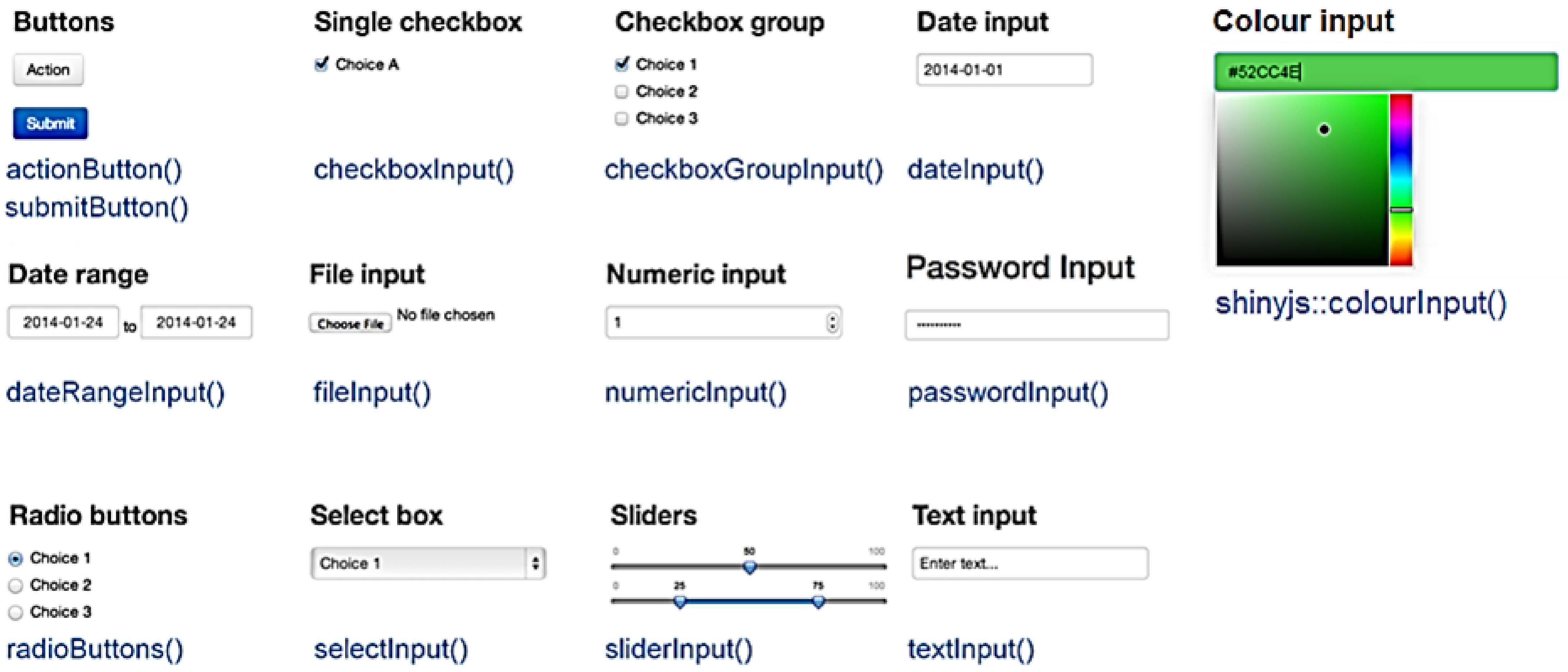
```
ui <- navbarPage("My Application",
  tabPanel("Component 1"),
  tabPanel("Component 2"),
  navbarMenu("More",
    tabPanel("Sub-Component A"),
    tabPanel("Sub-Component B"))
)
```



The UI defines the "what" and "where" for:

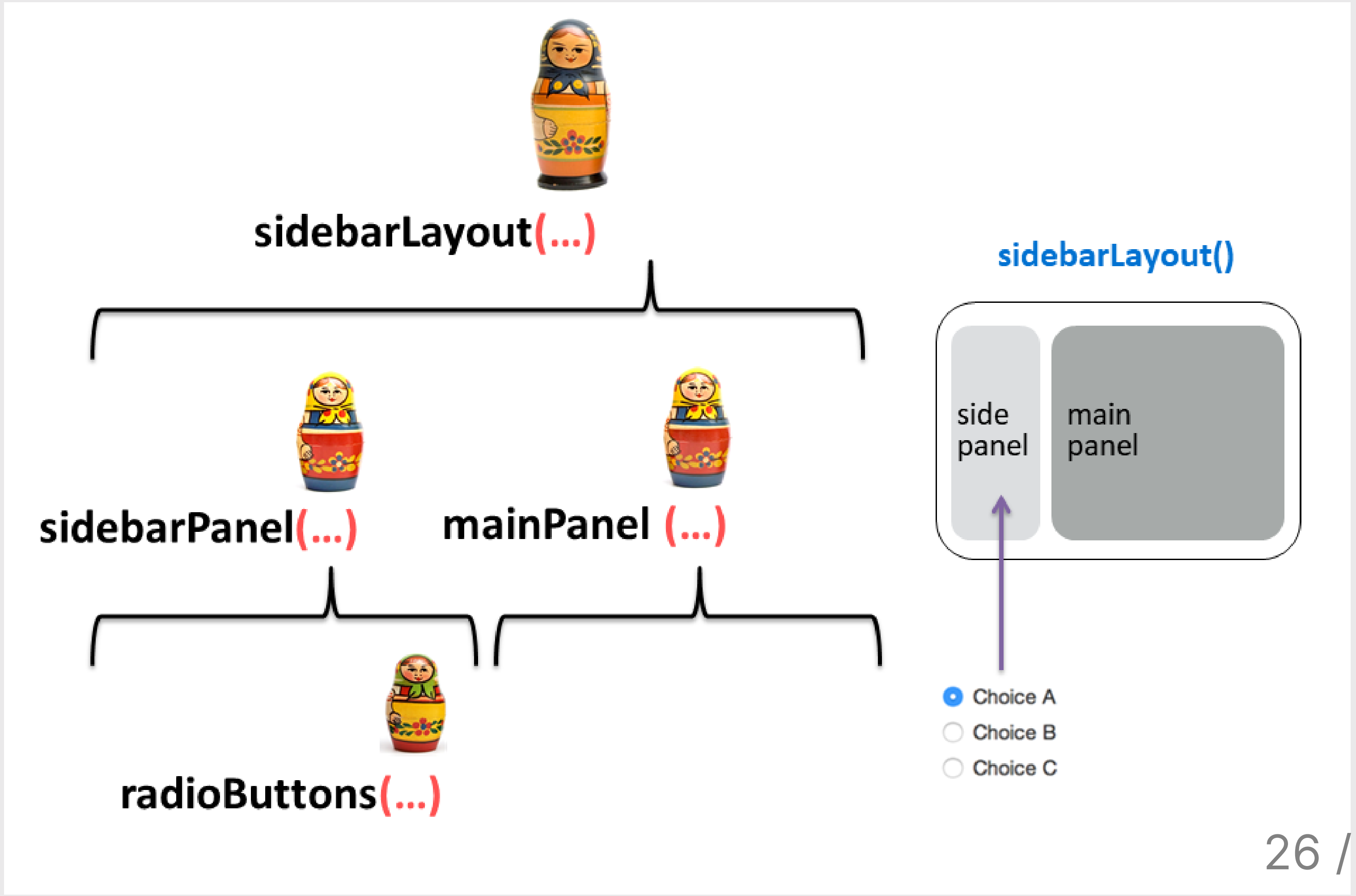
1. **Inputs**: collect values from the user
2. **Output**: display something to the user

Inputs: collect values from the user



Example Input: Radio buttons in the sidebar

```
ui <- fluidPage(
  sidebarLayout(
    sidebarPanel(
      radioButtons(…)
    ),
    mainPanel(…)
  )
)
```



Quick practice

Open the `widgets.R` app and click the "Run App" button

(((((((((( ))))))))))

```
    ) #mainPanel
  ) #sidebarLayout
) #fluidPage
```

Your Turn

10:00

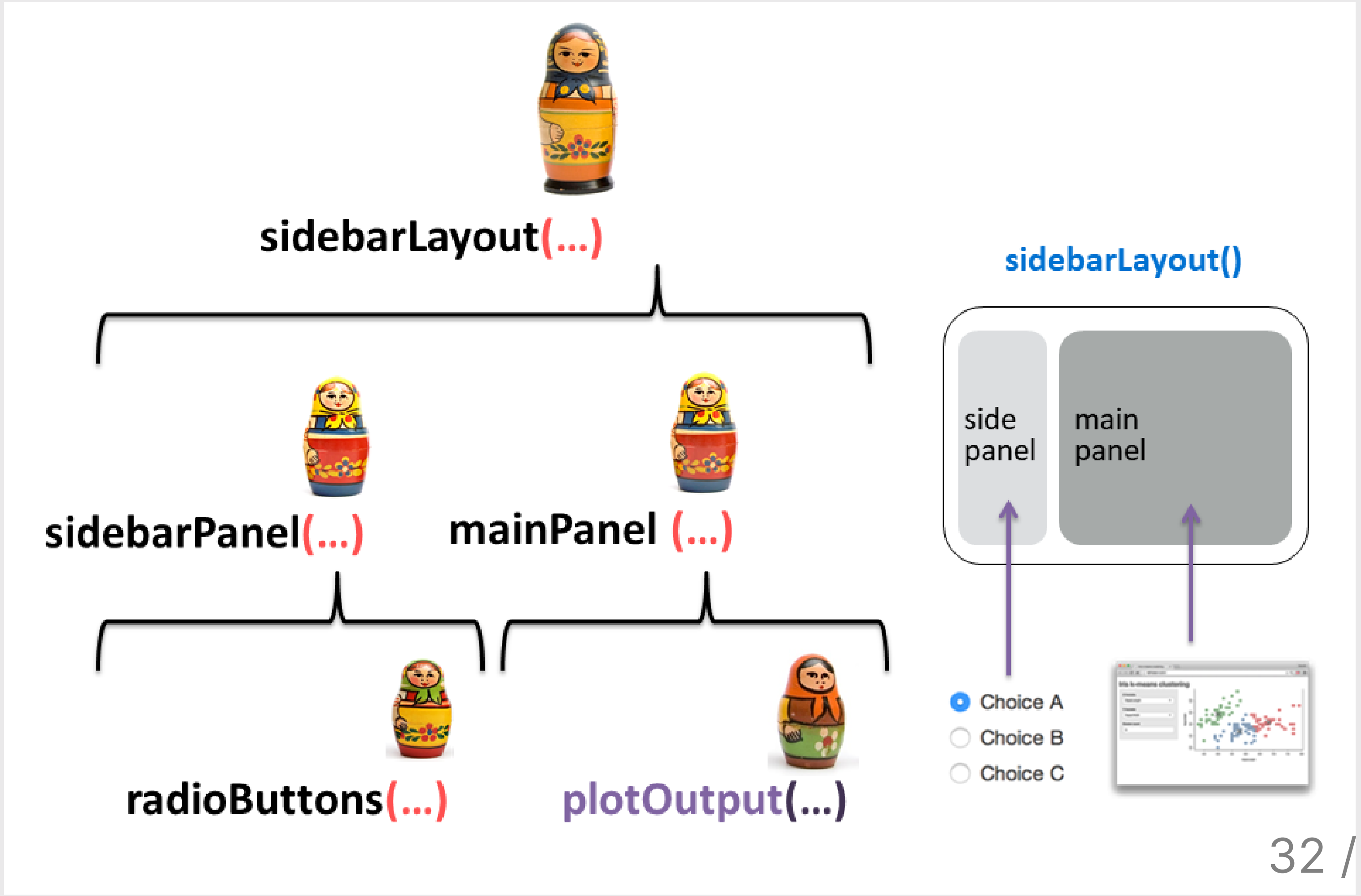
1. Open the `widgets.R` file.
2. Go to the Shiny Widgets Gallery and pick a new widget.
3. Look at the code for the widget and try to add that widget to the sidebar in the `widgets.R` file below all the other widgets.
4. Debug together! (ask each other questions)

The UI defines the "what" and "where" for:

1. **Inputs**: collect values from the user
2. **Output**: display something to the user

Example Output: Put a plot in the main panel

```
ui <- fluidPage(
  sidebarLayout(
    sidebarPanel(
      radioButtons(…)
    ),
    mainPanel(
      plotOutput(…)
    )
  )
)
```



Output: display something to the user

Output function	Description
`plotOutput()`	Display a reactive *plot*
`dataTableOutput()`	Display a `DT::datatable()`
`textOutput()`	Display reactive *text*
`imageOutput()`	Display an image

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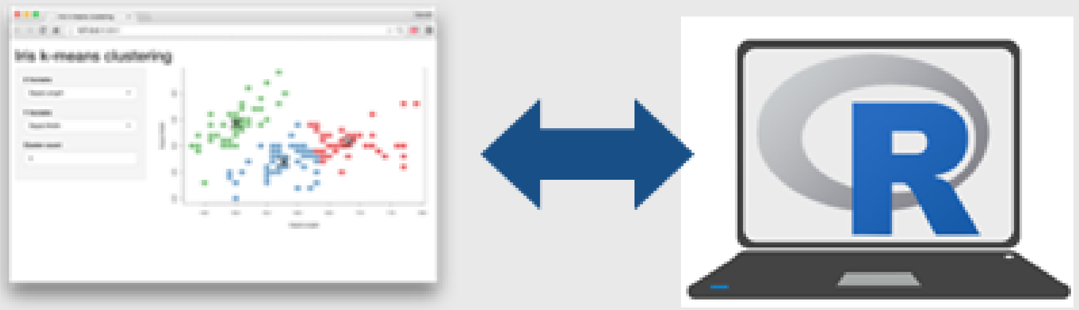
Building a shiny app



`ui`

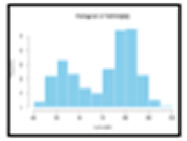
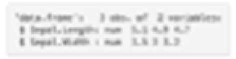
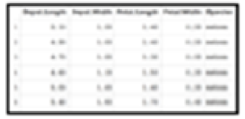
1. Pick a layout function, e.g. `sidebarLayout()`
2. Add inputs widgets
3. Add `*Output()` functions

`server`

1. Use `render*()` functions to make outputs
2. Link outputs with `output$<id>`
3. Link inputs with `input$<id>`

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

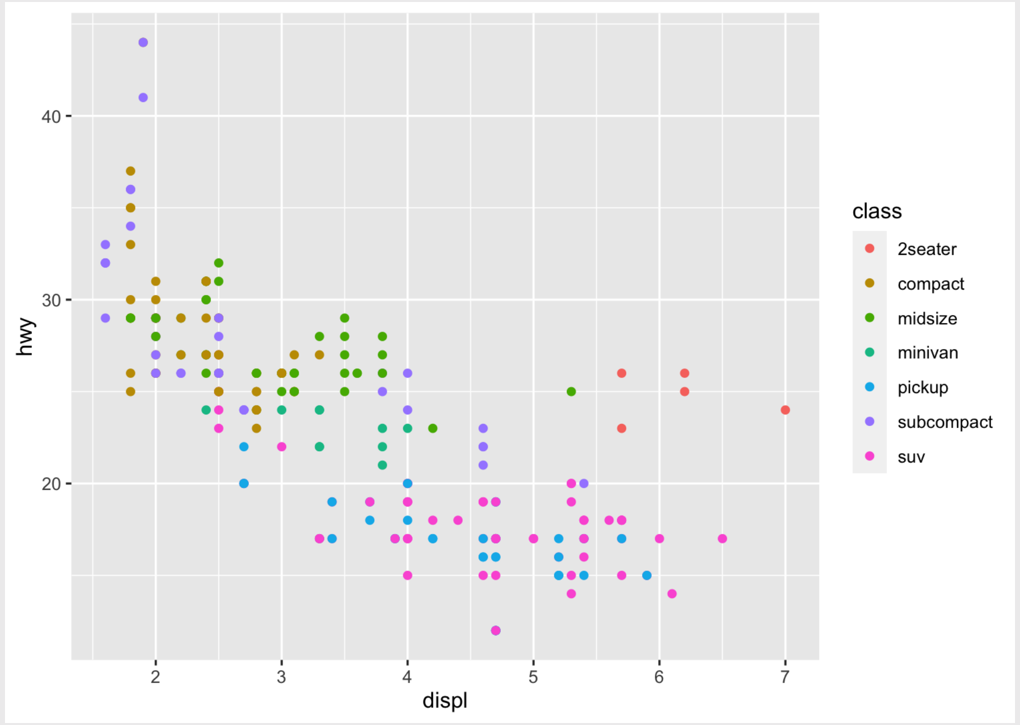
works with

	DT::renderDataTable(expr, options, callback, escape, env, quoted)	dataTableOutput(outputId, icon, ...)
	renderImage(expr, env, quoted, deleteFile)	imageOutput(outputId, width, height, click, dblclick, hover, hoverDelay, hoverDelayType, brush, clickId, hoverId, inline)
	renderPlot(expr, width, height, res, ..., env, quoted, func)	plotOutput(outputId, width, height, click, dblclick, hover, hoverDelay, hoverDelayType, brush, clickId, hoverId, inline)
	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, ...)

Using `renderPlot()`: make a plot

```r
library(ggplot2)

ggplot(mpg) +
  geom_point(
    aes(x = displ, y = hwy, color = class))
```



Link plot to output with `output$<id>`

`ui`

```r
ui <- fluidPage(
  sidebarLayout(
    sidebarPanel(
      radioButtons(…)
    ),
    mainPanel(
      plotOutput(
        outputId = "mpg_plot"
      )
    )
  )
)
```

`server`

```r
server <- function(input, output, session) {
  output$mpg_plot <- renderPlot({
    ggplot(mpg) +
      geom_point(
        aes(x = displ, y = hwy, color = class))
  })
}
```

Link user inputs to plot with `input$<id>`

`ui`

```r
ui <- fluidPage(
  sidebarLayout(
    sidebarPanel(
      radioButtons(
        inputId = "xvar",
        label = "Select the x-axis variable:",
        selected = "displ",
        choices = c(
          "Highway miles per gallon" = "hwy",
          "City miles per gallon" = "cty",
          "Engine displacement, in litres" = "displ")
      ),
    ),
    mainPanel(
      plotOutput(
        outputId = "mpg_plot"
      )
    )
  )
)
```

`server`

```r
server <- function(input, output, session) {
  output$mpg_plot <- renderPlot({
    ggplot(mpg) +
      geom_point(
        aes_string(
          x = input$xvar,
          y = "hwy",
          color = "class"))
  })
}
```

Note: I switched the ggplot code from `aes()` to `aes_string()`

Quick practice

Open the `mpg.R` app and click the "Run App" button

Your Turn

10:00

1. Open the `caseConverter.R` file.
2. In the `server`: Write code in the provided `renderText()` to convert the input text to lower case.
3. Run the app and test that it's working.
4. In the `ui` main panel: Add two more `textOutput()` functions for also displaying the input text in "upper" case and "title" case.
5. In the `server`: Define two more outputs to convert the input text to "upper" case and "title" case.

Intermission

05:00

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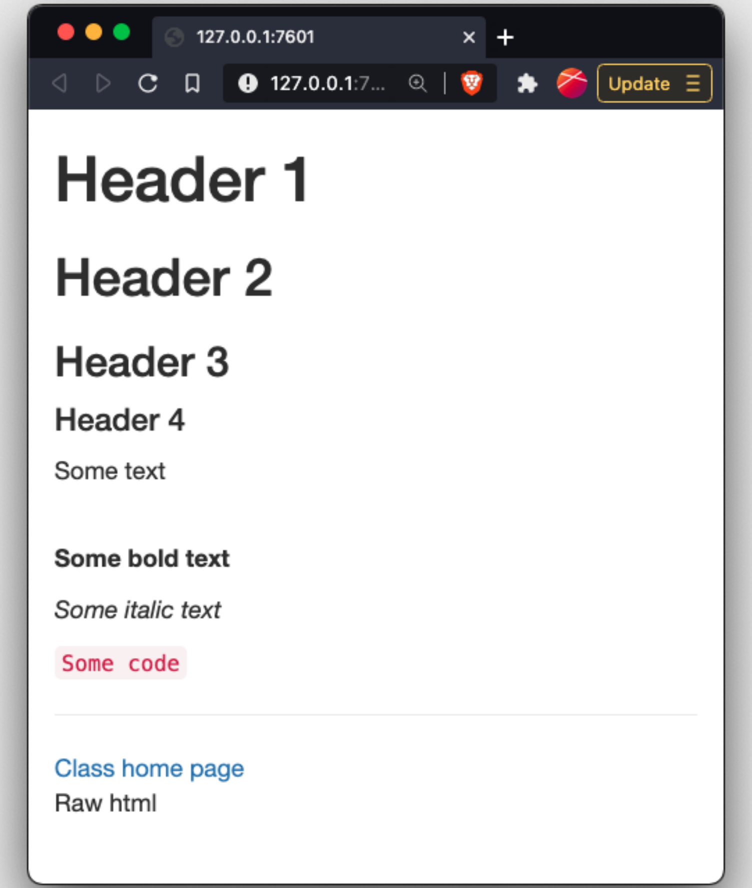
Use html functions to add text

See example in `html.R` app

```
ui <- fluidPage(
  h1("Header 1"),
  h2("Header 2"),
  h3("Header 3"),
  h4("Header 4"),
  p("Some text"),
  br(),
  p(strong("Some bold text")),
  p(em("Some italic text")),
  p(code("Some code")),
  hr(),
  a(href="https://eda.seas.gwu.edu/2022-Fall/",
    "Class home page"),
  HTML("<p>Raw html</p>")
)
```



Header 1

Header 2

Header 3

Header 4

Some text

Some bold text

Some italic text

`Some code`

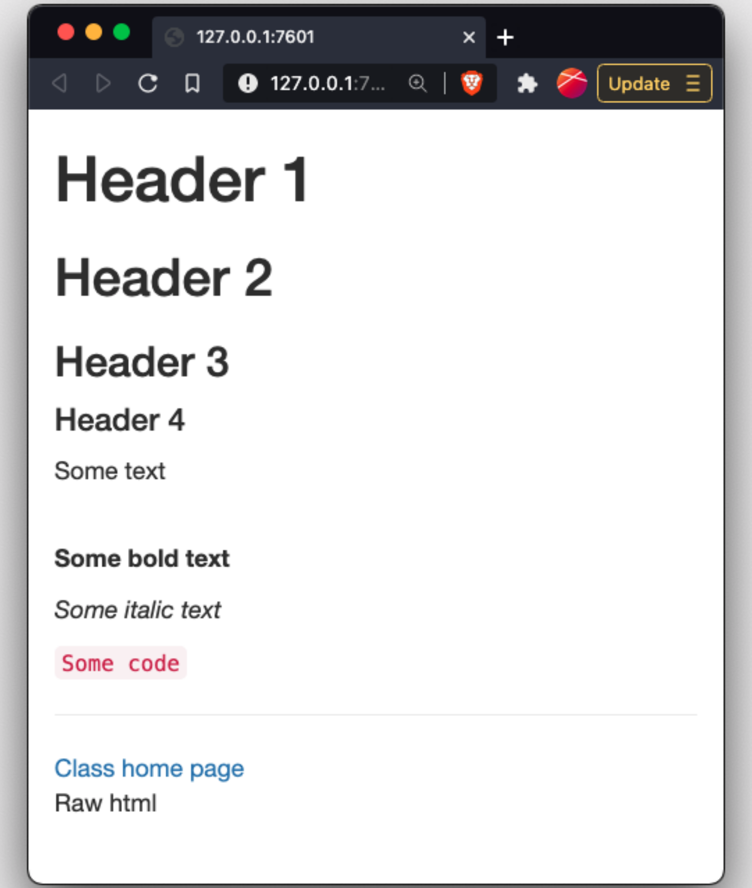
Class home page

Raw html

Can also just use plain markdown

See example in `markdown.R` app

```
ui <- fluidPage(
  markdown("
  # Header 1
  ## Header 2
  ### Header 3
  #### Header 4
  Some text
  **Some bold text**
  _Some italic text_
  `Some code`
  [Class home page](https://eda.seas.gwu.edu/2022-Fa
  ")
)
```



Header 1

Header 2

Header 3

Header 4

Some text

Some bold text

Some italic text

`Some code`

Class home page
Raw html

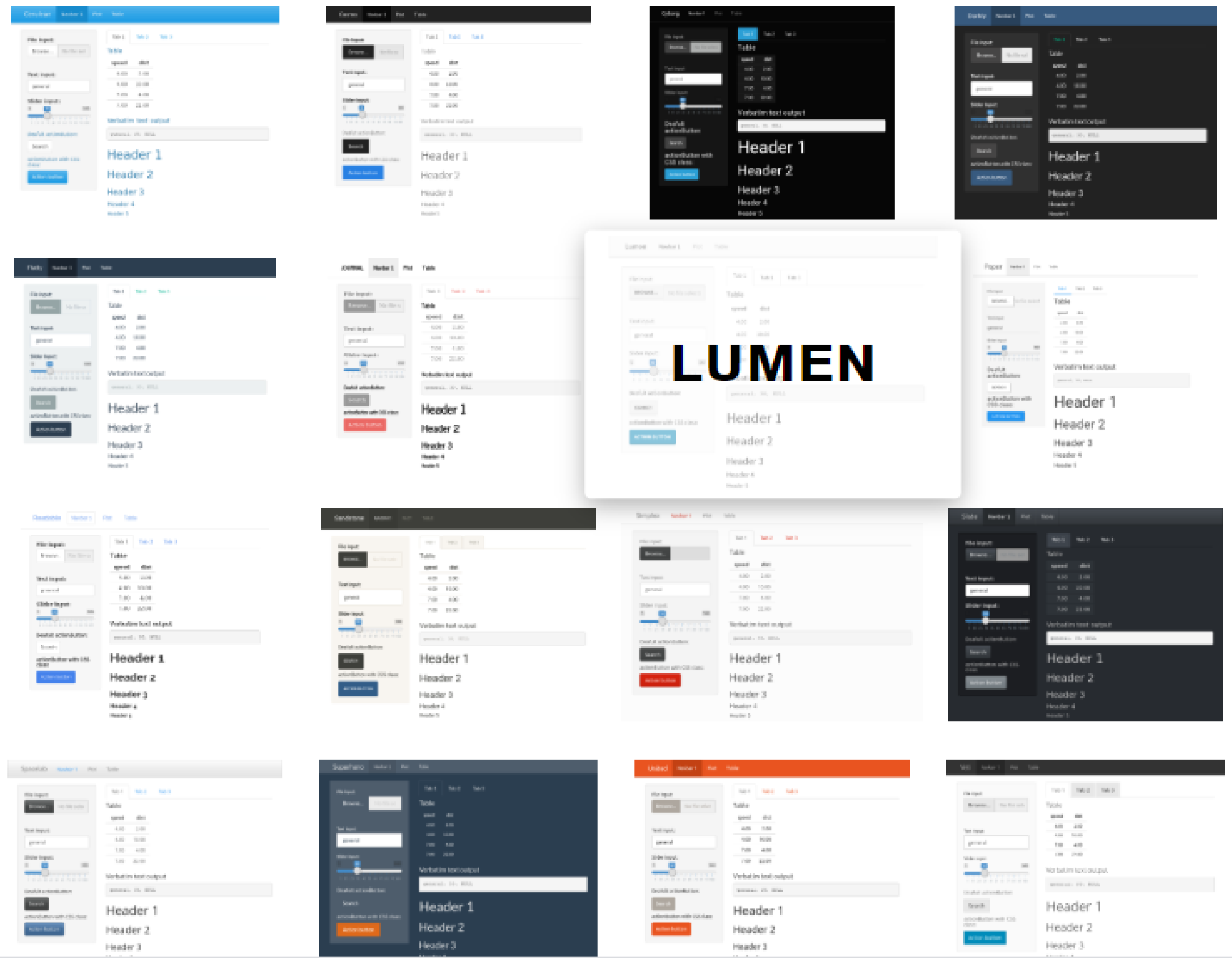
Quick practice

02:00

Open your `caseConverter.R` app and add html functions or markdown to add the following:

- Give the app a title by inserting a level 1 header in the `fluidPage()` function and before the `sidebarLayout()` function.
- In the main `ui` panel, add a short description of what the app does.

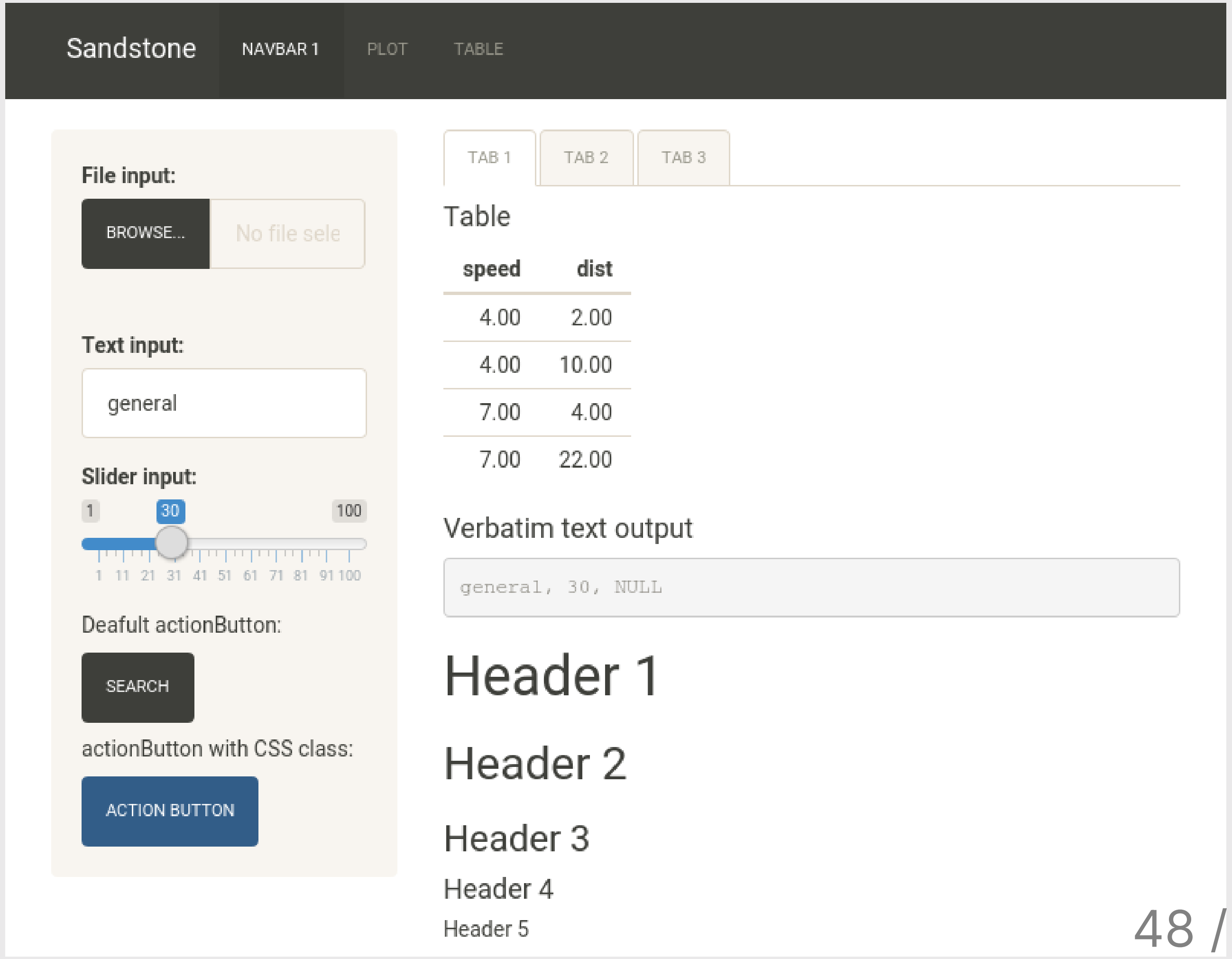
Add a theme with "shinythemes" package



Insert theme at top of main ui layout function

```r
library(shinythemes)

ui <- fluidPage(
  theme = shinytheme("sandstone"),
  sidebarLayout(
    sidebarPanel(
      <insert widgets>
    ),
    mainPanel(
      <insert outputs>
    )
  )
)
```



Table

speed	dist
4.00	2.00
4.00	10.00
7.00	4.00
7.00	22.00

Verbatim text output

```
general, 30, NULL
```

Header 1

Header 2

Header 3

Header 4

Header 5

Fancier widgets with "shinyWidgets" package

Open the `shinyWidgets.R` app and click the "Run App" button

Common shiny situations

- Filtering for a single category: `federalSpending.R`

- Filtering for multiple categories: `federalSpendingCompare.R`

Filtering for a single category: `federalSpending.R`

```r
ui <- fluidPage(

  h1("Federal R&D Spending by Department"),

  sidebarLayout(

    sidebarPanel(
      selectInput(
        inputId = "department",
        label = "Choose a department:",
        selected = "DOD",
        choices = c(...)
    ),

    mainPanel(
      plotOutput("spendingPlot")
    )
  )
)
```

```r
server <- function(input, output){
  output$spendingPlot <- renderPlot({

    # Filter out the data based on the user input
    data <- federal_spending %>%
      filter(department == input$department)

    ggplot(data) +
      geom_col(
        aes(x = year, y = rd_budget),
        fill = "steelblue", width = 0.7, alpha = 0.
      scale_y_continuous(
        labels = scales::dollar,
        expand = expansion(mult = c(0, 0.05))) +
      theme_half_open(font_size = 18) +
      labs(
        x = "Year",
        y = "$USD Millions",
        title = paste("Federal R&D Spending"))

  })
}
```

Filtering for multiple categories: `federalSpendingCompare.R`

```r
ui <- fluidPage(

  h1("Federal R&D Spending by Department"),

  sidebarLayout(

    sidebarPanel(
      selectInput(
        inputId = "department",
        label = "Choose a department:",
        selected = "DOD",
        multiple = TRUE,
        choices = c(...)
    ),

    mainPanel(
      plotOutput("spendingPlot")
    )
  )
)
```

```r
server <- function(input, output){
  output$spendingPlot <- renderPlot({

    # Filter out the data based on the user input
    data <- federal_spending %>%
      filter(department %in% input$department)

    ggplot(data) +
      geom_col(
        aes(x = year, y = rd_budget),
        fill = "steelblue", width = 0.7, alpha = 0.
      facet_wrap(~department) +
      scale_y_continuous(
        labels = scales::dollar,
        expand = expansion(mult = c(0, 0.05))) +
      theme_half_open(font_size = 18) +
      labs(
        x = "Year",
        y = "$USD Millions",
        title = paste("Federal R&D Spending"))

  })
}
```

If you really want to get good at this:

1. Print out this Cheatsheet
2. Watch this 2.5 Hour Comprehensive RStudio Tutorial
3. Use this reference manual: Mastering Shiny

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You can deploy an app for free on shinyapps.io

Follow the RStudio guide

1. Create a shinyapps.io account
2. Open your tokens, click "Show", copy the code
3. Run the code in RStudio
4. Deploy your app:

```r
library(rsconnect)
deployApp()
```

Your Turn

15:00

1. Open the `internetUsers.R` file.
2. Modify the server code so that the inputs control the plot.
3. Deploy your app to shinyapps.io

Fill out course evals: https://gwu.smartevals.com/

(please be specific!)