Week 13: *Interactivity*

EMSE 4572 / 6572: Exploratory Data Analysis

John Paul Helveston

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Week 13: *Interactivity*

1. Interactive charts with plotly
2. Interactive tables

Intermission

3. Shiny apps
4. Shiny extras

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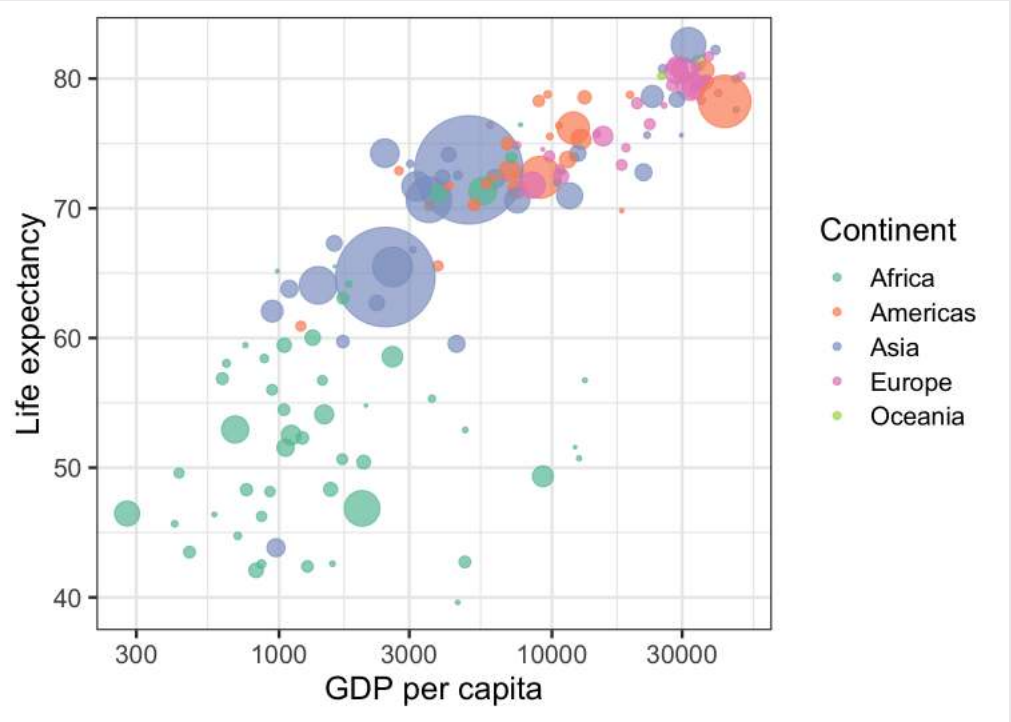
Plotly uses JavaScript to create interactive charts

But you don't have to know JavaScript to use it! 🎉

Turn any ggplot into an interactive chart with `ggplotly()`

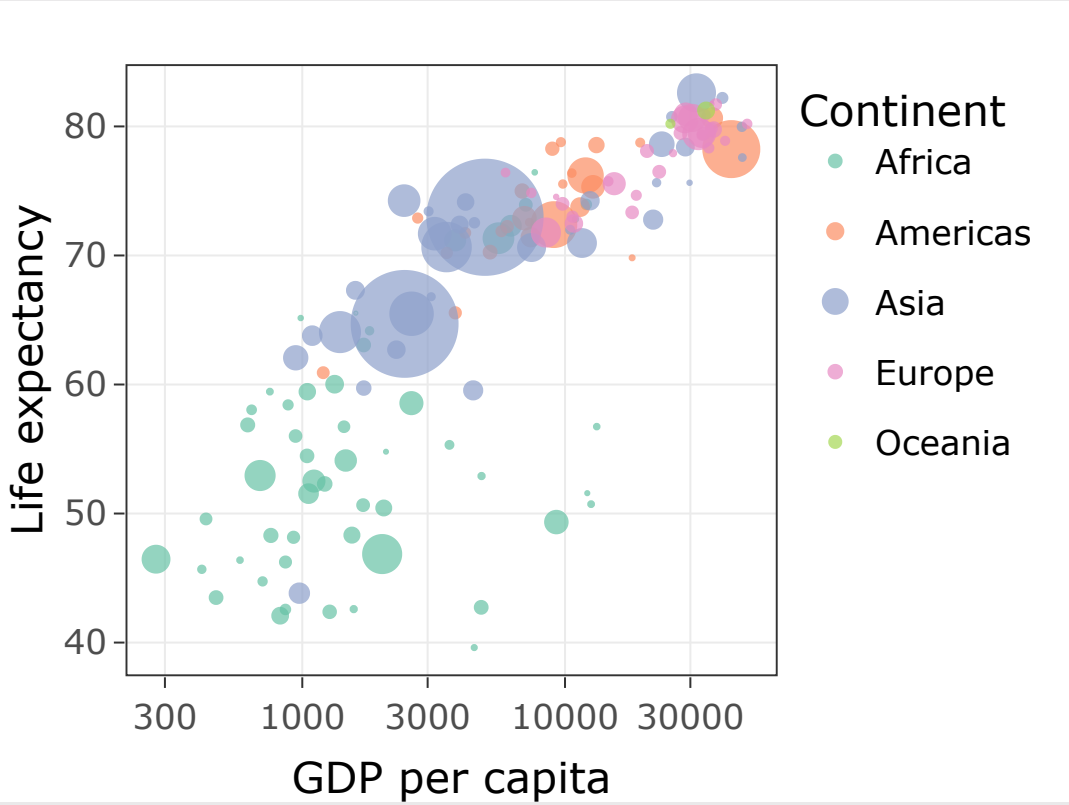
```
plot <- gapminder %>%
  filter(year == 2007) %>%
  ggplot(aes(x = gdpPercap, y = lifeExp,
             size = pop, color = continent,
             label = country)) +
  geom_point(alpha = 0.7) +
  scale_color_brewer(palette = 'Set2') +
  scale_size_area(
    guide = FALSE, max_size = 25) +
  scale_x_log10() +
  theme_bw(base_size = 16) +
  labs(x = 'GDP per capita',
       y = 'Life expectancy',
       color = 'Continent')

plot
```



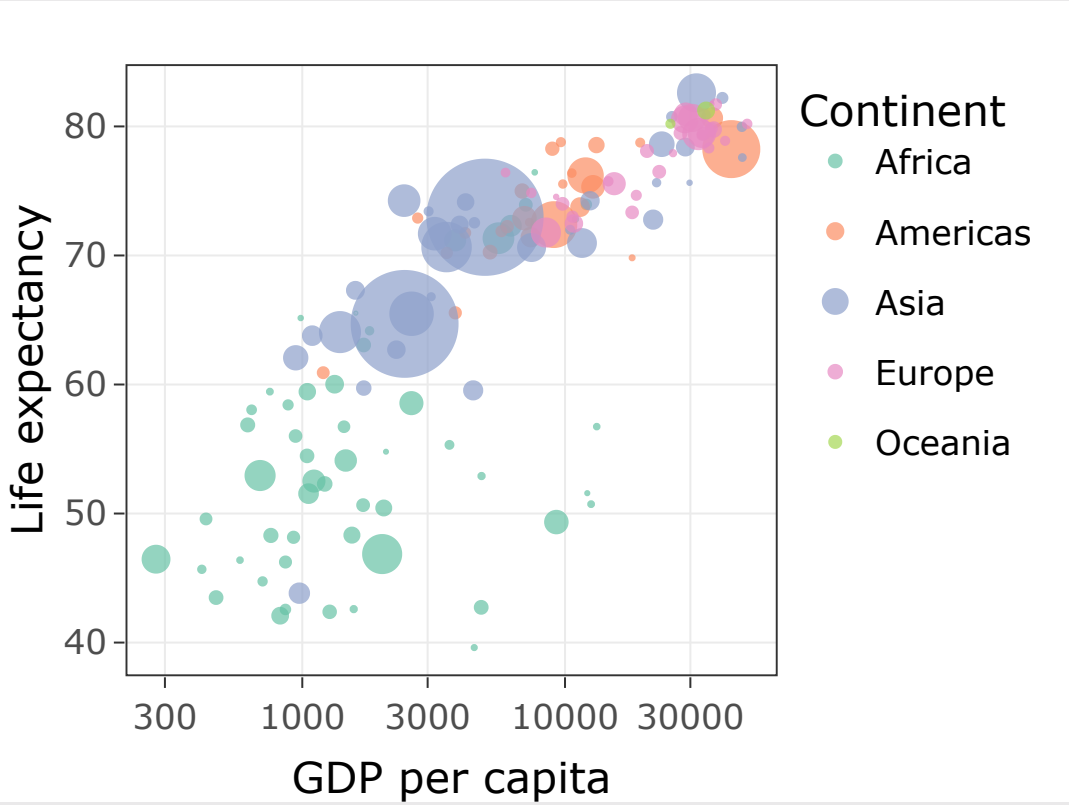
Turn any ggplot into an interactive chart with `ggplotly()`

```
ggplotly(plot)
```



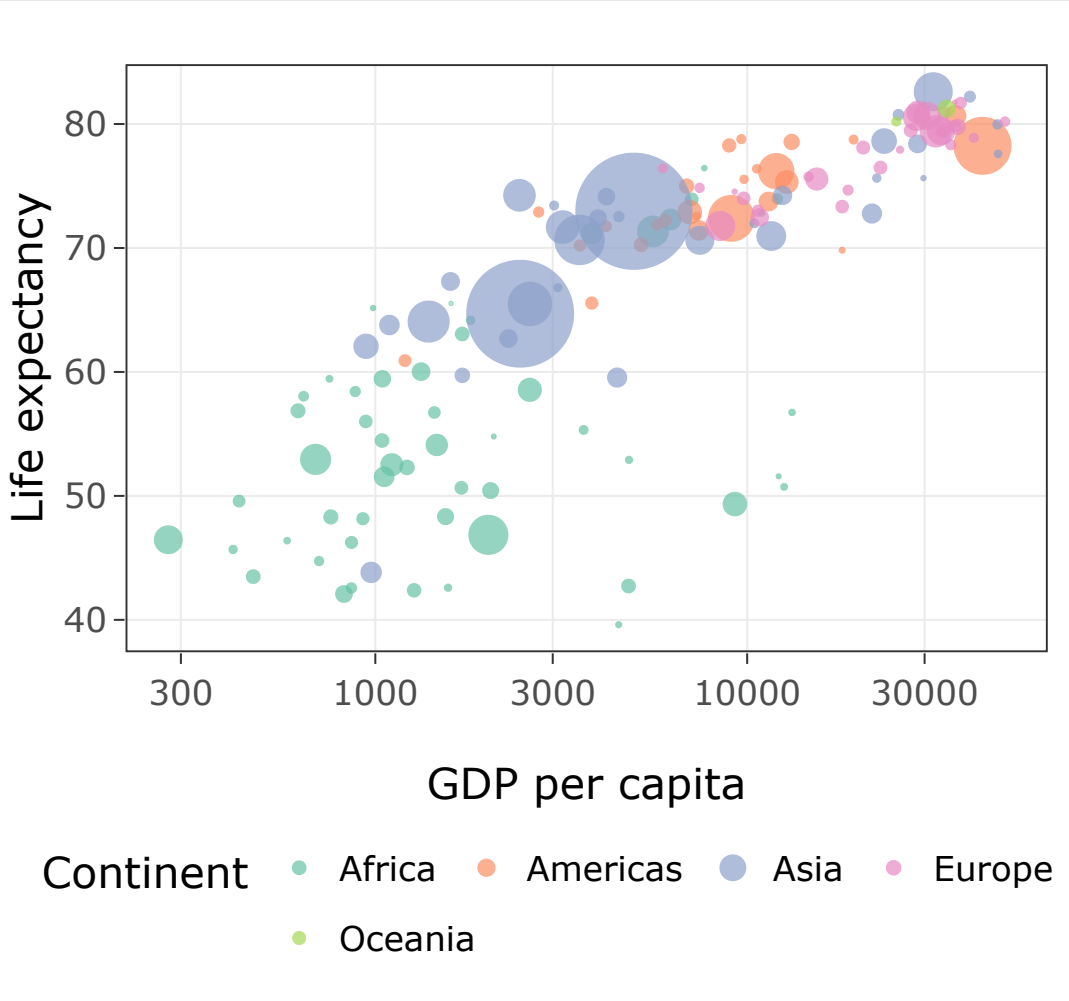
Modify the data shown with `tooltip` argument

```
ggplotly(
  plot,
  tooltip = c("country", "pop")
)
```



Modify other features by piping on `plotly` functions

```
ggplotly(
  plot,
  tooltip = c("country", "pop")
) %>%
  layout(legend = list(
    orientation = "h", x = 0, y = -0.3))
```

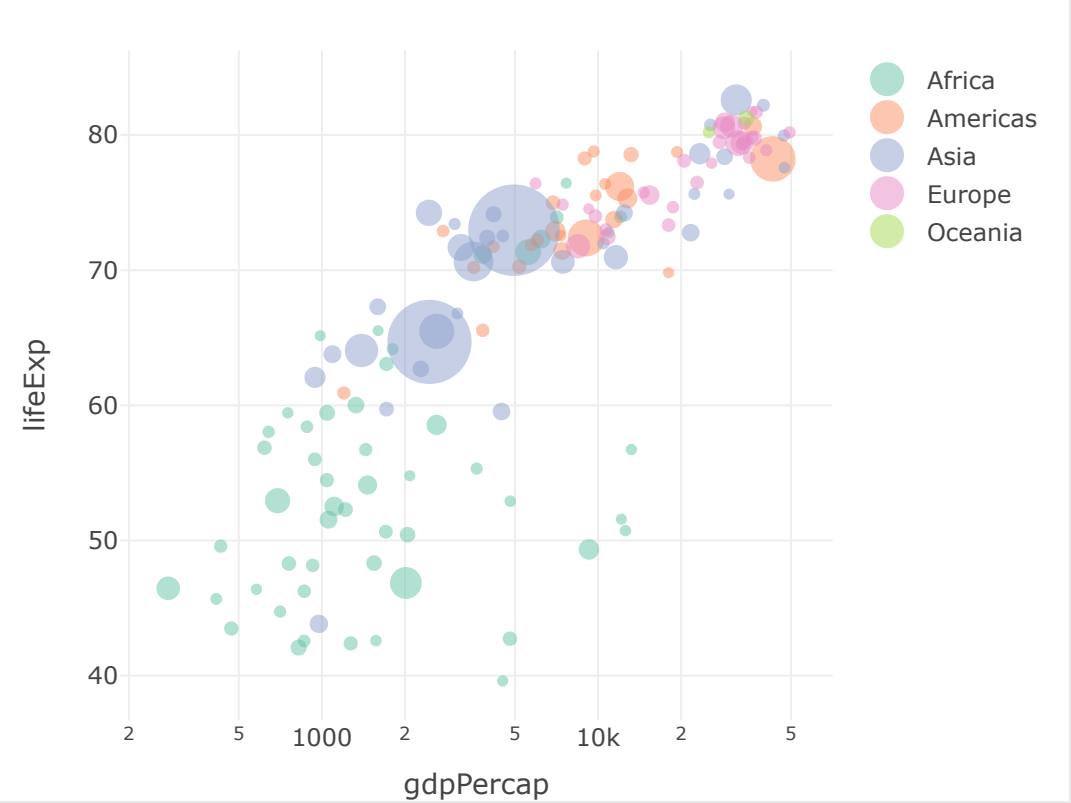


Reference guide: https://plotly.com/ggplot2/

Make interactive charts with `plot_ly()`

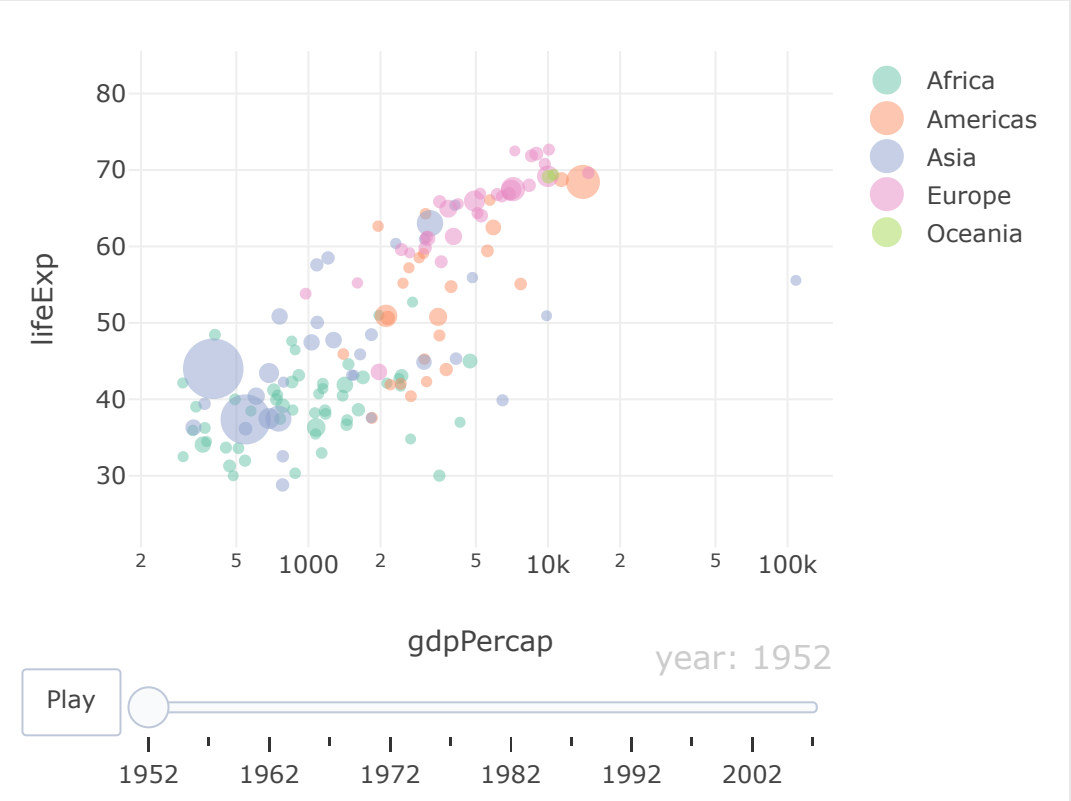
(More examples here: https://plotly.com/r/)

```
plot_ly(
  data = gapminder %>% filter(year == 2007),
  type = 'scatter',
  x = ~gdpPercap,
  y = ~lifeExp,
  size = ~pop,
  color = ~continent,
  text = ~country,
  mode = "markers",
  sizes = c(10, 1000),
  marker = list(opacity = 0.5),
  hoverinfo = "text"
  ) %>%
  layout(xaxis = list(type = "log"))
```



Animation is relatively easy with `plot_ly()`

```r
plot_ly(
  data = gapminder,
  type = 'scatter',
  x = ~gdpPercap,
  y = ~lifeExp,
  size = ~pop,
  color = ~continent,
  text = ~country,
  frame = ~year,
  mode = "markers",
  sizes = c(10, 1000),
  marker = list(opacity = 0.5),
  hoverinfo = "text"
  ) %>%
  layout(xaxis = list(type = "log"))
```



Save as html page

```
htmlwidgets::saveWidget(
  ggplotly(plot),
  file = here::here('figs', 'gapminder.html')
)
```

Insert using iframe

```
htmltools::tags$iframe(
  src         = here::here('figs', 'gapminder.html'),
  width       = "100%",
  height      = "400",
  scrolling   = "no",
  seamless    = "seamless",
  frameBorder = "0"
)
```

One more option: https://g2r.opifex.org/index.html

Your Turn: Interactive Charts

10:00

1. Open your reflection from this past week (or a previous week)
2. With a classmate, take turns sharing your interactive chart, or go back to a chart we made in a previous class and make it interactive using either `ggplotly()` or `plot_ly()`
3. If you have an example you want to share, post your code in Slack

Week 13: *Interactivity*

1. Interactive charts with plotly
2. Interactive tables

Intermission

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4. Shiny extras

Make pretty static tables with `kable()`

```r
library(knitr)

gapminder %>%
  kable()
```

country	continent	year	lifeExp	pop	gdpPercap
Afghanistan	Asia	1952	28.80100	8425333	779.4453
Afghanistan	Asia	1957	30.33200	9240934	820.8530
Afghanistan	Asia	1962	31.99700	10267083	853.1007
Afghanistan	Asia	1967	34.02000	11537966	836.1971
Afghanistan	Asia	1972	36.08800	13079460	739.9811
Afghanistan	Asia	1977	38.43800	14880372	786.1134
Afghanistan	Asia	1982	39.85400	12881816	978.0114
Afghanistan	Asia	1987	40.82200	13867957	852.3959
Afghanistan	Asia	1992	41.67400	16317921	649.3414
Afghanistan	Asia	1997	41.76300	22227415	635.3414
Afghanistan	Asia	2002	42.12900	25268405	726.7341

Behind the scenes:

`kable()` generates the code to make a pretty table

```
gapminder %>%
  kable(format = "pipe")
```

|country |continent | year| lifeExp| pop| gdpPercap| |:----------|:---------|----:|--------:|----------:|----------:| |Afghanistan |Asia | 1952| 28.80100| 8425333| 779.4453| |Afghanistan |Asia | 1957| 30.33200| 9240934| 820.8530| |Afghanistan |Asia | 1962| 31.99700| 10267083| 853.1007| |Afghanistan |Asia | 1967| 34.02000| 11537966| 836.1971| |Afghanistan |Asia | 1972| 36.08800| 13079460| 739.9811| |Afghanistan |Asia | 1977| 38.43800| 14880372| 786.1134| |Afghanistan |Asia | 1982| 39.85400| 12881816| 978.0114| |Afghanistan |Asia | 1987| 40.82200| 13867957| 852.3959| |Afghanistan |Asia | 1992| 41.67400| 16317921| 649.3414| |Afghanistan |Asia | 1997| 41.76300| 22227415| 635.3414| |Afghanistan |Asia | 2002| 42.12900| 25268405| 726.7341| |Afghanistan |Asia | 2007| 43.82800| 31889923| 974.5803| |Albania |Europe | 1952| 55.23000| 1282697| 1601.0561| |Albania |Europe | 1957| 59.28000| 1476505| 1942.2842| |Albania |Europe | 1962| 64.82000| 1728137|

Behind the scenes:

`kable()` generates the code to make a pretty table

```
gapminder %>%
  kable(format = "html")
```

```
#> <table>
#>  <thead>
#>   <tr>
#>    <th style="text-align:left;"> country </th>
#>    <th style="text-align:left;"> continent </th>
#>    <th style="text-align:right;"> year </th>
#>    <th style="text-align:right;"> lifeExp </th>
#>    <th style="text-align:right;"> pop </th>
#>    <th style="text-align:right;"> gdpPercap </th>
#>   </tr>
#>  </thead>
#> <tbody>
#>   <tr>
#>    <td style="text-align:left;"> Afghanistan </td>
#>    <td style="text-align:left;"> Asia </td>
#>    <td style="text-align:right;"> 1952 </td>
```

Make *interactive* tables with:

`DT::datatable()`

Make *interactive* tables with `datatable()`

```
library(DT)

gapminder %>%
  datatable()
```

Show 10 entries Search:

	country	continent	year	lifeExp	pop
1	Afghanistan	Asia	1952	28.801	8425333
2	Afghanistan	Asia	1957	30.332	9240934
3	Afghanistan	Asia	1962	31.997	10267083
4	Afghanistan	Asia	1967	34.02	11537966
5	Afghanistan	Asia	1972	36.088	13079460
6	Afghanistan	Asia	1977	38.438	14880372
7	Afghanistan	Asia	1982	39.854	12881816
8	Afghanistan	Asia	1987	40.822	13867957
9	Afghanistan	Asia	1992	41.674	16317921
10	Afghanistan	Asia	1997	41.763	22227415

Showing 1 to 10 of 1,704 entries Previous 1 2 3 4 5 … 1

Make *interactive* tables with `datatable()`

```
gapminder %>%
  datatable(
    options = list(
      pageLength = 5,
      lengthMenu = c(5, 10, 15, 20
  )
```

Show 5 entries Search:

	country	continent	year	lifeExp	pop
1	Afghanistan	Asia	1952	28.801	8425333
2	Afghanistan	Asia	1957	30.332	9240934
3	Afghanistan	Asia	1962	31.997	10267083
4	Afghanistan	Asia	1967	34.02	11537966
5	Afghanistan	Asia	1972	36.088	13079460

Showing 1 to 5 of 1,704 entries Previous 1 2 3 4 5 … 34

Modify features by piping on functions

```
gapminder %>%
  datatable() %>%
  formatCurrency('gdpPercap') %>%
  formatStyle(
    'country',
    color = 'red',
    backgroundColor = 'black',
    fontWeight = 'bold')
```

Show 10 entries Search:

	country	continent	year	lifeExp	pop
1	Afghanistan	Asia	1952	28.801	8425333
2	Afghanistan	Asia	1957	30.332	9240934
3	Afghanistan	Asia	1962	31.997	10267083
4	Afghanistan	Asia	1967	34.02	11537966
5	Afghanistan	Asia	1972	36.088	13079460
6	Afghanistan	Asia	1977	38.438	14880372
7	Afghanistan	Asia	1982	39.854	12881816
8	Afghanistan	Asia	1987	40.822	13867957
9	Afghanistan	Asia	1992	41.674	16317921
10	Afghanistan	Asia	1997	41.763	22227415

Showing 1 to 10 of 1,704 entries Previous 1 2 3 4 5 … 1

Modify features by piping on functions

```
gapminder %>%
  datatable() %>%
  formatCurrency('gdpPercap') %>%
  formatStyle(
    'country',
    color = 'red',
    backgroundColor = 'black',
    fontWeight = 'bold') %>%
  formatStyle(
    'lifeExp',
    background = styleColorBar(
      gapminder$lifeExp, 'dodgerblu
    backgroundSize = '100% 90%',
    backgroundRepeat = 'no-repeat'
    backgroundPosition = 'center')
```

Show 10 entries Search:

	country	continent	year	lifeExp	pop
1	Afghanistan	Asia	1952	28.801	8425333
2	Afghanistan	Asia	1957	30.332	9240934
3	Afghanistan	Asia	1962	31.997	10267083
4	Afghanistan	Asia	1967	34.02	11537966
5	Afghanistan	Asia	1972	36.088	13079460
6	Afghanistan	Asia	1977	38.438	14880372
7	Afghanistan	Asia	1982	39.854	12881816
8	Afghanistan	Asia	1987	40.822	13867957
9	Afghanistan	Asia	1992	41.674	16317921
10	Afghanistan	Asia	1997	41.763	22227415

Showing 1 to 10 of 1,704 entries Previous 1 2 3 4 5 … 1

Make *interactive* tables with:

`reactable::reactable()`

Make *interactive* tables with `reactable()`

```
library(reactable)

gapminder %>%
  reactable()
```

country	continent	year	lifeExp	pop	gdpPe
Afghanistan	Asia	1952	28.801	8425333	779.445
Afghanistan	Asia	1957	30.332	9240934	820.853
Afghanistan	Asia	1962	31.997	10267083	853.1
Afghanistan	Asia	1967	34.02	11537966	836.197
Afghanistan	Asia	1972	36.088	13079460	739.981
Afghanistan	Asia	1977	38.438	14880372	786.1
Afghanistan	Asia	1982	39.854	12881816	978.011
Afghanistan	Asia	1987	40.822	13867957	852.395
Afghanistan	Asia	1992	41.674	16317921	649.341
Afghanistan	Asia	1997	41.763	22227415	635.34

1–10 of 1704 rows Previous **1** 2 3 4 5 ... 171 Next

`reactable()` has some nice options!

```r
library(reactable)

gapminder %>%
  reactable(
    searchable = TRUE,
    highlight = TRUE,
    filterable = TRUE,
    defaultPageSize = 5,
    showPageSizeOptions = TRUE,
    pageSizeOptions = c(5, 10, 15)
  )
```

Search

country	continent	year	lifeExp	pop	gdpPe
Afghanistan	Asia	1952	28.801	8425333	779.445
Afghanistan	Asia	1957	30.332	9240934	820.853
Afghanistan	Asia	1962	31.997	10267083	853.1
Afghanistan	Asia	1967	34.02	11537966	836.197
Afghanistan	Asia	1972	36.088	13079460	739.981

1–5 of 1704 rows Show 5

Previous **1** 2 3 4 5 ... 341 Next

Add more features with reactablefmtr library

```r
library(reactable)
library(reactablefmtr)

gapminder %>%
  reactable(
    searchable = TRUE,
    highlight = TRUE,
    filterable = TRUE,
    defaultPageSize = 5,
    showPageSizeOptions = TRUE,
    pageSizeOptions = c(5, 10, 15)
    columns = list(
      lifeExp = colDef(cell = data_
        gapminder,
        colors = c("#d7191c", "#ff
      align = "center")) ## align
  )
```

Search

country	continent	year	lifeExp	pop
Afghanistan	Asia	1952	28.801	8425333
Afghanistan	Asia	1957	30.332	9240934
Afghanistan	Asia	1962	31.997	10267083
Afghanistan	Asia	1967	34.02	11537966
Afghanistan	Asia	1972	36.088	13079460

1–5 of 1704 rows Show 5

Previous 1 2 3 4 5 ... 341 Next

Add more features with `sparkline` library (example)

```r
library(reactable)
library(sparkline)

gapminder_summary <- gapminder %>%
  group_by(country) %>%
  summarise(lifeExp = list(lifeExp)) %>%
  mutate(leftExpTrend = NA)

gapminder_reactable_sparkline <- gapminder_
  reactable(
    searchable = TRUE,
    highlight = TRUE,
    filterable = TRUE,
    defaultPageSize = 5,
    showPageSizeOptions = TRUE,
    columns = list(
      lifeExp = colDef(
        cell = function(values) {
          sparkline(
            values, type = "bar", chartRang
            chartRangeMax = max(gapminder$l
        }),
      leftExpTrend = colDef(
        cell = function(value, index) {
          sparkline(gapminder_summary$lifeE
        })
  ))
```

References:

- https://rstudio.github.io/DT/
- https://glin.github.io/reactable/
- https://kcuilla.github.io/reactablefmtr/

Your Turn: Interactive Tables

20:00

Use `reactable()` to make the following interactive table

Read [this example]() on how to embed images in table cells, then use the `gapminder_flags` data frame to make the interactive table.

Search

flag	country	continent	year	lifeExp	
	Afghanistan	Asia	1952	28.801	8425
	Afghanistan	Asia	1957	30.332	9240
	Afghanistan	Asia	1962	31.997	10267
	Afghanistan	Asia	1967	34.02	11537
	Afghanistan	Asia	1972	36.088	13079

1–5 of 1704 rows Show 5

Previous **1** 2 3 4 5 ... 341 Next

Intermission

05:00

Week 13: *Interactivity*

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License

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

New libraries to install

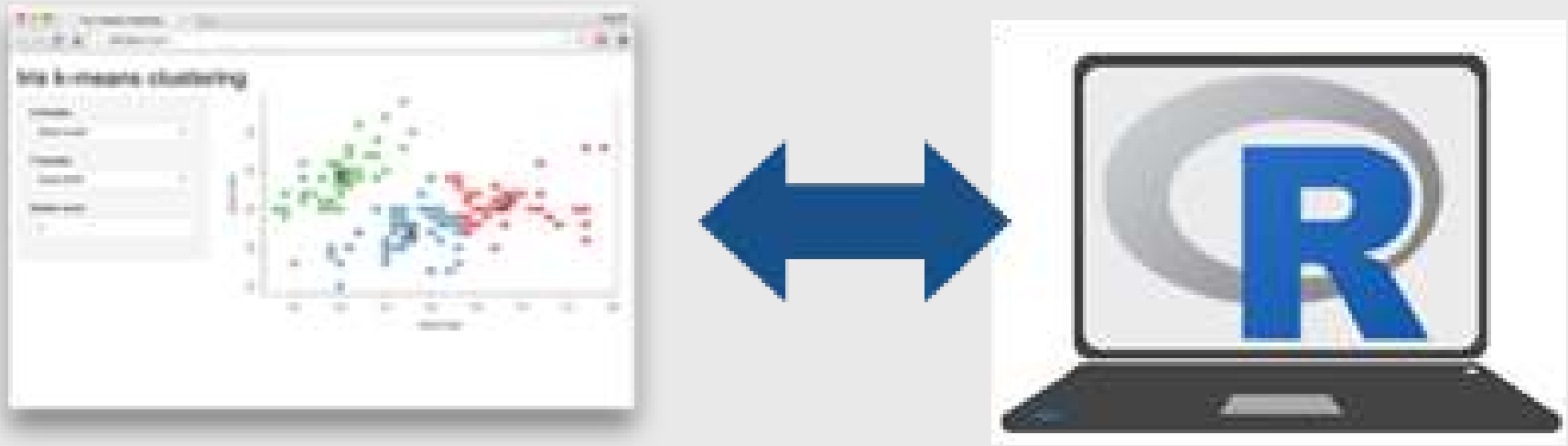
```
install.packages('shiny')
install.packages('shinyWidgets')
install.packages('rsconnect')
```

Interactive Webapps in R

Check out the Shiny Gallery

Anatomy of a Shiny App

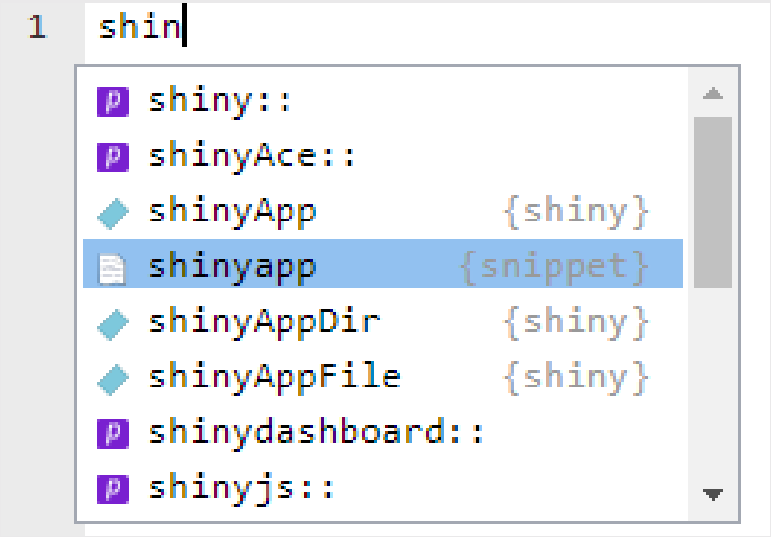
A Shiny app is a web page (UI) connected to a computer running a live R session (Server)



app.R

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

Just start typing `shiny`...




```
library(shiny)

ui <- fluidPage(

)

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

}

shinyApp(ui, server)
```

Building a shiny app

`ui`

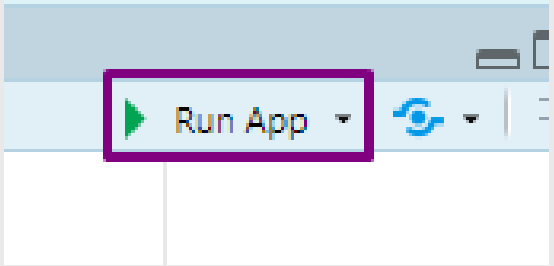
1. Pick a layout function
2. Add inputs widgets
3. Add `*Output()` functions

`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...

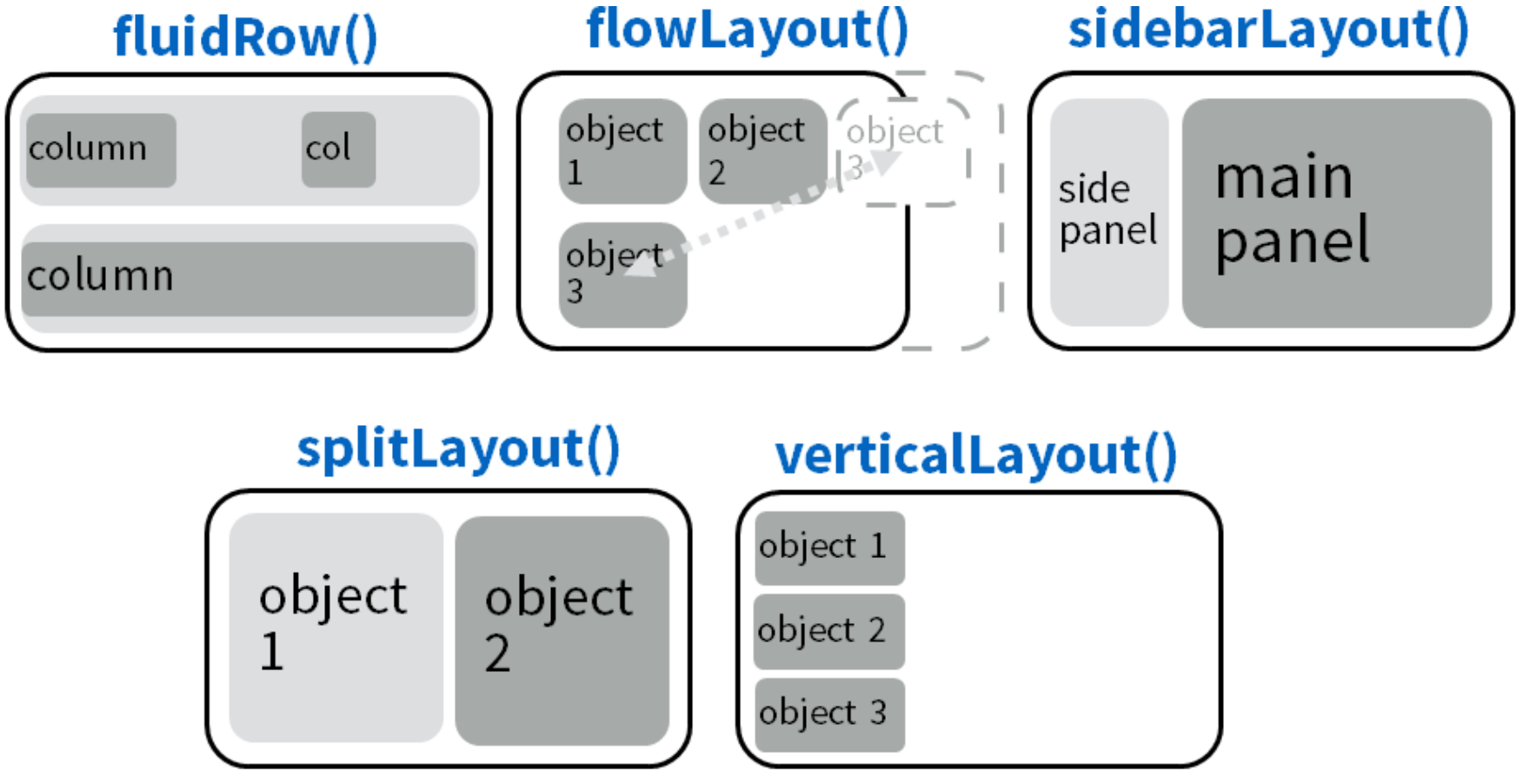
```r
library(shiny)

# 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)
```

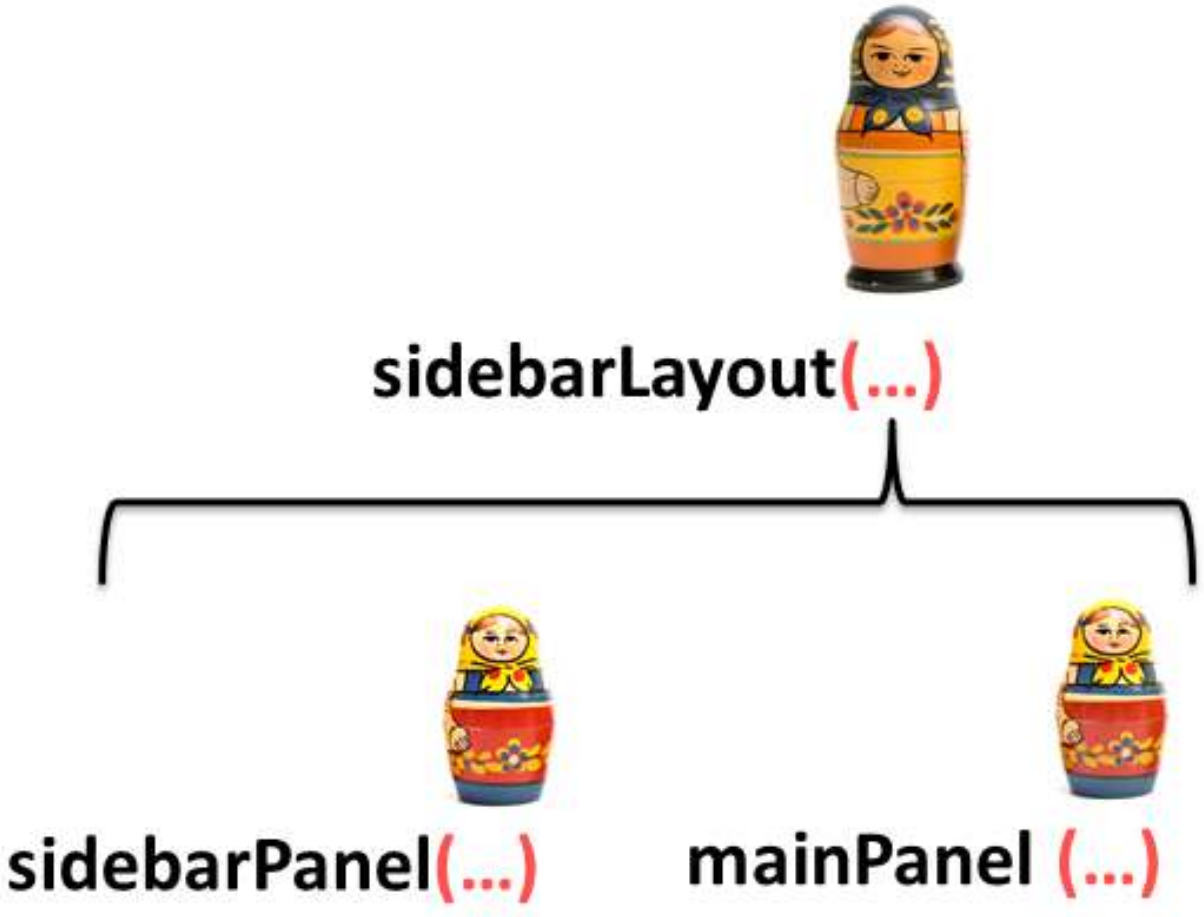
User Interface (UI)

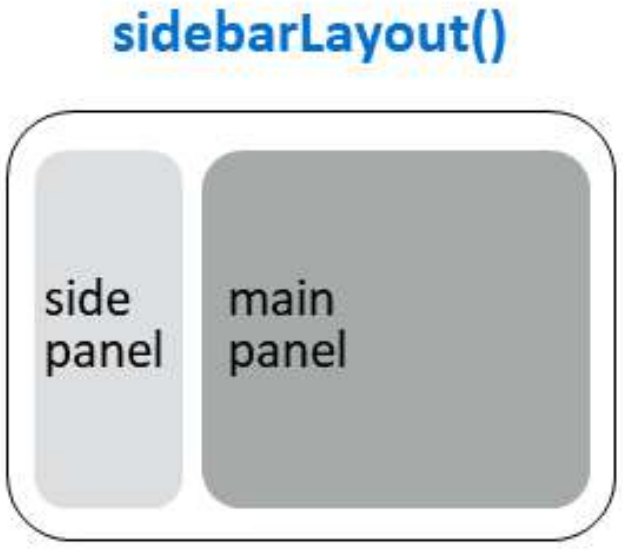
Matryoshka Dolls

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

Top level is usually `fluidPage()`

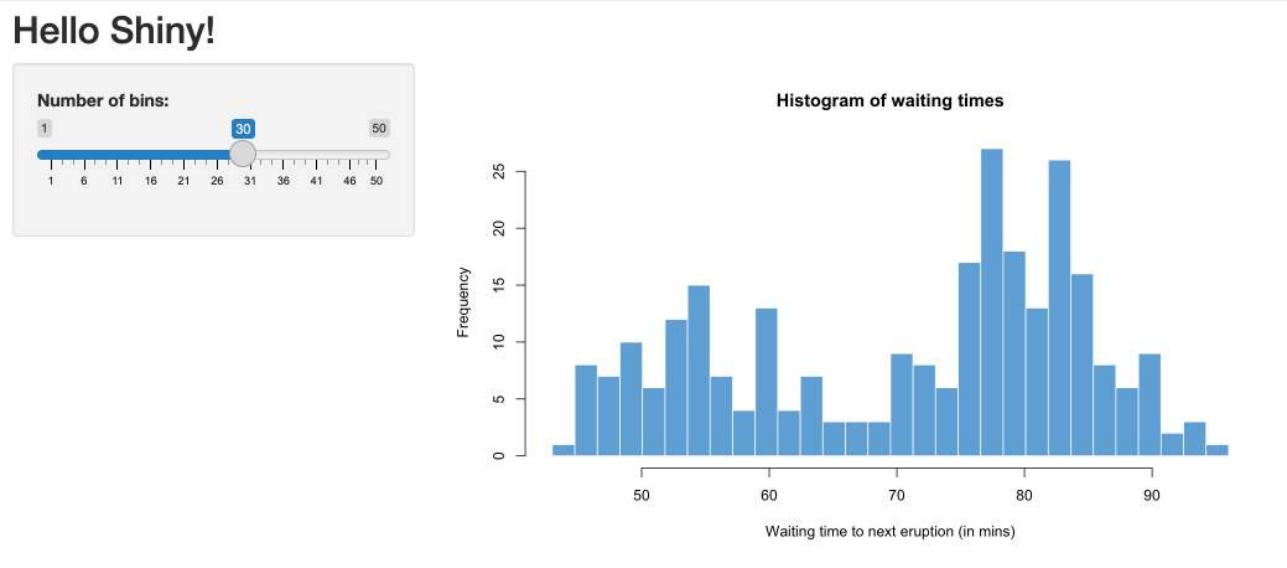



sidebarLayout(...)
sidebarPanel(...)
mainPanel (...)


sidebarLayout()
side panel
main panel

sidebarLayout()

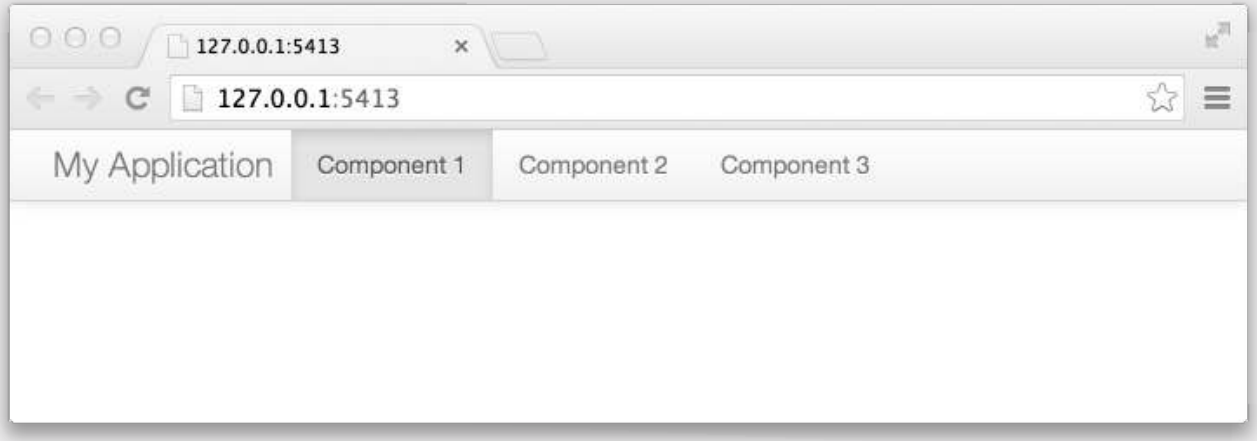
```
ui <- fluidPage(

  titlePanel("Hello Shiny!"),

  sidebarLayout(

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

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



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

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

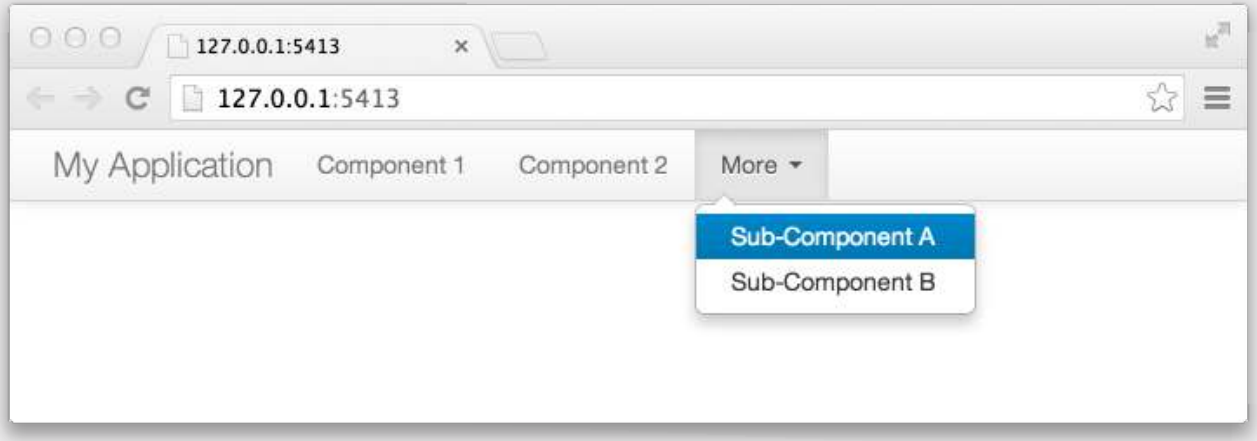
```
ui <- navbarPage("My Application",
  tabPanel("Component 1"),
  tabPanel("Component 2"),
  tabPanel("Component 3")
)
```



`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

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()

Colour input

#52CC4E

shinyjs::colourInput()

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

0 50 100

0 25 75 100

sliderInput()

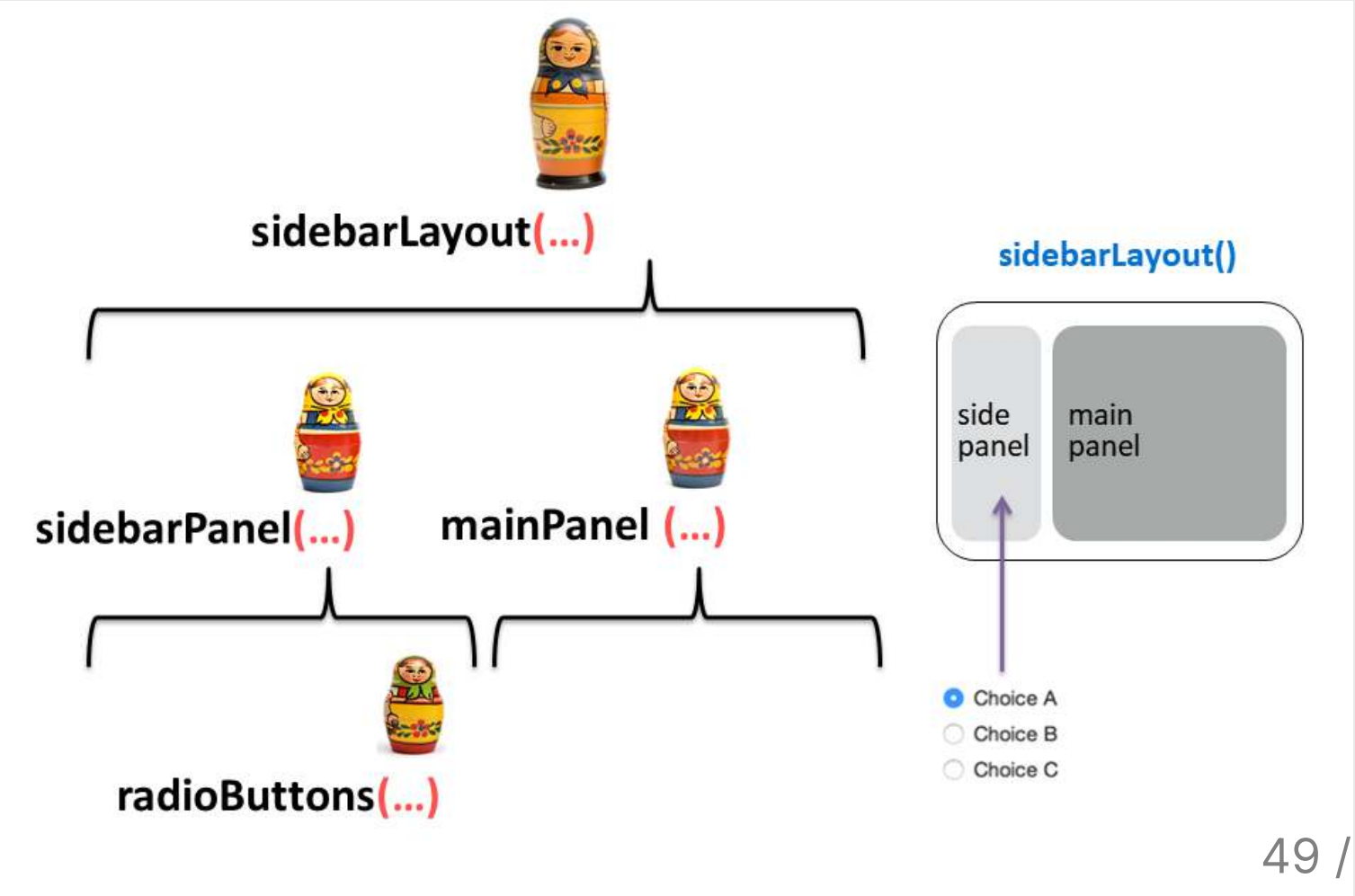
Text input

Enter text...

textInput()

Example Input: Radio buttons in the sidebar

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



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

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

Quick practice

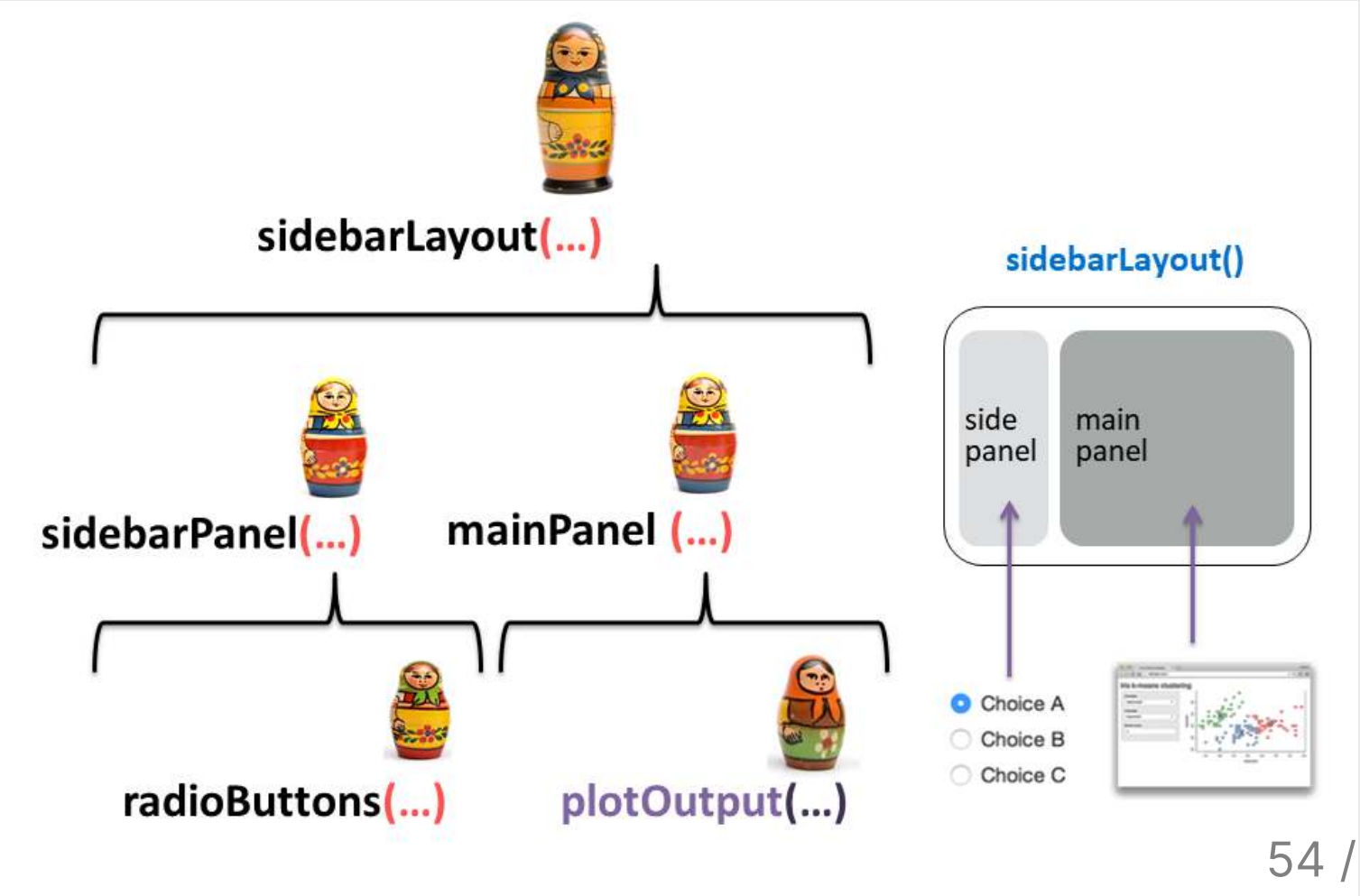
1. Open the `widgets.R` file.
2. Run the app (Click "run app" button).
3. Go to the Shiny Widgets Gallery to see other input widgets.

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

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

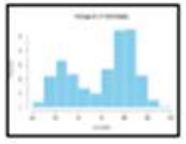
DT::**renderDataTable**(expr, options, callback, escape, env, quoted)

works with

dataTableOutput(outputId, icon, …)

renderImage(expr, env, quoted, deleteFile)

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

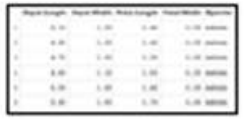


renderPlot(expr, width, height, res, …, env, quoted, func)

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)

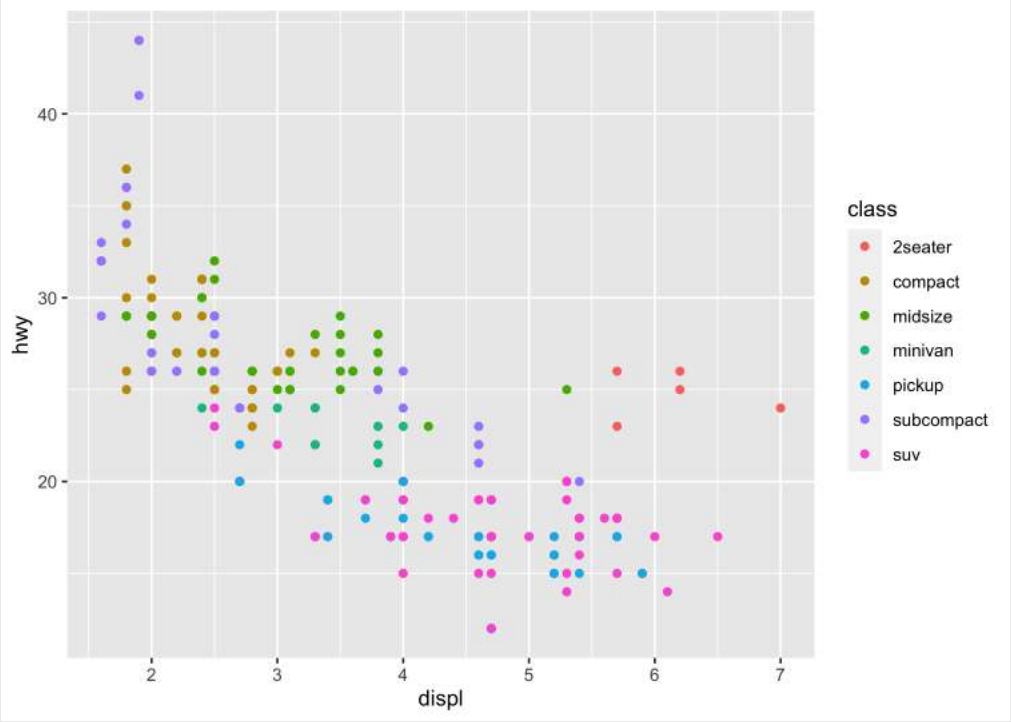
textOutput(outputId, container, inline)

renderUI(expr, env, quoted, func)

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

Using `renderPlot()`: make a plot

```
library(ggplot2)

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



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

`ui`

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

`server`

```
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`

```
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`

```
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()`

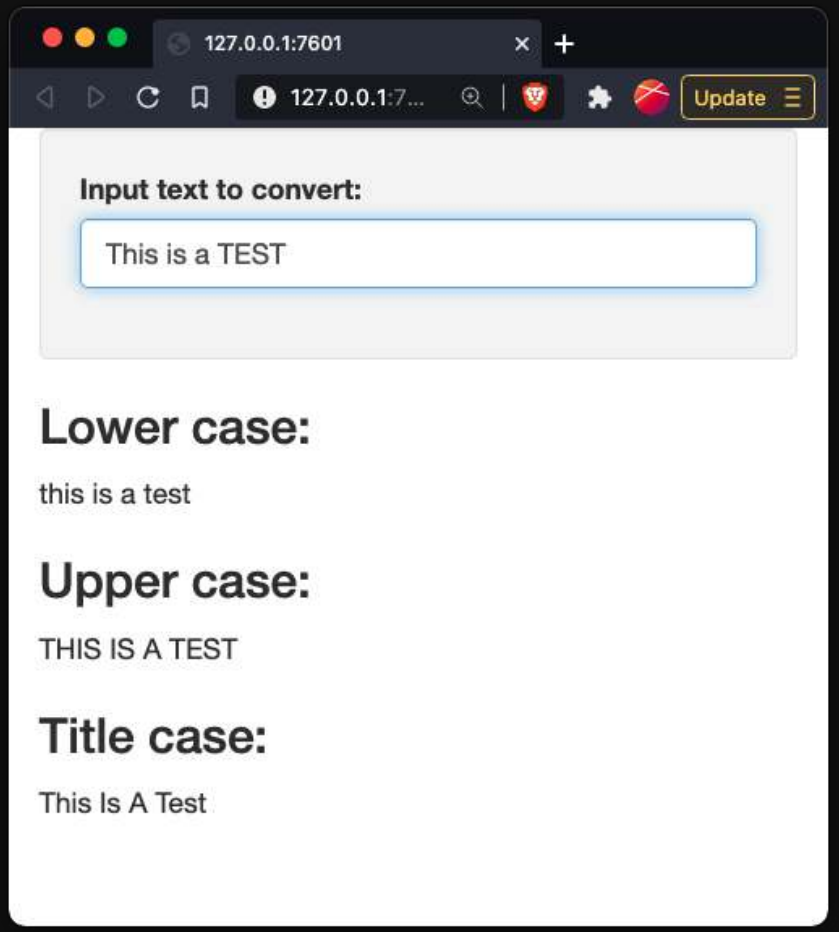
Quick practice

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.



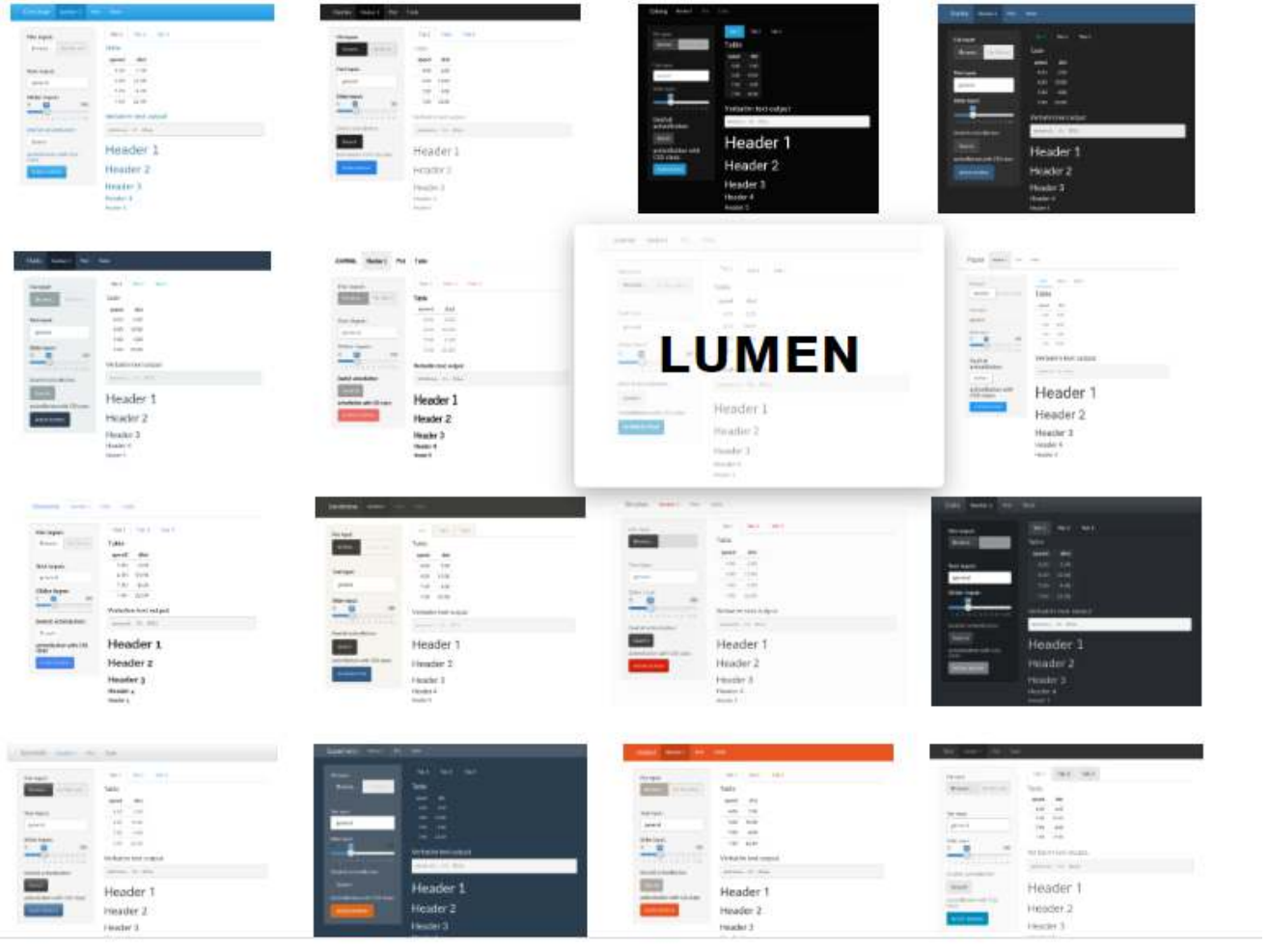
Week 13: *Interactivity*

1. Interactive charts with plotly
2. Interactive tables

Intermission

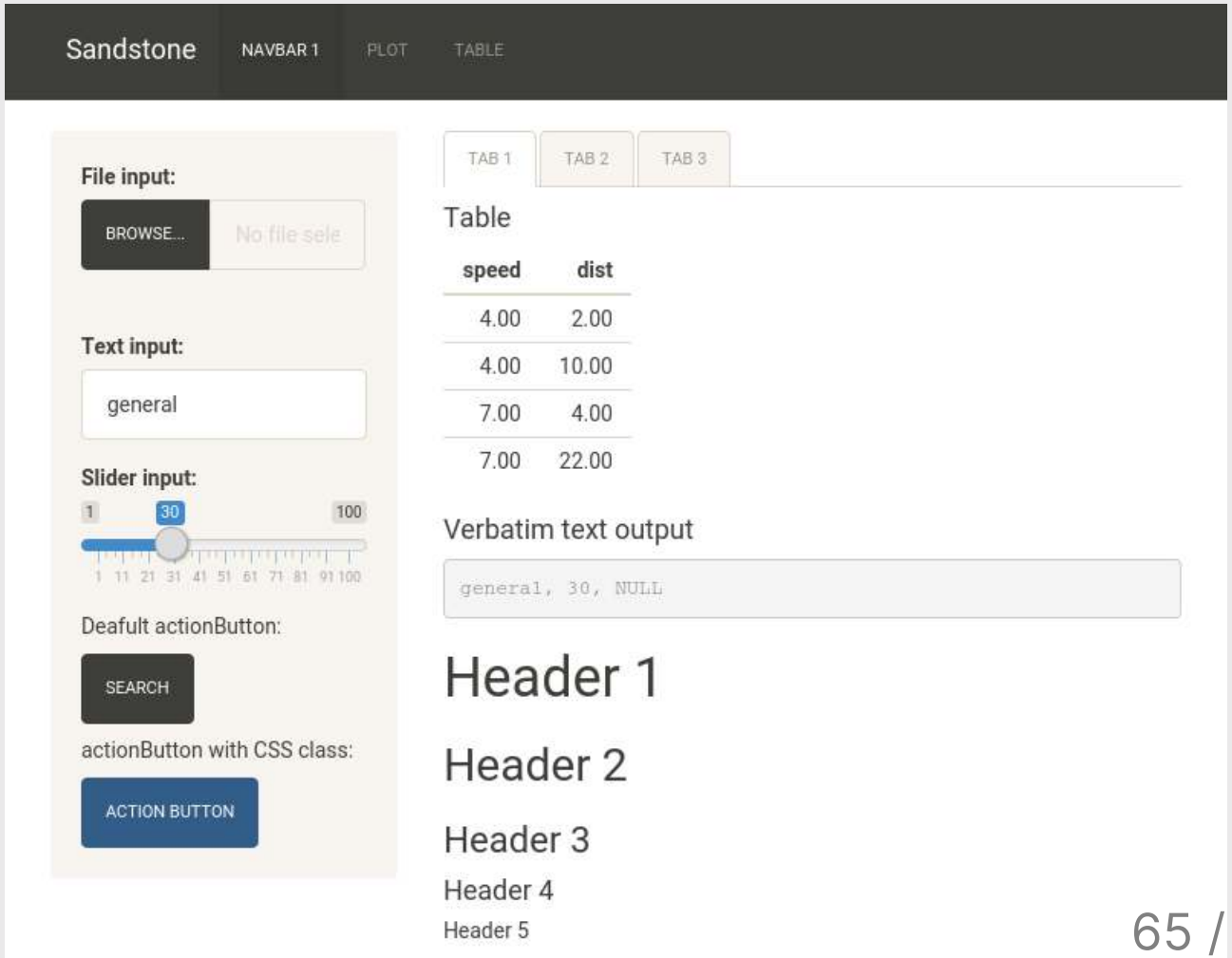
3. Shiny apps
4. Shiny extras

Add a theme with "shinythemes" package



Insert theme at top of main `ui` layout function

```
library(shinythemes)

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



Fancier widgets with "shinyWidgets" package

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

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

You can deploy an app for free on shinyapps.io

Follow this 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:

```
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