R Shiny Part II

Programming for Statistical Science

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Supplementary materials

Full video lecture available in Zoom Cloud Recordings

Additional resources

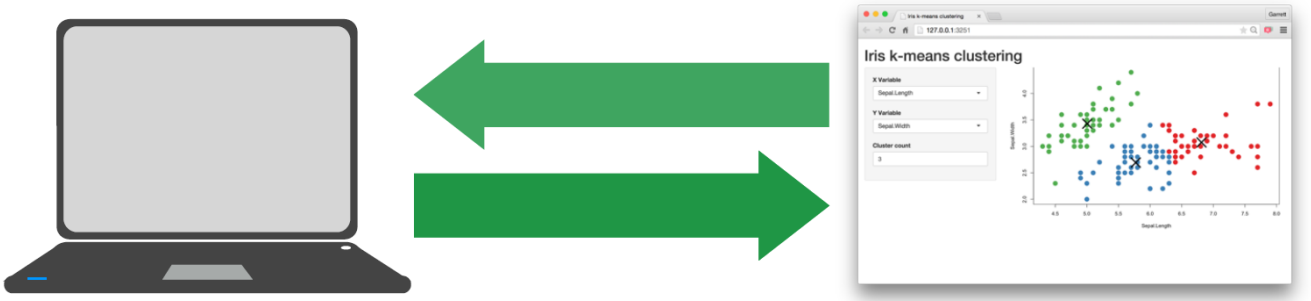
- Shiny reactivity
- Shiny code quality

Recall

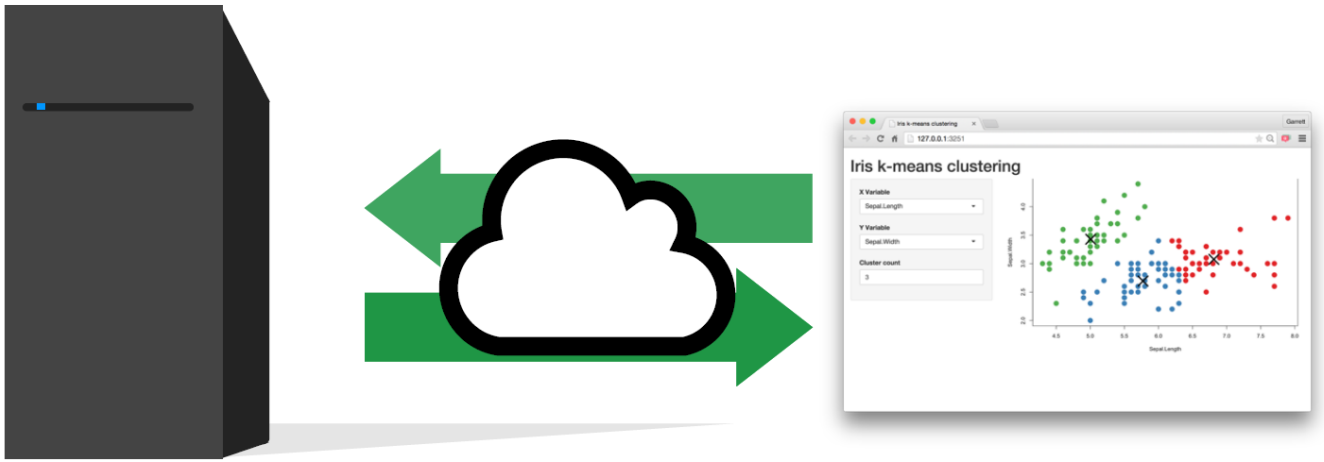
What is Shiny?

- Shiny is an R package.
- Build web-based apps with R in RStudio.
- Shiny can incorporate CSS themes and JavaScript actions.

How does Shiny work?



How does Shiny work?



How does Shiny work?

Main components of Rshiny

```
 # Load package shiny
library(shiny)
# Define UI for application
ui <- fluidPage(


)

# Define server logic
server <- function(input, output)


}

# Build and run the application
shinyApp(ui = ui, server = server)
```

- Function `fluidPage()` creates a dynamic HTML user interface you see when you look at an RShiny app. Convention is to save this as an object named `ui`.
- Function `server()` is user-defined and contains R commands your computer or external server need to run the app.
- Function `shinyApp()` builds the app based on the user interface and server pair of code.

User interface review

- Build the user interface inside function `fluidPage()` and save it as an object named `ui`.
- Function `fluidPage()` scales its components in real-time to fill all available browser width - dynamic HTML user interface.
- Build inputs with `*Input(inputId, label, ...)`.
- Build outputs with `*Output(outputId, ...)`.
- Separate multiple inputs and outputs with commas.
- Run your app after each added input or output to minimize complications later on.

Function `server()` review

- The server function does the work in terms of building and rebuilding R objects.
- Save output you build to `output$<outputId>`.
- Build output with a `render*()` function.
- Access inputs with `input$<inputId>`.
- Multiple outputs can be placed in the server function.
- Reactivity happens automatically when you use inputs to build rendered outputs.

UI Layouts

Layouts

- Use layout functions to position elements in your app.
- Use panels to group elements into a single unit for aesthetic or functional purposes.
- Design your own layout or use a packaged layout.

Rows with `fluidRow()`

```
ui <- fluidPage(
  fluidRow(
    # add inputs/outputs to row 1
  ),
  fluidRow(
    # add inputs/outputs to row 2
  ),
  fluidRow(
    # add inputs/outputs to row 3
  )
)
```

Rows and columns

```
ui <- fluidPage(

  fluidRow(
    column(width = 5,
      # add inputs/outputs
      # column width 5
    ),
    column(width = 7,
      # add inputs/outputs
      # column width 7
    )
  ),

  fluidRow(
    column(width = 8, offset = 2,
      # add inputs/outputs
      # 2 units in from left
    )
  )
)
```

Rows and columns example

```
ui <- fluidPage(

  fluidRow(
    column(width = 5,
      passwordInput(inputId = "pass",
                    label = "Enter password:"),
      actionButton(inputId = "passbtn",
                   label = "Submit password")
    ),

    column(width = 7,
      paste("Add some description in row 1",
            "of the column with a width of 7",
            "here...", sep = " ")
    )
  ),

  fluidRow(
    column(width = 8, offset = 2,
      checkboxGroupInput(inputId = "checks",
                         label = "",
                         choices = c("Choice 1",
                                     "Choice 2",
                                     "Choice 3",
                                     "Choice 4")),
      "Add some more text in Row 2 here..."
    )
  )
)
```

Panels

`absolutePanel()`
Panel position set rigidly (absolutely), not fluidly

`conditionalPanel()`
A JavaScript expression determines whether panel is visible or not.

`fixedPanel()`
Panel is fixed to browser window and does not scroll with the page

`headerPanel()`
Panel for the app's title, used with pageWithSidebar()

`inputPanel()`
Panel with grey background, suitable for grouping inputs

`mainPanel()`
Panel for displaying output, used with pageWithSidebar()

`navlistPanel()`
Panel for displaying multiple stacked tabPanels(). Uses sidebar navigation

`sidebarPanel()`
Panel for displaying a sidebar of inputs, used with pageWithSidebar()

`tabPanel()`
Stackable panel. Used with navlistPanel() and tabsetPanel()

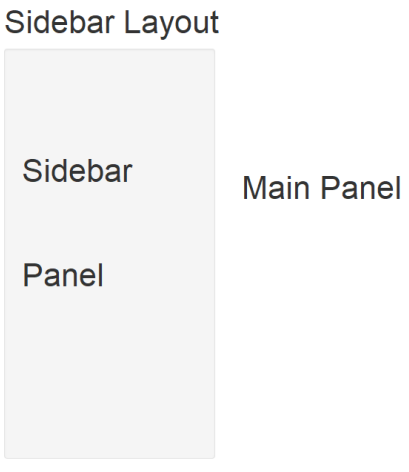
`tabsetPanel()`
Panel for displaying multiple stacked tabPanels(). Uses tab navigation

`titlePanel()`
Panel for the app's title, used with pageWithSidebar()

`wellPanel()`
Panel with grey background.

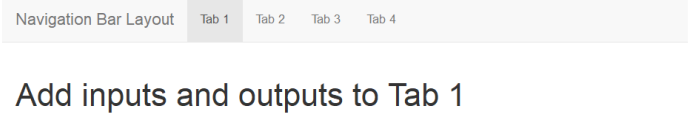
Packaged layout:
`sidebarLayout()`

```
ui <- fluidPage(

  # give a title in quotes
  titlePanel(),

  sidebarLayout(

    sidebarPanel(

      # inputs/outputs

    ),

    mainPanel(

      # inputs/outputs

    )
  )
)
```



Packaged layout: `navbarPage()`

```
ui <- fluidPage(

  navbarPage(title = "Navigation Bar Layout",

    tabPanel("Tab 1",
             # add inputs/outputs
             ),

    tabPanel("Tab 2",
             # add inputs/outputs
             ),

    tabPanel("Tab 3",
             # add inputs/outputs
            ),

    tabPanel("Tab 4",
             # add inputs/outputs
            )

  )
)
```



Packaged layout: `navbarPage()`

```
ui <- fluidPage(

  navbarPage(title = "Navigation Bar Layout",

    tabPanel("Tab 1",
             # add inputs/outputs
             ),

    tabPanel("Tab 2",
             # add inputs/outputs
             ),

    tabPanel("Tab 3",
             # add inputs/outputs
            ),

    tabPanel("Tab 4",
             # add inputs/outputs
            )

  )
)
```

Layout recap

- Use `fluidRow()` to arrange elements in rows; use columns() to arrange elements in columns, where total width is 12
- Use `sidebarPanel()` and `mainPanel()` to partition app with the packaged layout function sidebarLayout()
- Use `tabPanel()` with packaged layouts `navbarPage()` or `navbarMenu()`.

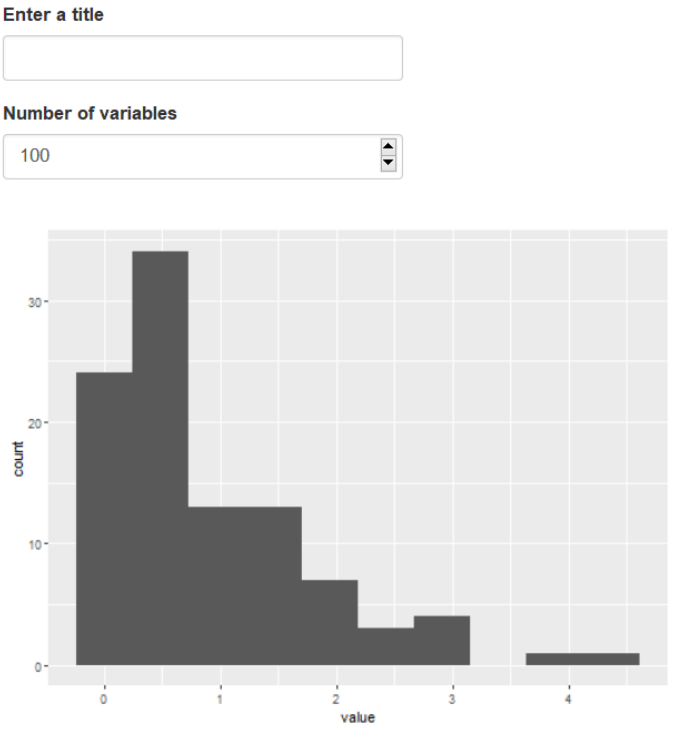
Reactivity

Frequency of code execution

- Shiny will run the whole script the first time your app is launched.
- Each time a new user visits your app, Shiny runs the server function again, one time.
- As users interact with widgets, Shiny will re-run the corresponding R expressions that depend on a widget whose value was changed.

Consider the simple app

```
library(shiny)
library(tidyverse)

# Build UI
ui <- fluidPage(
  textInput(inputId = "title",
            label = "Enter a title"),

  numericInput(inputId = "num",
               label = "Number of variables",
               value = 100,
               min = 1),

  plotOutput(outputId = "hist")
)

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

  output$hist <- renderPlot({
    ggplot(as_tibble(rexp(input$num)),
           aes(x = value)) +
      geom_histogram(bins = 10) +
      labs(title = input$title)
  })
}

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



Is there a problem?

```
library(shiny)
library(tidyverse)

# Build UI
ui <- fluidPage(
  textInput(inputId = "title",
            label = "Enter a title"),

  numericInput(inputId = "num",
               label = "Number of variables",
               value = 100,
               min = 1),

  plotOutput(outputId = "hist")
)

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

  output$hist <- renderPlot({
    ggplot(as_tibble(rexp(input$num)),
           aes(x = value)) +
      geom_histogram(bins = 10) +
      labs(title = input$title)
  })
}

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

- Every time you change the title, `labs(title = input$title)` new random numbers will be generated. If a single input changes in a block of code inside a render function, then the entire block of code is re-run.

- This is very inefficient and can cause problems.

Attempted solution

```
library(shiny)
library(tidyverse)

# Build UI
ui <- fluidPage(
  textInput(inputId = "title",
            label = "Enter a title"),

  numericInput(inputId = "num",
               label = "Number of variables",
               value = 100,
               min = 1),

  plotOutput(outputId = "hist")
)

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

  data <- rexp(input$num)

  output$hist <- renderPlot({
    ggplot(as_tibble(data),
           aes(x = value)) +
      geom_histogram(bins = 10) +
      labs(title = input$title)
  })
}

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

```
Error in .getReactiveEnvironment()
Operation not allowed without
an active reactive context.

(You tried to do something that ca
only be done from inside a reactiv
expression or observer.)
```

- Reactive inputs must be in a reactive-type function.

Reactive expressions

The render functions are reactive-type functions. Function `reactive()` builds a reactive object. The object will respond to every reactive source in the code.

Rather than

```
data <- rexp(input$num)
```

use

```
data <- reactive({rexp(input$num)})
```

A reactive expression has two special properties:

1. call a reactive expression like a function, `data()`;
2. reactive expressions cache their values, the value is retained until it becomes invalidated.

Solution

```
library(shiny)
library(tidyverse)

# Build UI
ui <- fluidPage(
  textInput(inputId = "title",
            label = "Enter a title"),

  numericInput(inputId = "num",
               label = "Number of variables",
               value = 100,
               min = 1),

  plotOutput(outputId = "hist")
)

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

  data <- reative({rexp(input$num)})

  output$hist <- renderPlot({
    ggplot(as_tibble(data()),
           aes(x = value)) +
      geom_histogram(bins = 10) +
      labs(title = input$title)
  })
}

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

Complementary functions for reactivity

Function	Purpose
`isolate()`	prevent reactions
`observeEvent()`	trigger code, useful for action button
`observe()`	similar to `observeEvent()`
`eventReactive()`	delay reactions

Dynamic UI

Dynamic interface

Shiny offers four main approaches to build a dynamic UI:

1. Function `conditionalPanel()`: wraps UI elements, does require very very minimal JavaScript knowledge

2. Function `renderUI()`: use in `server()` in conjunction with the `uiOutput()` function in `ui`, lets you generate calls to UI functions and make the results appear in a predetermined place in the UI.

3. Functions `insertUI()` and `removeUI()`: allow you to add or remove pieces of UI code

4. Use JavaScript directly

References

1. Shiny. (2020). https://shiny.rstudio.com/.