Introduction to R Shiny

SBW - Data Visualization Workshop

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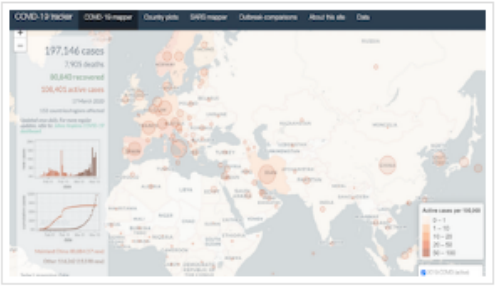
NBIS, SciLifeLab

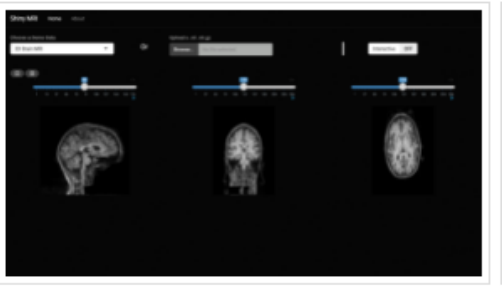
Contents

Life sciences



COVID-19 tracker

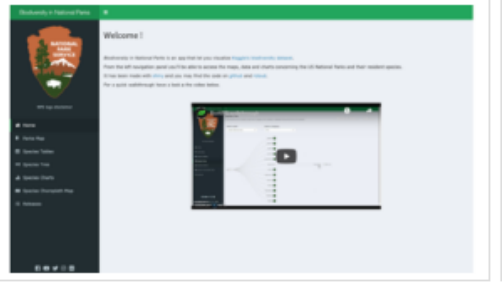
Exploring large hospital data for better use of antimicrobials



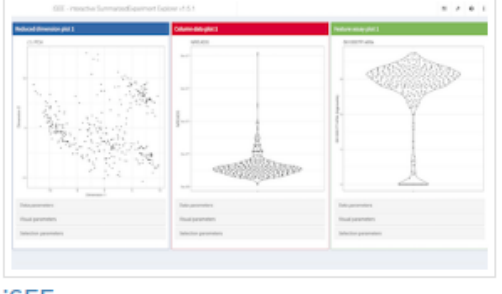
ShinyMRI - View MRI images in Shiny

A/B Testing Sample Size Calculator

ctmmweb, a web app to analysis Animal tracking data

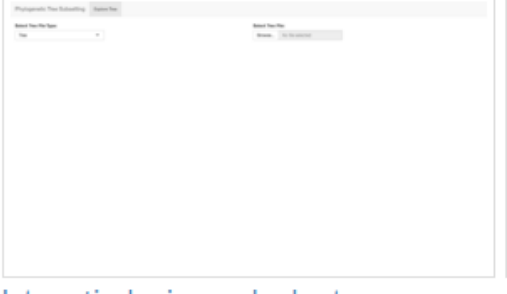


Visualizing Biodiversity in National Parks data



iSEE

MOTE: An Effect Size Calculator



Interactively view and subset phylogenetic trees

What is shiny?

- Interactive documents & web applications
- Completely created using R
- Needs a live environment

Usage

- Standalone web applications
- Dashboard/Flexboard
- Interactive RMarkdown
- Gadgets/RStudio extensions

App structure

- UI Layout
- UI Inputs (Widgets)
- UI Outputs
- Renderer
- Builder

Code structure

One file format

app.R

```
ui <- fluidPage()
server <- function(input,output) {}
shinyApp(ui=ui,server=server)
```

Two file format

ui.R

```
ui <- fluidPage()
```

server.R

```
server <- function(input,output) {}
```

App execution

- Change to app directory, then run `runApp()`
- Use `shinyApp()`

```
shinyApp(
ui=fluidPage(),
server=function(input,output) {}
)
```

- From Rmd file using `rmarkdown::run()`
- Running as a separate process from terminal

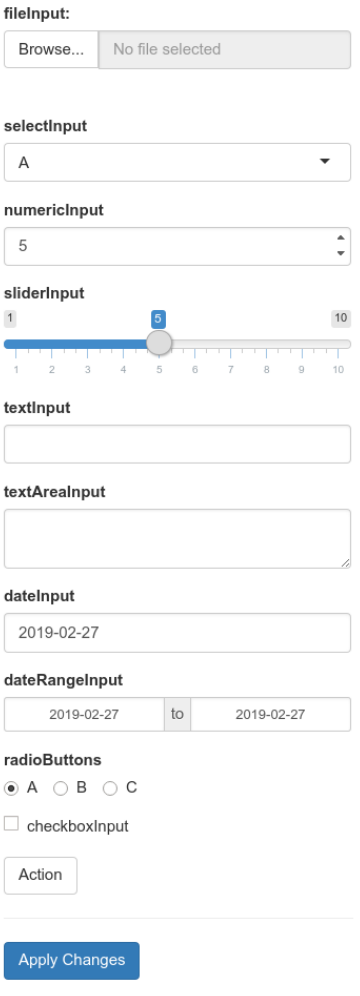
```
R -e "shiny::runApp('~/shinyapp')"
```

UI • Layout

```
shinyApp(
ui=fluidPage(
  titlePanel("Title Panel"),
  sidebarLayout(
    sidebarPanel(
      helpText("Sidebar Panel")
    ),
    mainPanel(tabsetPanel(
                tabPanel("tab1",
                         fluidRow(
                           column(6,helpText("Col1")),
                           column(6,
                                  helpText("Col2"),
                                  fluidRow(
```

UI • Widgets • Input

```
shinyApp(
ui=fluidPage(
  fluidRow(
    column(4,
           fileInput("file-input","fileInput:"),
           selectInput("select-input",label="selectI
           numericInput("numeric-input",label="numer
           sliderInput("slider-input",label="sliderI
           textInput("text-input",label="textInput")
           textAreaInput("text-area-input",label="te
           dateInput("date-input",label="dateInput")
           dateRangeInput("date-range-input",label="
           radioButtons("radio-button",label="radioB
           checkboxInput("checkbox","checkboxInput",
           actionButton("action-button","Action"),
           hr(),
           submitButton()
    )
  )
),
server=function(input,output) {
})
```



Widgets gallery

UI • Widgets • Outputs

```
shinyApp(
ui=fluidPage(fluidRow(column(5,
           textInput("text_input",label="textInput",
           hr(),
           htmlOutput("html_output"),
           textOutput("text_output"),
           verbatimTextOutput("verbatim_text_output"
           tableOutput("table_output"),
           plotOutput("plot_output",width="300px",he
    ))),
server=function(input, output) {
  output$html_output <- renderText({input$text_input
  output$text_output <- renderText({input$text_input
  output$verbatim_text_output <- renderText({input$t
  output$table_output <- renderTable({iris[1:3,1:3]}
  output$plot_output <- renderPlot({
    plot(iris[,1],iris[,2])
  })
})
```

textInput

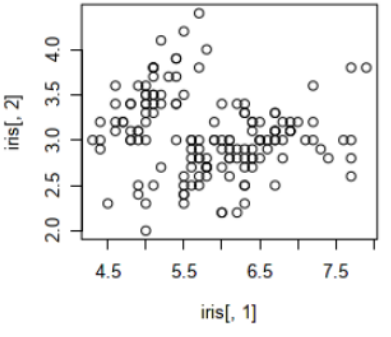
<h3 style='color:red'>Red text</h3>

Red text

<h3 style='color:red'>Red text</h3>

```
<h3 style='color:red'>Red text</h3>
```

Sepal.Length	Sepal.Width	Petal.Length
5.10	3.50	1.40
4.90	3.00	1.40
4.70	3.20	1.30



Dynamic UI

- UI elements are created conditionally using `uiOutput()` / `renderUI()`

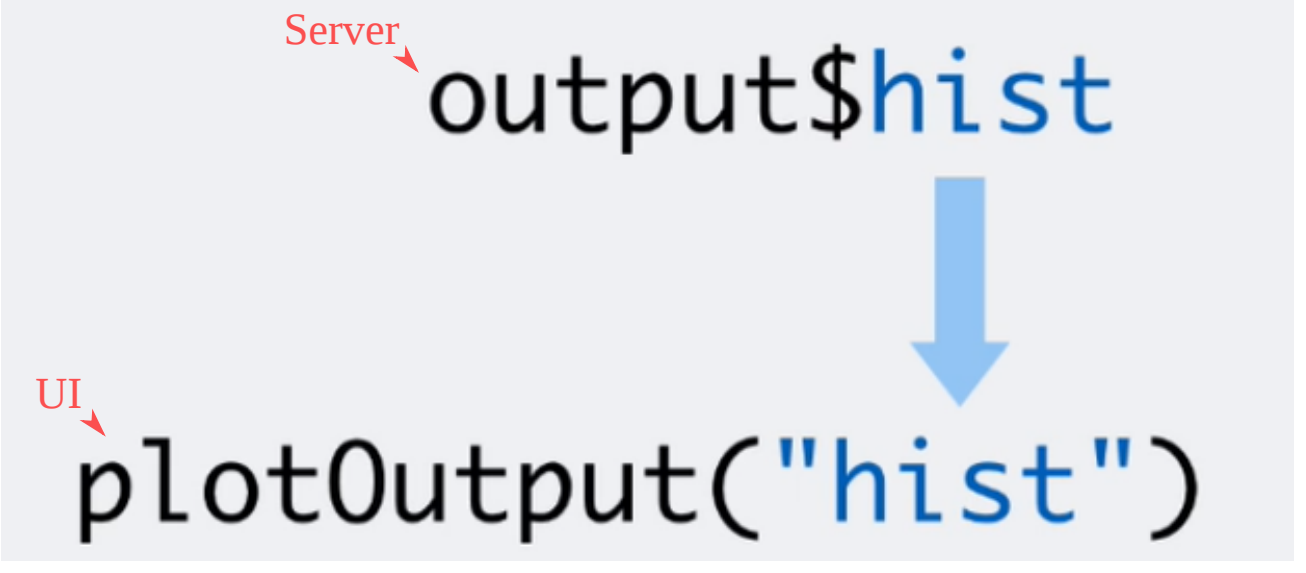
```
shinyApp(
ui=fluidPage(
  selectInput("data",label="Select data",
              choices=c("mtcars","faithful","iris")),
  tableOutput("table"),
 uiOutput("ui")
),
server=function(input, output) {

  data <- reactive({ get(input$data, 'package:datasets') })

 output$ui <- renderUI({
  if(input$data=="iris") plotOutput("plot",width="400px")
  })

  output$plot <- renderPlot({hist(data()[, 1])})
  output$table <- renderTable({head(data())})
})
```

- Other options include `conditionalPanel()`, `insertUI()` and `removeUI()`

Server

- `Server` is a function that assembles your `input` into `output` using R based code.
- Three rules to be followed to write a server function:

Rule 1: Save objects to display to `output$`



Server

Rule 2: Build objects to display with `render*()`

- R-Code block (can even be an entire R script) between the braces `{}` inside the `render*()` function.

```
output$hist <- renderPlot({
                  title <- "histogram of 100 random numbers"
                  hist(rnorm(100), main = title)
              })
```

Different Render functions

Server

Rule 3: Use input values with `input$`

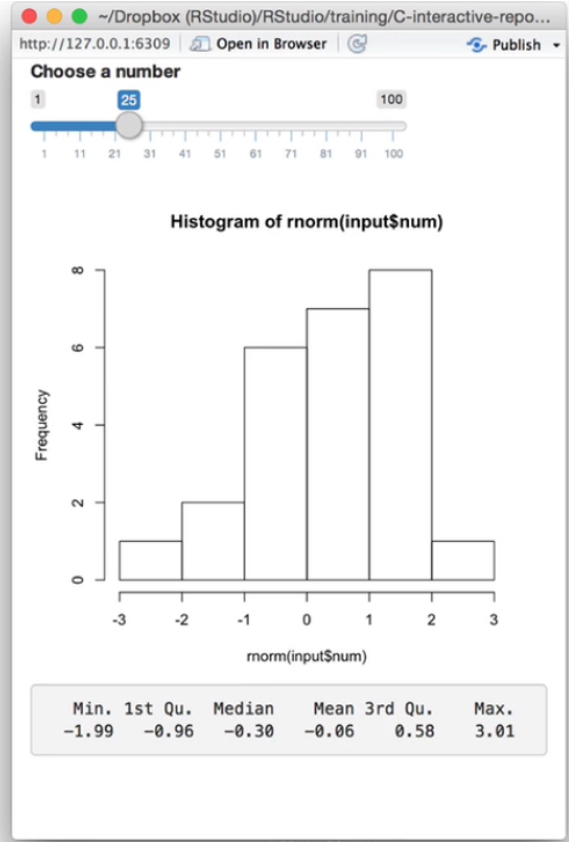
```
sliderInput(inputId = "num",…)
```

```
input$num
```

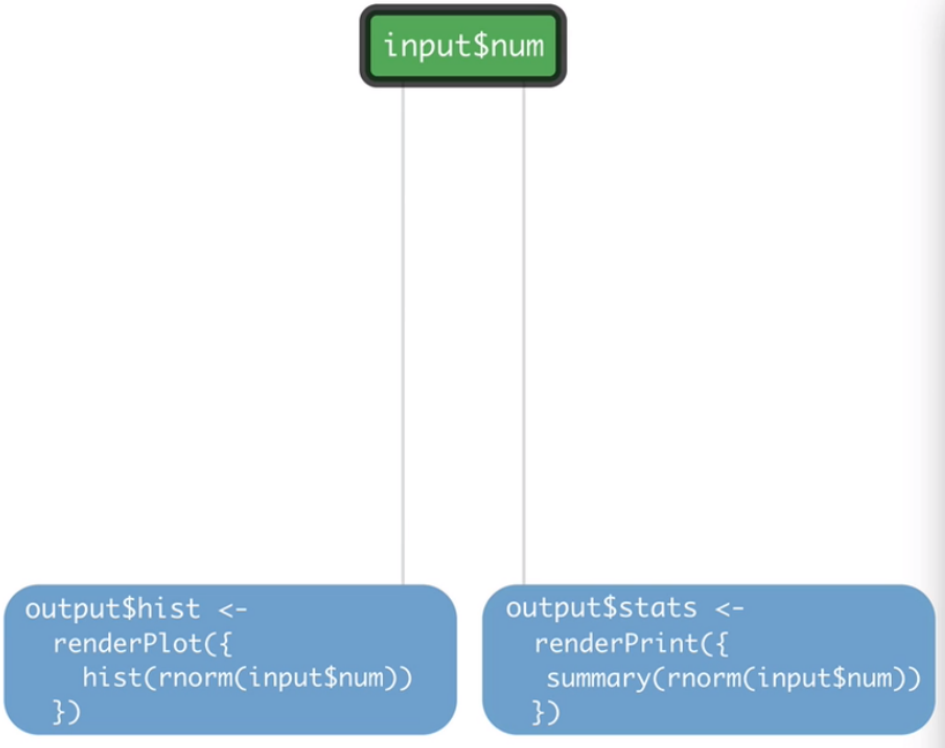
```
server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$num))
  })
}
```

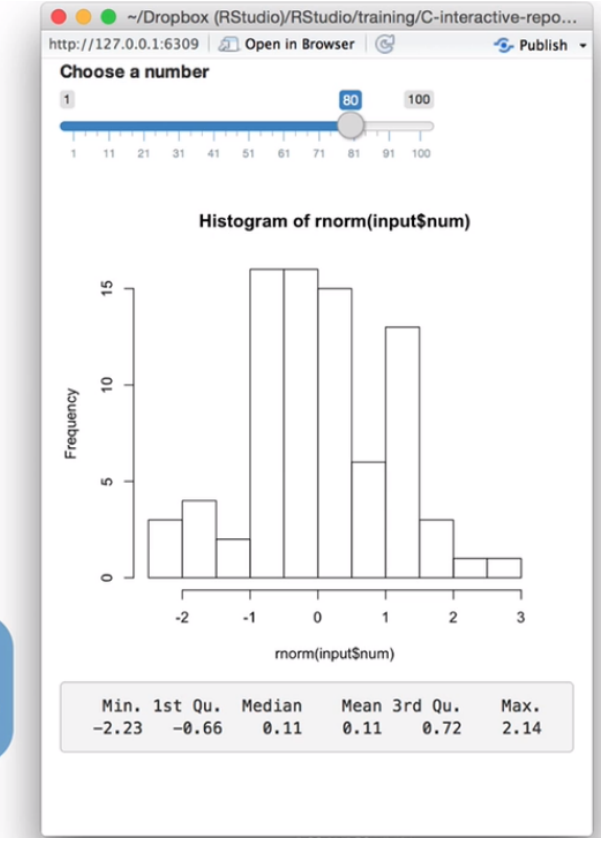
Reactivity

```
# 02-two-outputs

library(shiny)

ui <- fluidPage(
  sliderInput(inputId = "num",
    label = "Choose a number",
    value = 25, min = 1, max = 100),
  plotOutput("hist"),
  verbatimTextOutput("stats")
)

server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$num))
  })
  output$stats <- renderPrint({
    summary(rnorm(input$num))
  })
}

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

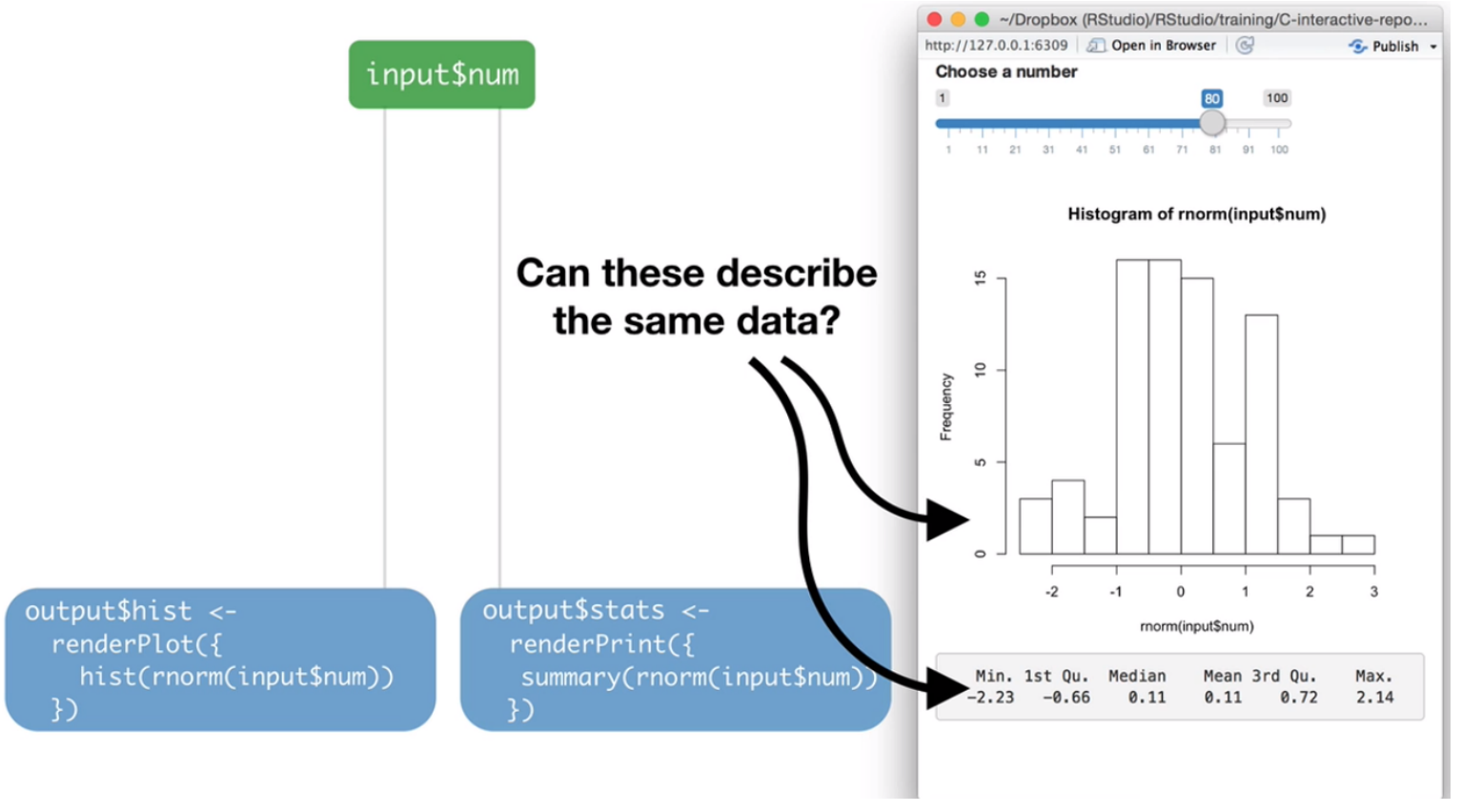


Reactivity

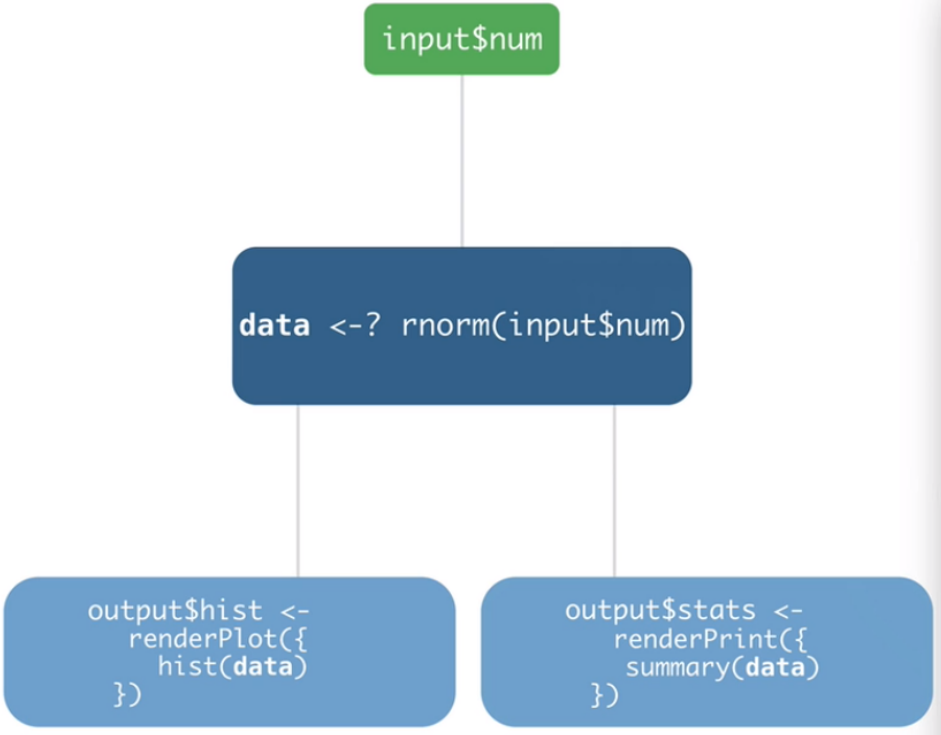

input$num
output$hist <-
renderPlot({
hist(rnorm(input$num))
})
output$stats <-
renderPrint({
summary(rnorm(input$num))
})

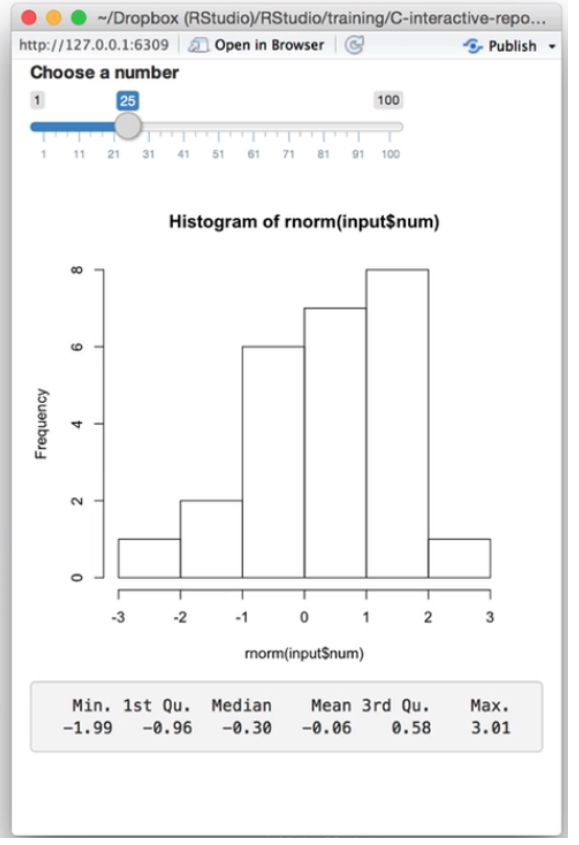

~/Dropbox (RStudio)/RStudio/training/C-interactive-repo...
http://127.0.0.1:6309
Open in Browser
Publish
Choose a number
1
80
100
1 11 21 31 41 51 61 71 81 91 100
Histogram of rnorm(input$num)
Frequency
0 5 10 15
-2 -1 0 1 2 3
rnorm(input$num)
Min. 1st Qu. Median Mean 3rd Qu. Max.
-2.23 -0.66 0.11 0.11 0.72 2.14

Reactivity


input$num
Can these describe the same data?
output$hist <-
renderPlot({
hist(rnorm(input$num))
})
output$stats <-
renderPrint({
summary(rnorm(input$num))
})
~/Dropbox (RStudio)/RStudio/training/C-interactive-repo...
http://127.0.0.1:6309
Open in Browser
Publish
Choose a number
1
80
100
Histogram of rnorm(input$num)
Frequency
rnorm(input$num)
Min. 1st Qu. Median Mean 3rd Qu. Max.
-2.23 -0.66 0.11 0.11 0.72 2.14

Reactivity


input$num
data <-? rnorm(input$num)
output$hist <-
renderPlot({
hist(data)
})
output$stats <-
renderPrint({
summary(data)
})


~/Dropbox (RStudio)/RStudio/training/C-interactive-repo...
http://127.0.0.1:6309
Open in Browser
Publish
Choose a number
1
25
100
Histogram of rnorm(input$num)
Frequency
rnorm(input$num)
Min. 1st Qu. Median Mean 3rd Qu. Max.
-1.99 -0.96 -0.30 -0.06 0.58 3.01

Reactivity

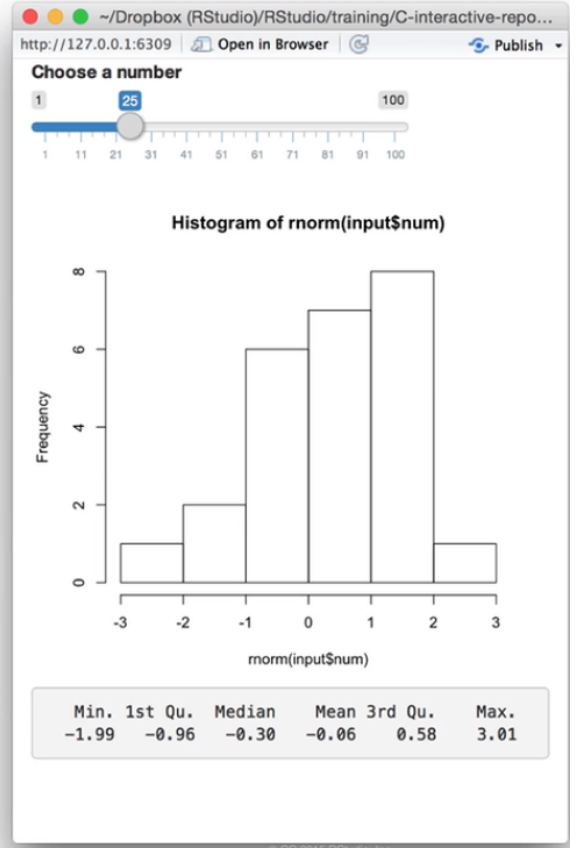
reactive()

Builds a reactive object (reactive expression)

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

Reactivity

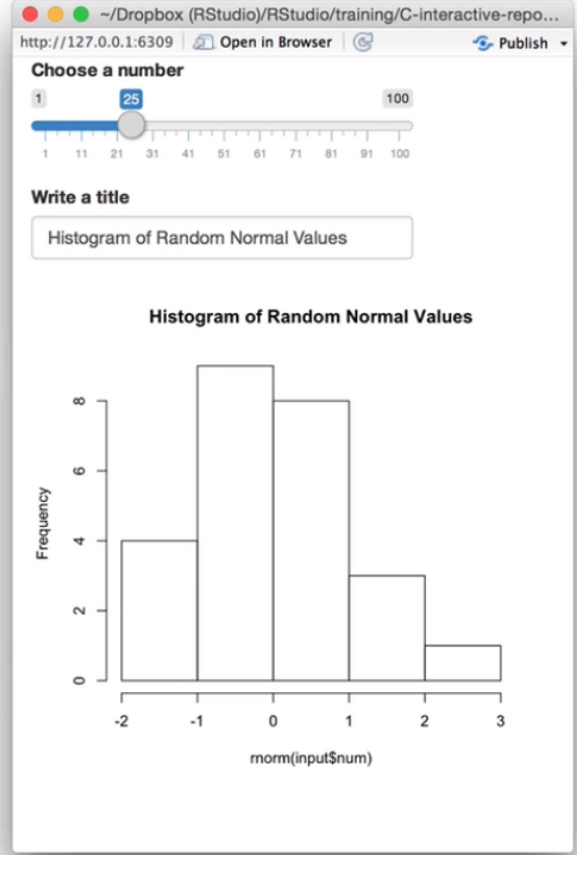
```
# 03-reactive

library(shiny)

ui <- fluidPage(
  sliderInput(inputId = "num",
    label = "Choose a number",
    value = 25, min = 1, max = 100),
  plotOutput("hist"),
  verbatimTextOutput("stats")
)

server <- function(input, output) {
  data <- reactive({
    rnorm(input$num)
  })
  output$hist <- renderPlot({
    hist(data())
  })
  output$stats <- renderPrint({
    summary(data())
  })
}

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



Isolate reactivity

- Reactivity can be controlled.
- You will notice that as soon as you try to change the title, the histogram will update with new values

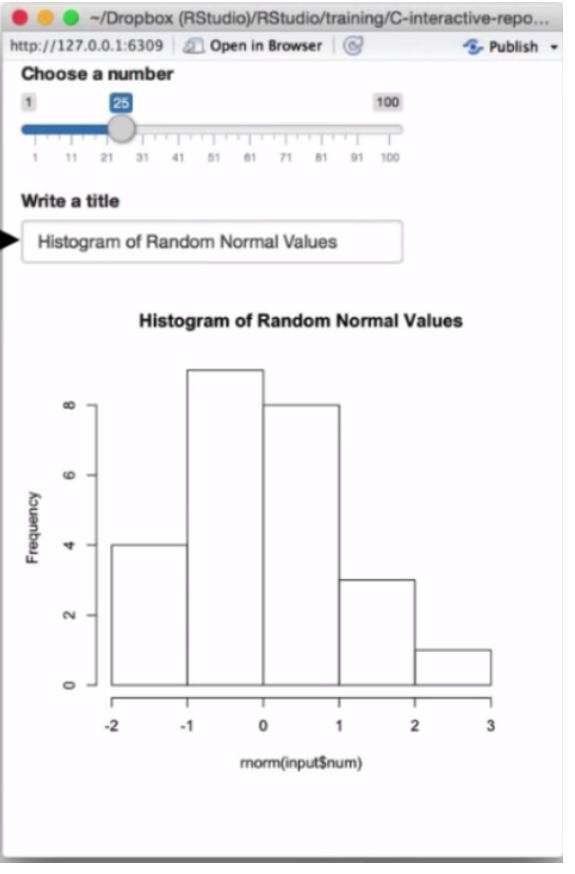
```
# 01-two-inputs

library(shiny)

ui <- fluidPage(
  sliderInput(inputId = "num",
    label = "Choose a number",
    value = 25, min = 1, max = 100),
  textInput(inputId = "title",
    label = "Write a title",
    value = "Histogram of Random Normal Values"),
  plotOutput("hist")
)

server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$num),
      main = input$title)
  })
}

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



Isolate reactivity

```
# 01-two-inputs

library(shiny)

ui <- fluidPage(
  sliderInput(inputId = "num",
    label = "Choose a number",
    value = 25, min = 1, max = 100),
  textInput(inputId = "title",
    label = "Write a title",
    value = "Histogram of Random Normal Values"),
  plotOutput("hist")
)

server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$num),
      main = input$title)
  })
}

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

Can we prevent the title field from updating the plot?



Isolate reactivity

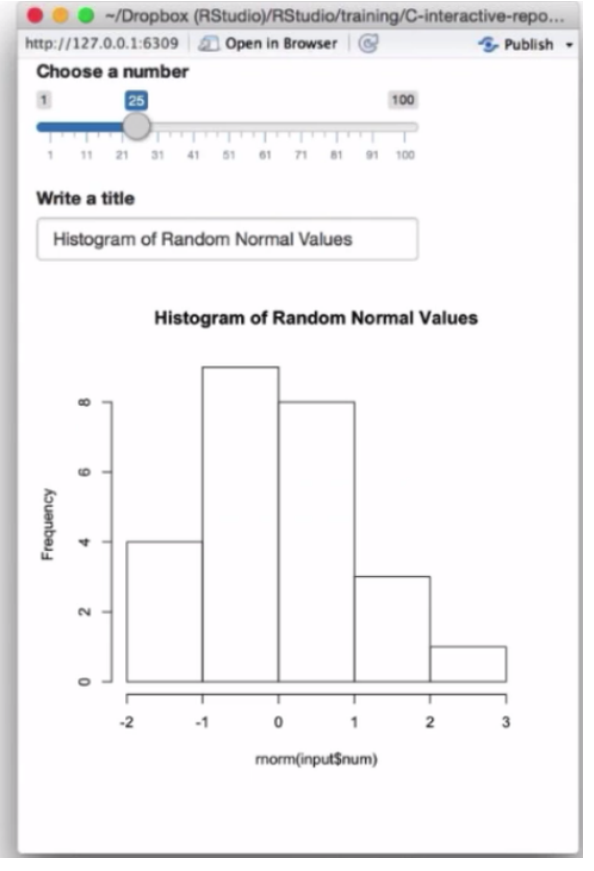
isolate()

Returns the result as a non-reactive value

```
isolate({ rnorm(input$num) })
```

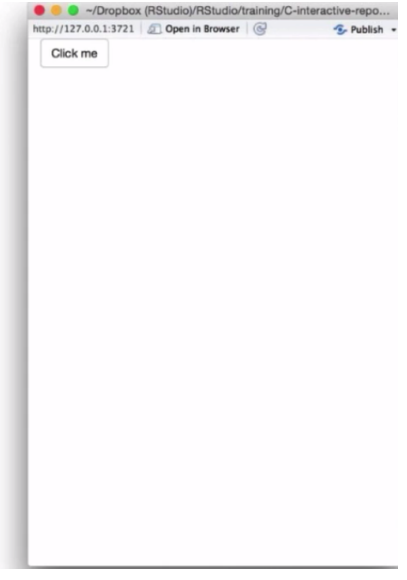
Isolate reactivity

```
# 04-isolate

library(shiny)

ui <- fluidPage(
  sliderInput(inputId = "num",
    label = "Choose a number",
    value = 25, min = 1, max = 100),
  textInput(inputId = "title",
    label = "Write a title",
    value = "Histogram of Random Normal Values"),
  plotOutput("hist")
)

server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$num),
      main = isolate({input$title}))
  })
}

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



observeEvent()

```
# 05-actionButton

library(shiny)

ui <- fluidPage(
  actionButton(inputId = "clicks",
    label = "Click me")
)

server <- function(input, output) {
  observeEvent(input$clicks, {
    print(as.numeric(input$clicks))
  })
}

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



Updating widgets

- Widgets can be updated once initialised.
- Add third argument **session** to server function

```
server=function(input,output,session) {}
```

- Example of a typical UI

```
ui=fluidPage(
  selectInput("select-input",label="selectInput",choices=c("A","B","C")),
  numericInput("numeric-input",label="numericInput",value=5,min=1,max=10),
  sliderInput("slider-input",label="sliderInput",value=5,min=1,max=10),
)
```

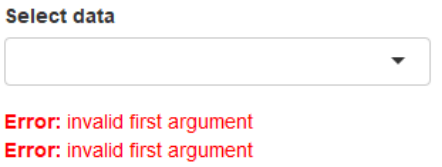
- Update functions can be used to update input widgets
- Reactive observer `observe({})` monitors for a conditional change

```
server=function(input,output,session) {
  observe({
    if(something) {
      updateSelectInput(session,"select-input",label="selectInput",choices=c("D","E","F")
      updateNumericInput(session,"numeric-input",label="numericInput",value=10,min=1,max=
      updateSliderInput(session,"slider-input",label="sliderInput",value=8,min=1,max=10)
    }
  })
}
```

Error validation

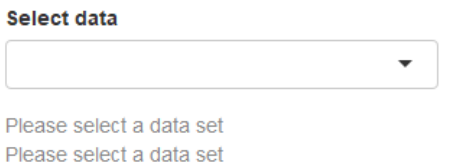
- Shiny returns an error with missing or incorrect values

```
shinyApp(
ui=fluidPage(
  selectInput("data_input",label="Select data",
              choices=c("","mtcars","faithful","iris")),
```



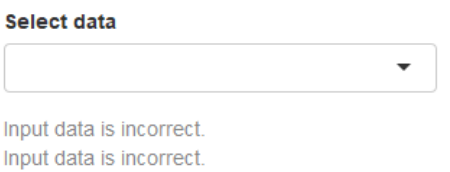
- Errors can be handled in a controlled manner
- `validate()` can be used to check input
- `validate()` using `need()`

```
shinyApp(
ui=fluidPage(
  selectInput("data_input",label="Select data",
              choices=c("","mtcars","faithful","iris")),
```



- `validate()` using custom function

```
valfn <- function(x) if(is.null(x) | is.na(x) | x=="") return
shinyApp(
ui=fluidPage(
  selectInput("data_input",label="Select data",
```



- `shiny::req()` checks input variable and silently stops execution

Download • Data

- Add button and `downloadHandler()` function

```
shinyApp(
ui=fluidPage(
  selectInput("data_input",label="Select data",
              choices=c("mtcars","faithful","iris")),
  textOutput("text_output"),
  downloadButton("button_download","Download")
),
server=function(input, output) {
  getdata <- reactive({ get(input$data_input, 'package:datasets') })
  output$text_output <- renderText(paste0("Selected dataset: ",input$data_input))

  output$button_download <- downloadHandler(
  filename = function() {
     paste0(input$data_input,".csv")
   },
  content = function(file) {
     write.csv(getdata(),file,row.names=FALSE,quote=F)
   })
})
```

- Run in system browser if Rstudio browser doesn't work
- See usage of download buttons

Download • Plots

```
shinyApp(
ui=fluidPage(
  selectInput("data_input",label="Select data",
              choices=c("mtcars","faithful","iris")),
  textOutput("text_output"),
  plotOutput("plot_output",width="400px"),
  downloadButton("button_download", "Download")
),
server=function(input, output) {
  getdata <- reactive({ get(input$data_input, 'package:datasets') })
  output$text_output <- renderText(paste0("Selected dataset: ",input$data_input))
  output$plot_output <- renderPlot({hist(getdata()[, 1])})

output$button_download <- downloadHandler(
  filename = function() {
    paste0(input$data_input,".png")
  },
  content = function(file) {
    png(file)
    hist(getdata()[, 1])
    dev.off()
  })
})
```

- Run in system browser if Rstudio browser doesn't work
- See usage of download buttons

Thank you. Questions?

Slide courtesy: Roy Francis (NBIS, RaukR2021)

R version 4.1.3 (2022-03-10)

Platform: x86_64-pc-linux-gnu (64-bit)

OS: Ubuntu 18.04.6 LTS

Built on : 19-Oct-2022 at 09:24:51