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Reactivity

The World's Local Training Provider

What is Reactivity?

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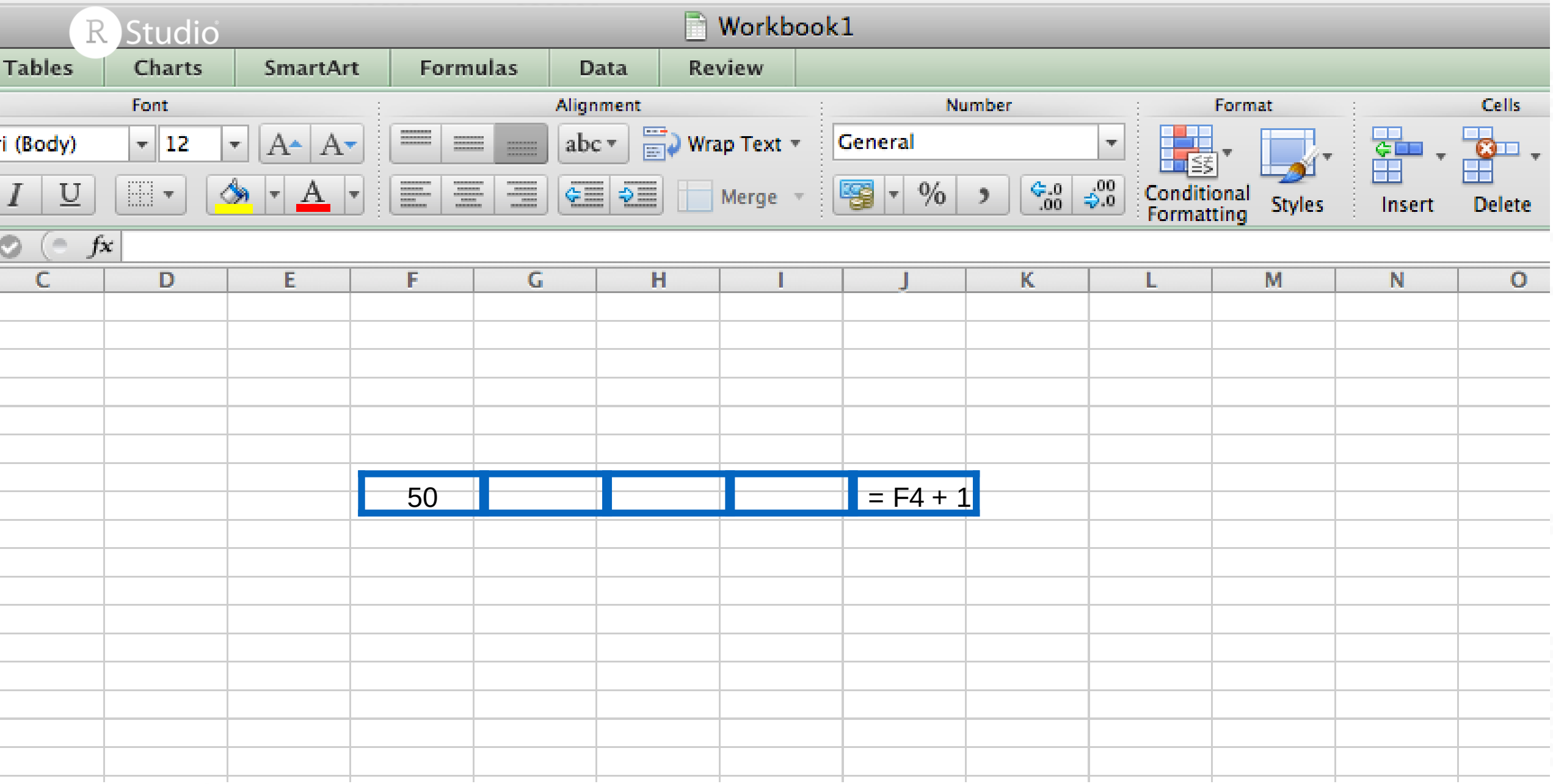

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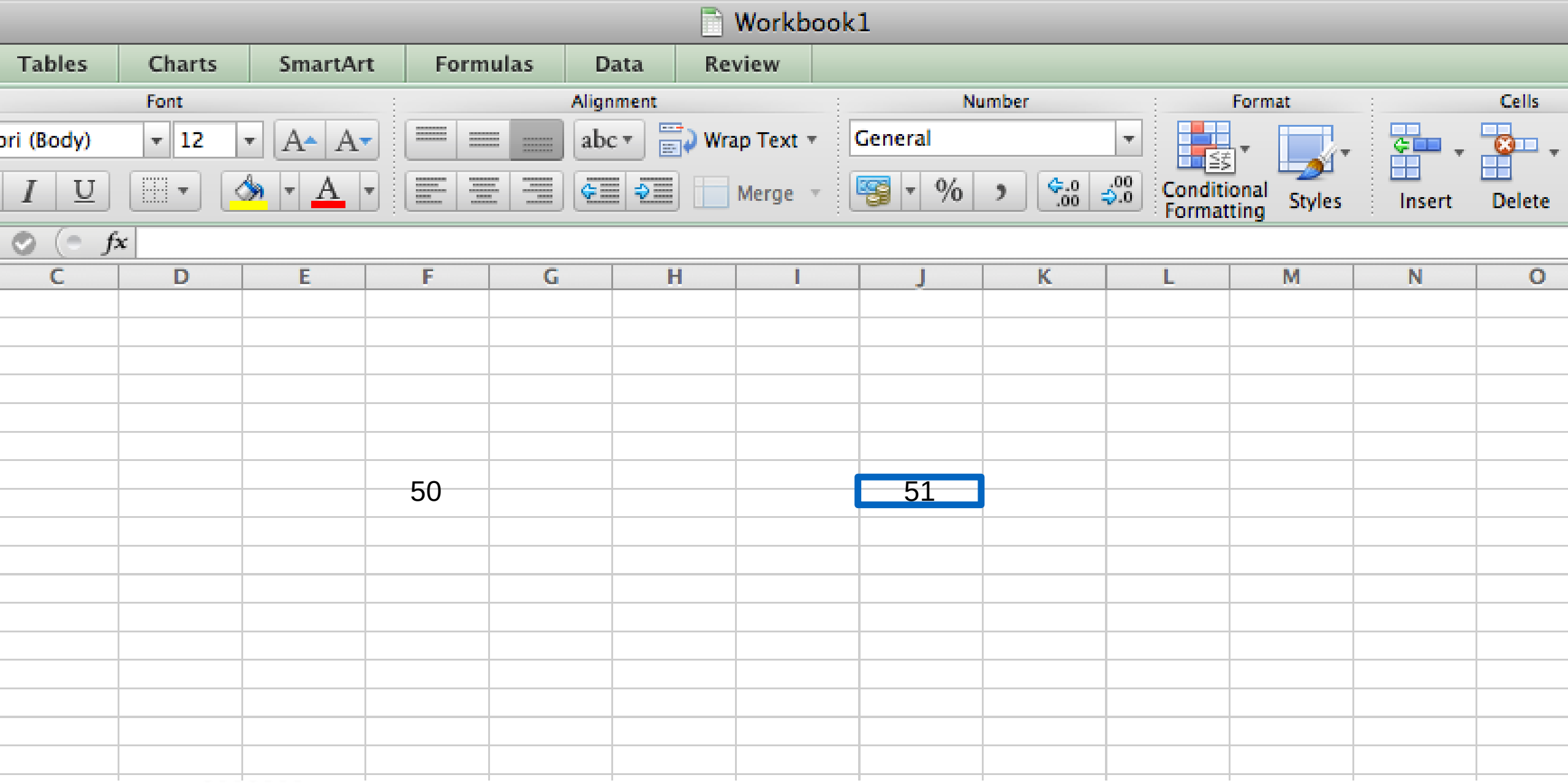

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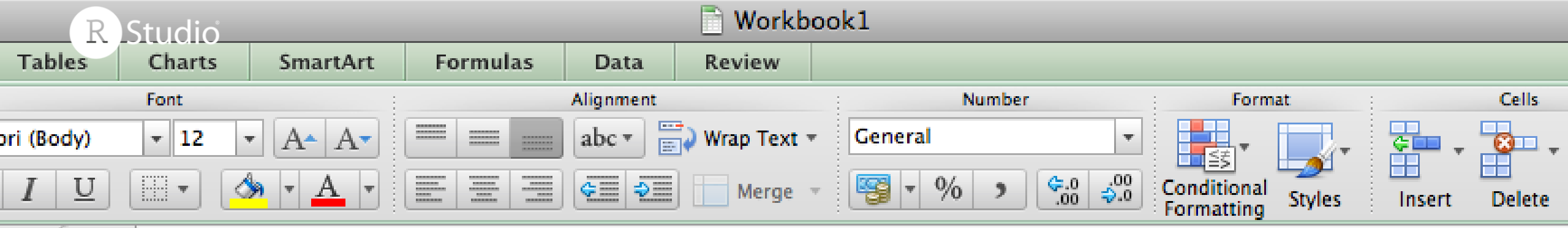

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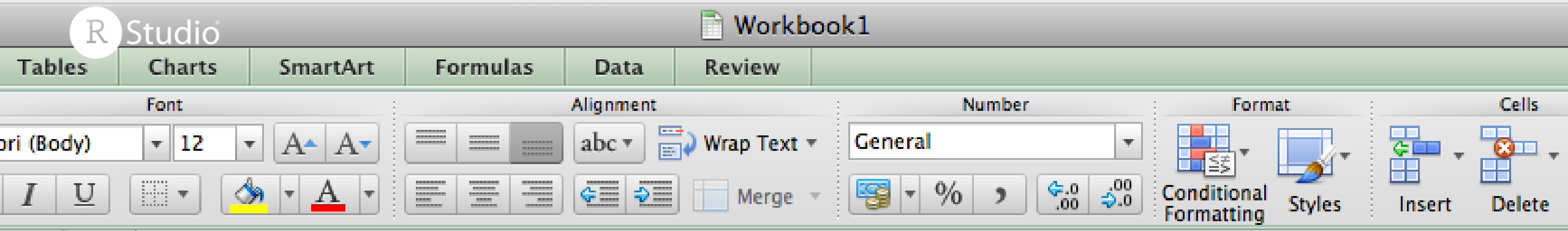

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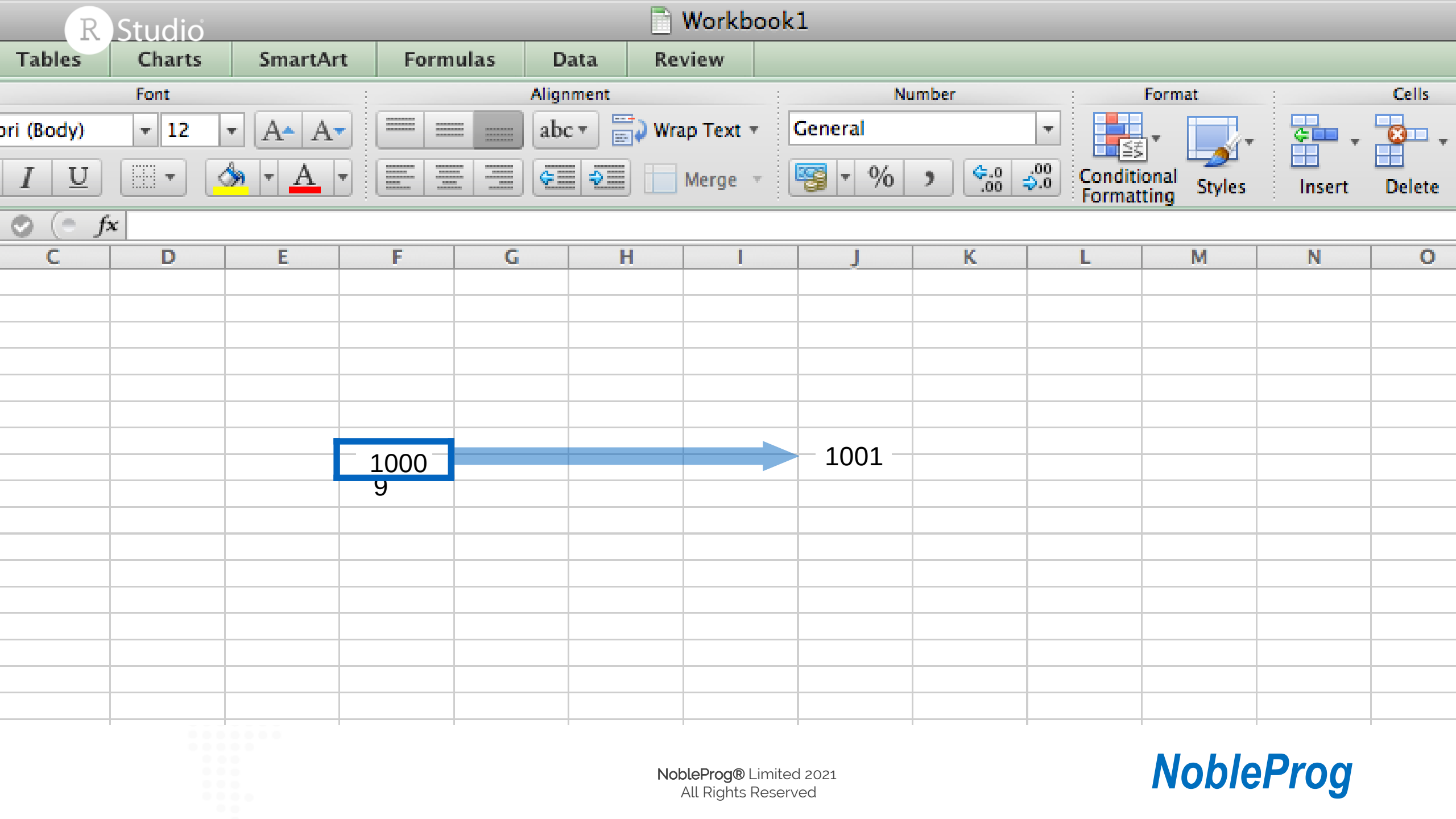

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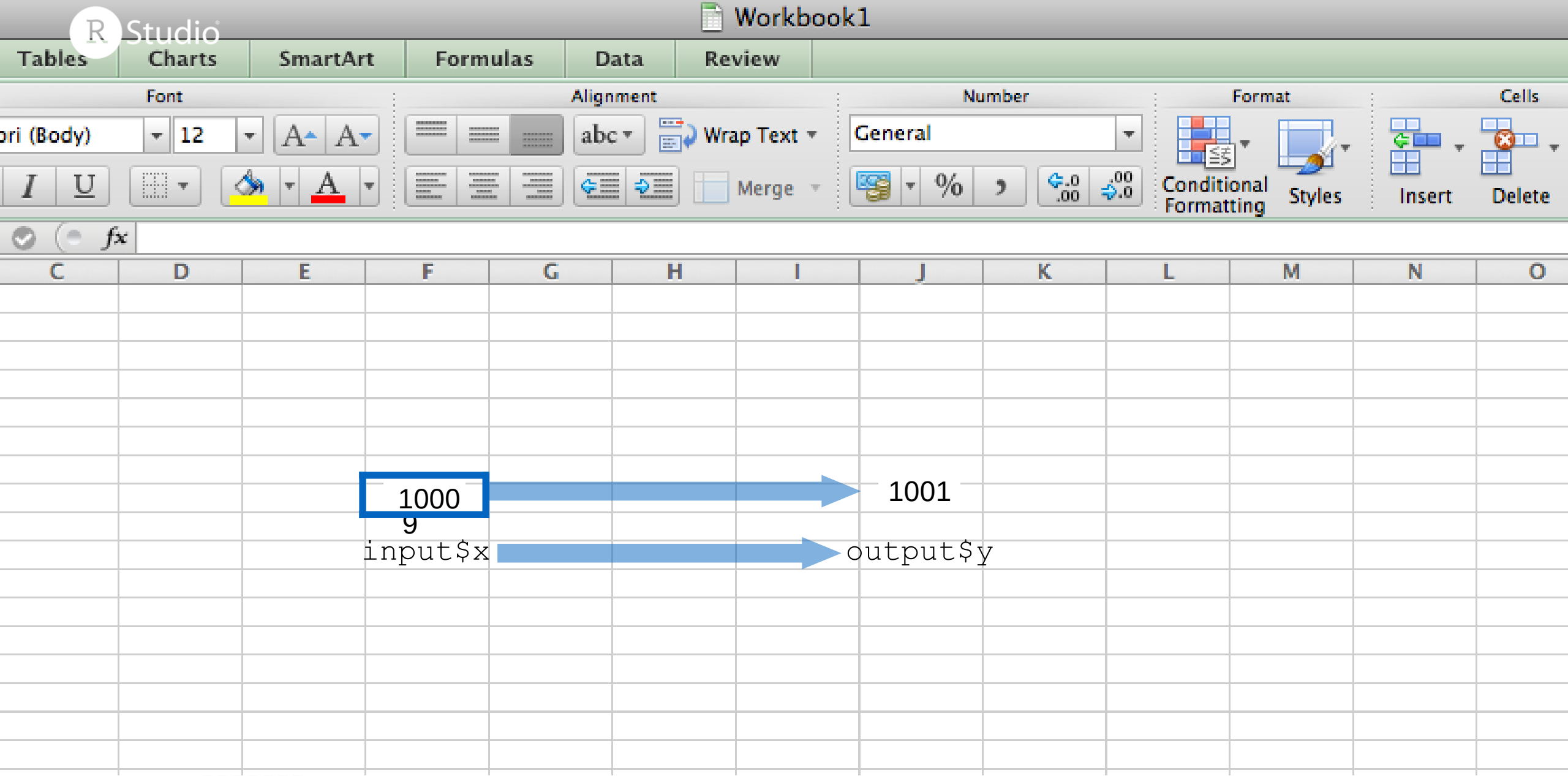

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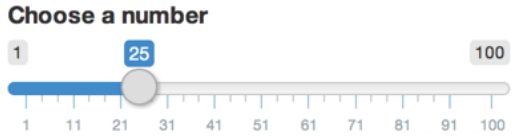

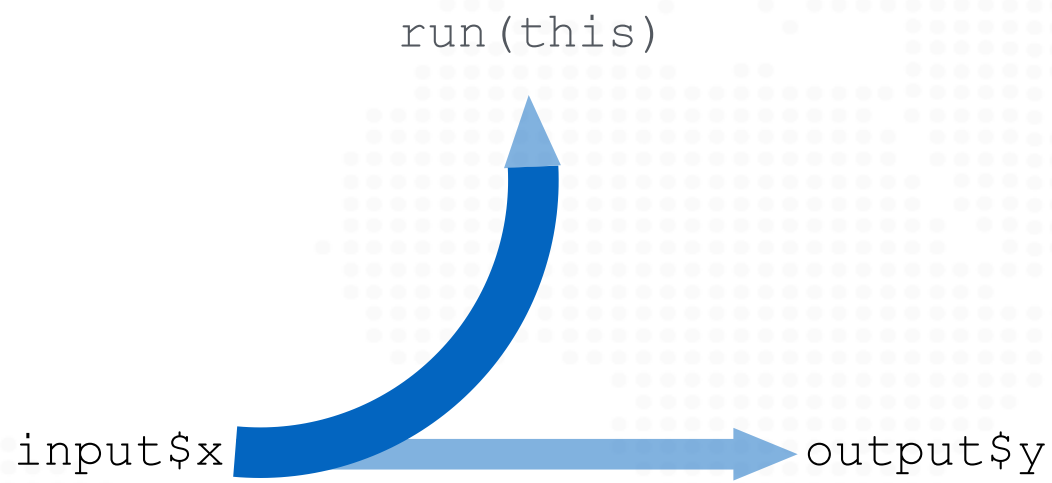

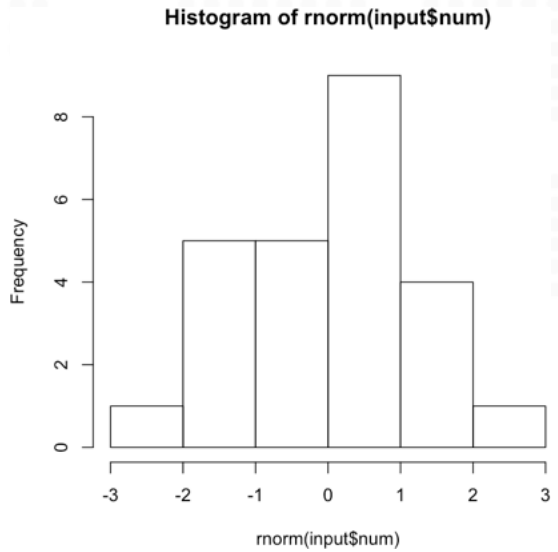

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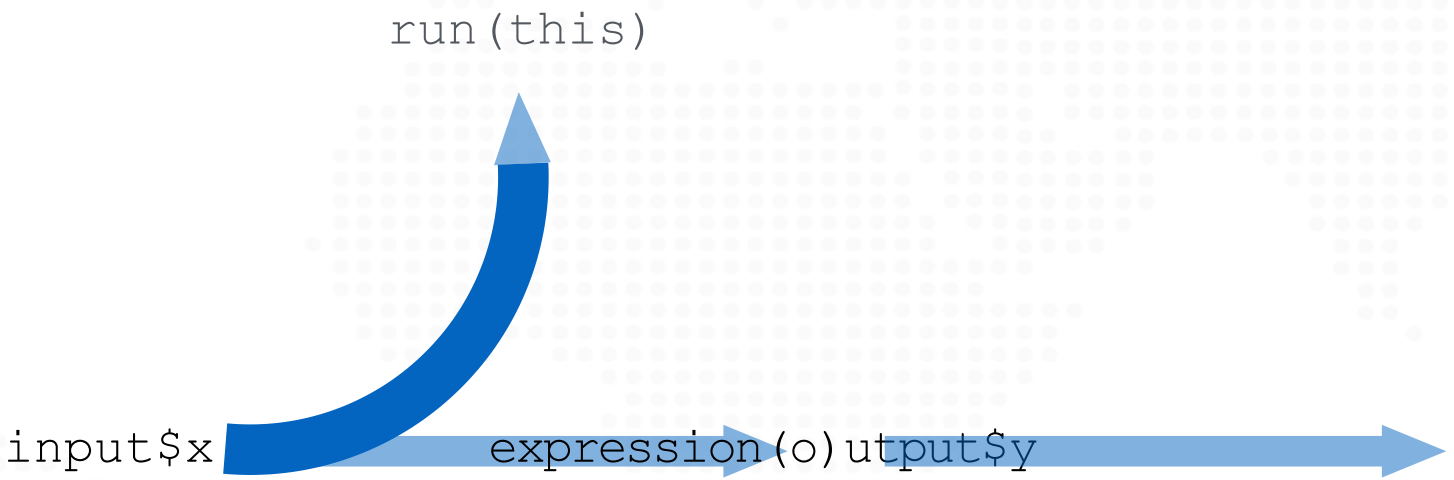

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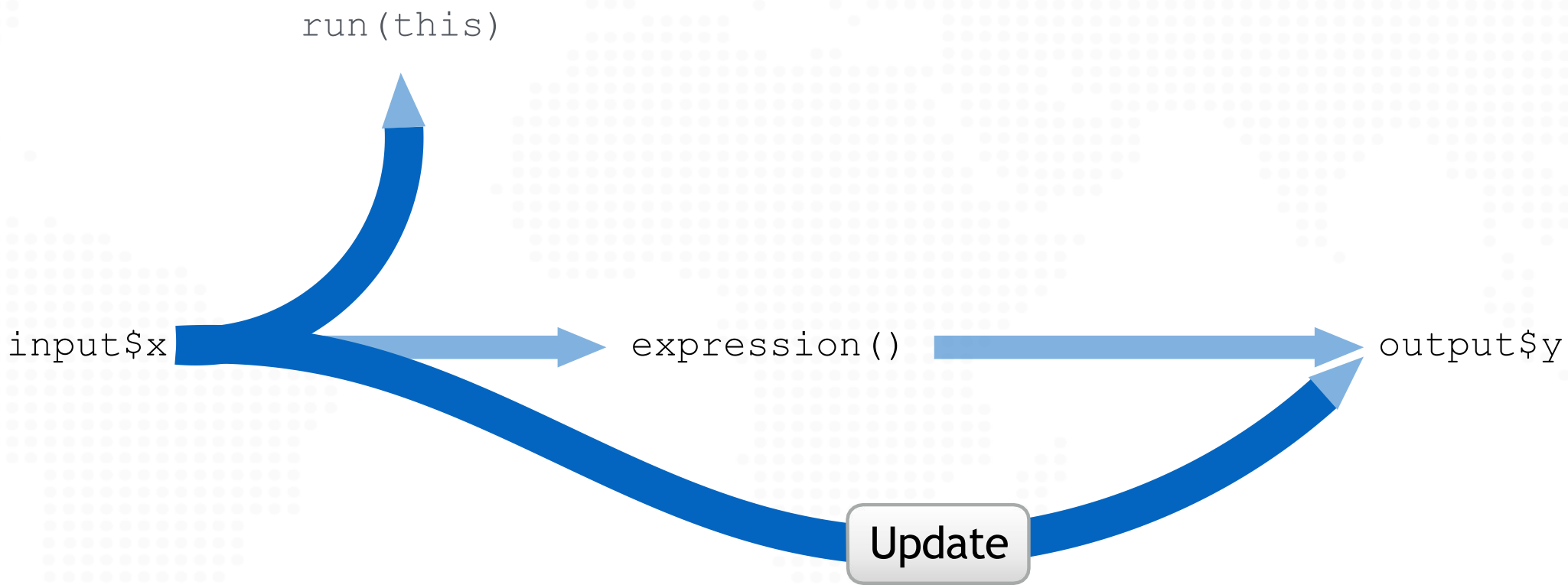

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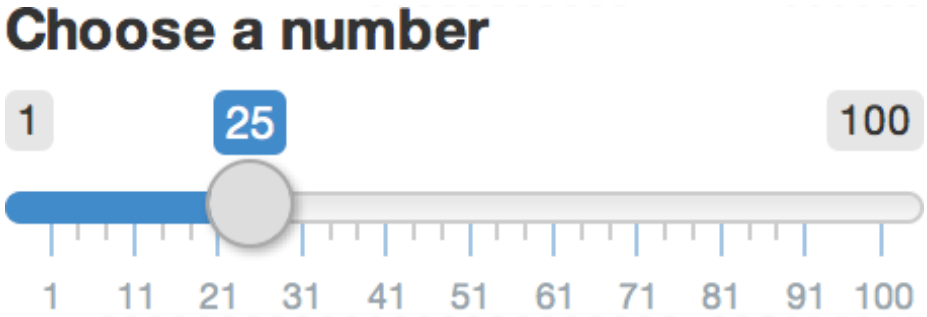
Syntax




```
sliderInput(inputId = "num", label = "Choose a number", …)
```

this input will provide a value saved as **input$num**

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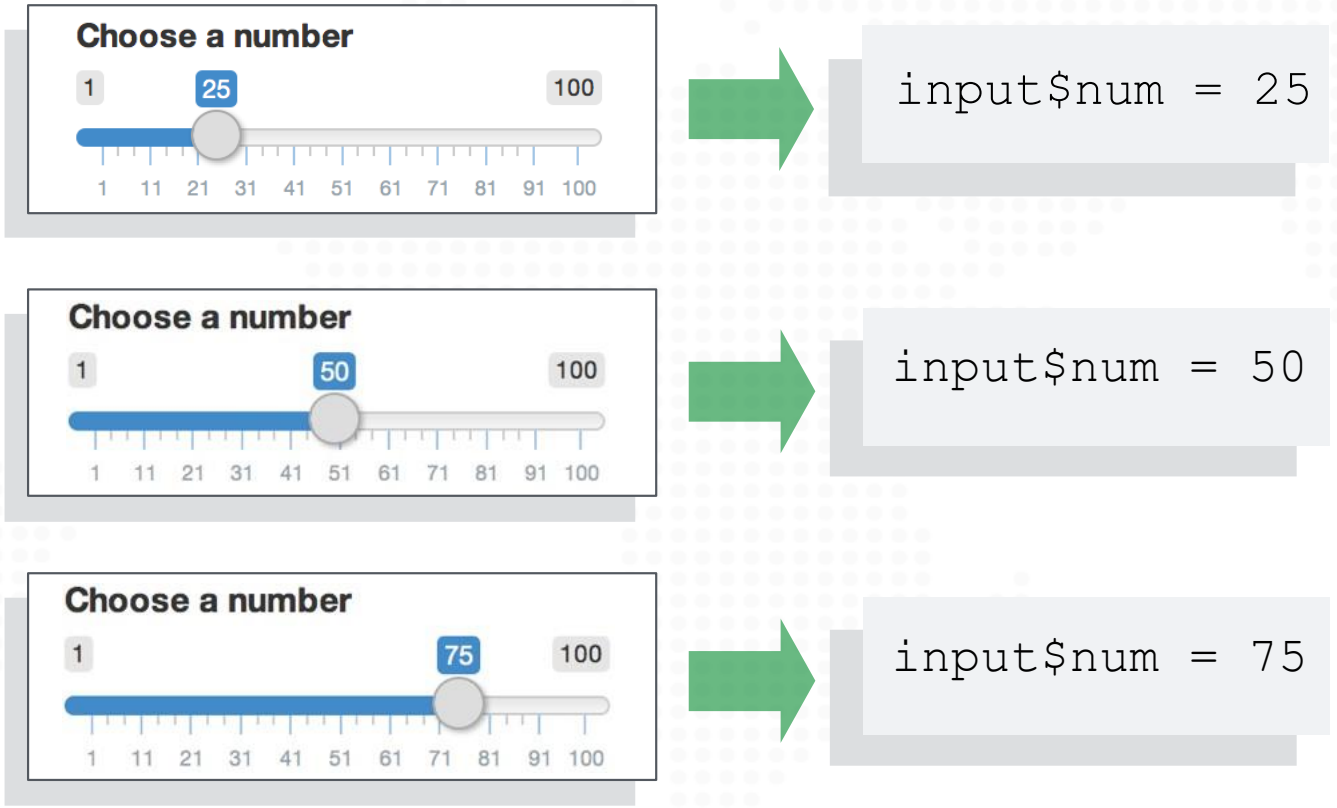
Input values

The input value changes whenever a user changes the input.



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Reactive values work together with reactive functions.
You cannot call a reactive value from outside of one.

```
renderPlot({ hist(rnorm(100, input$num)) })
```

```
hist(rnorm(100, input$num))
```


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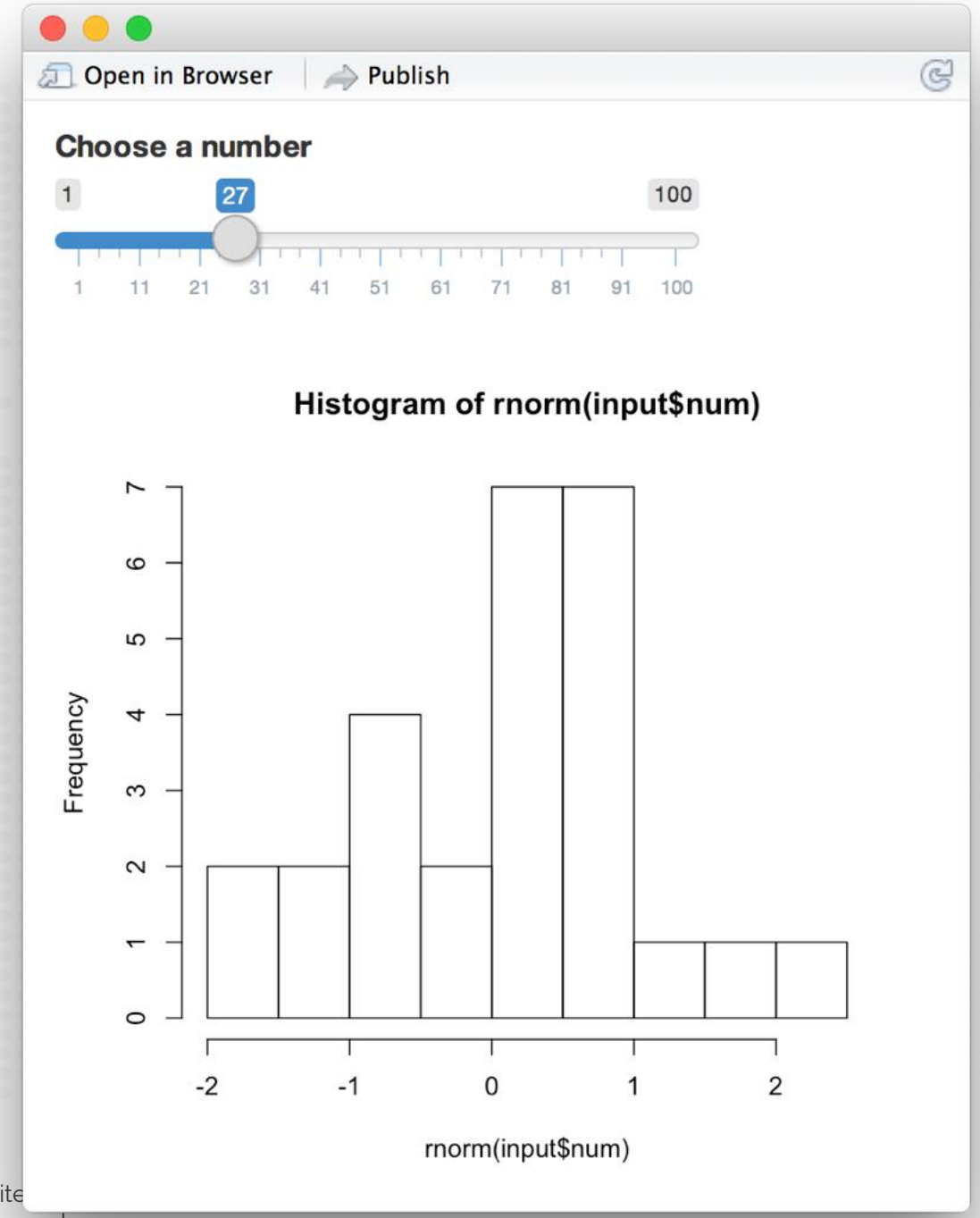
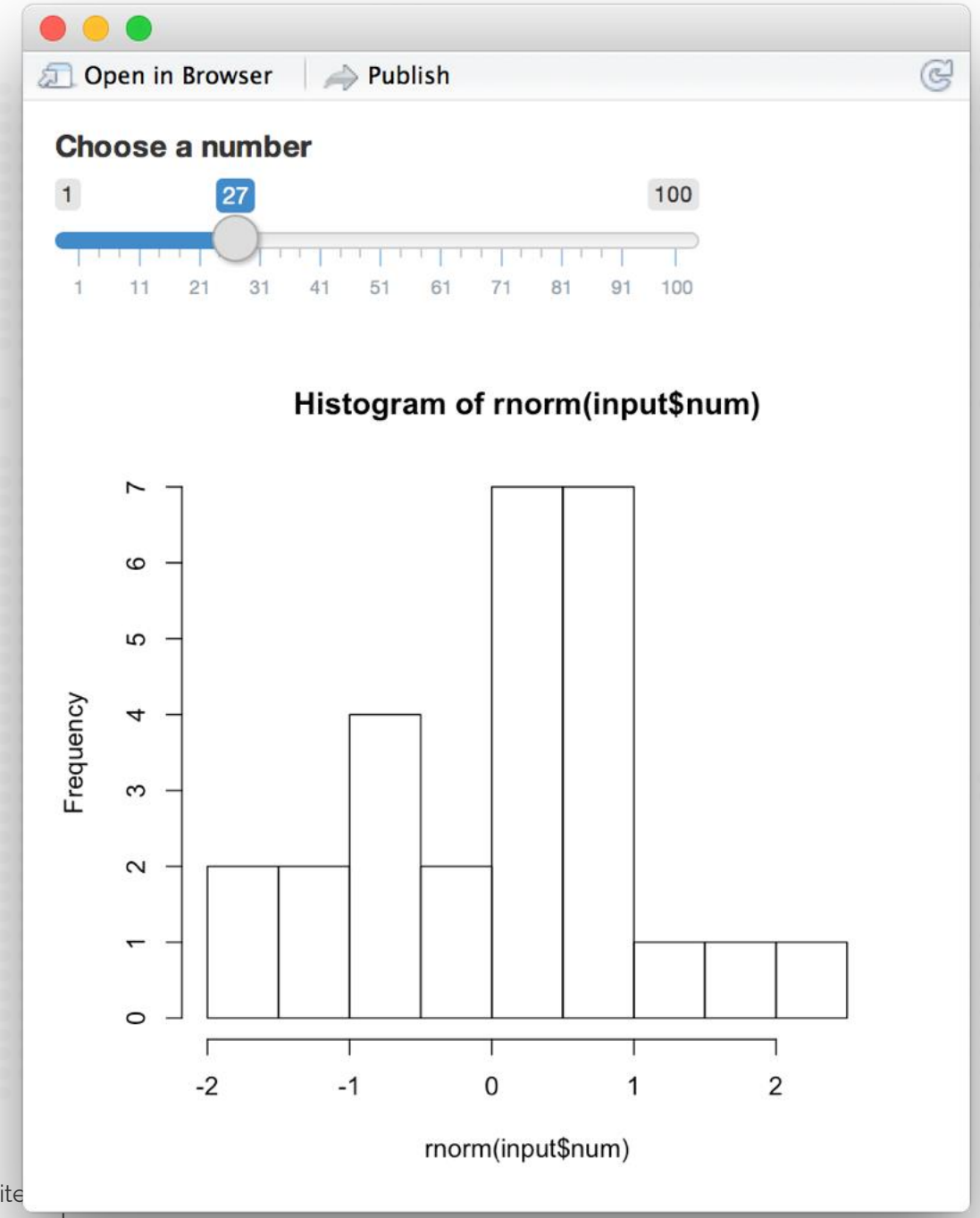
```
library(shiny)

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

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

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



```
library(shiny)

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

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

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

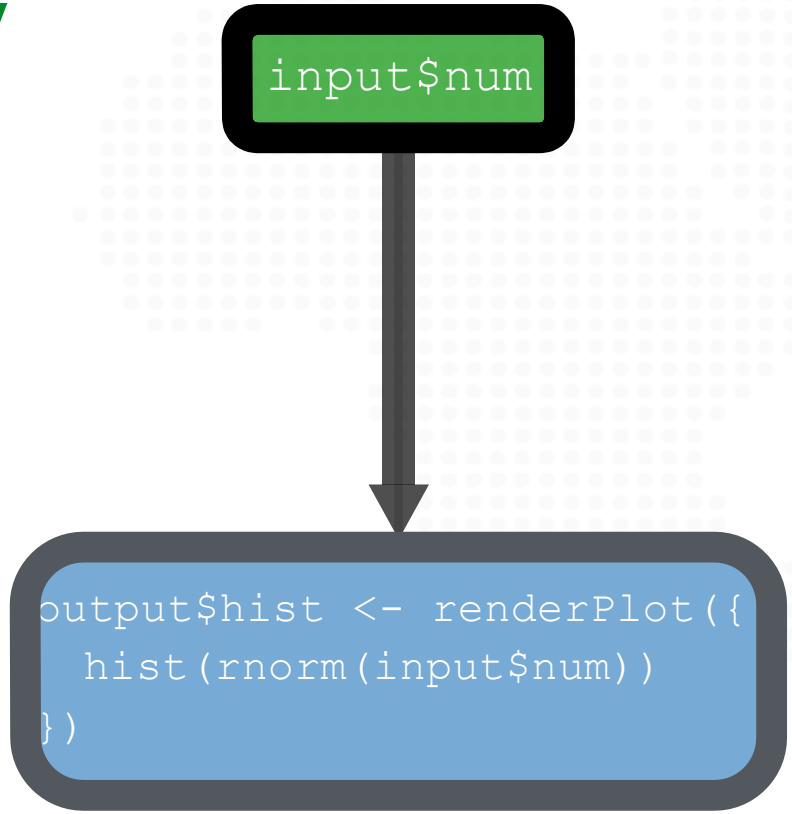


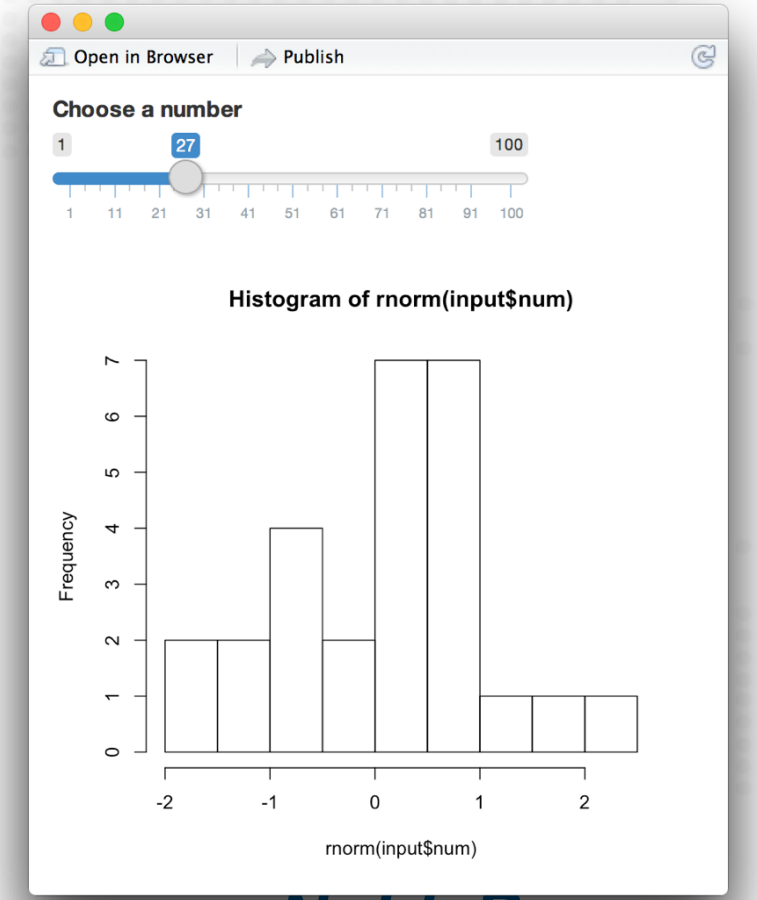
```
library(shiny)

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

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

}

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

```
 Error in .getReactiveEnvironment()
$currentContext() :
  Operation not allowed without an
active reactive context. (You tried
to do something that can only be done
from inside a reactive expression or
observer.)
```

Think of reactivity in R as a two step process

1 **Reactive values notify**
the functions that use them
when they become invalid





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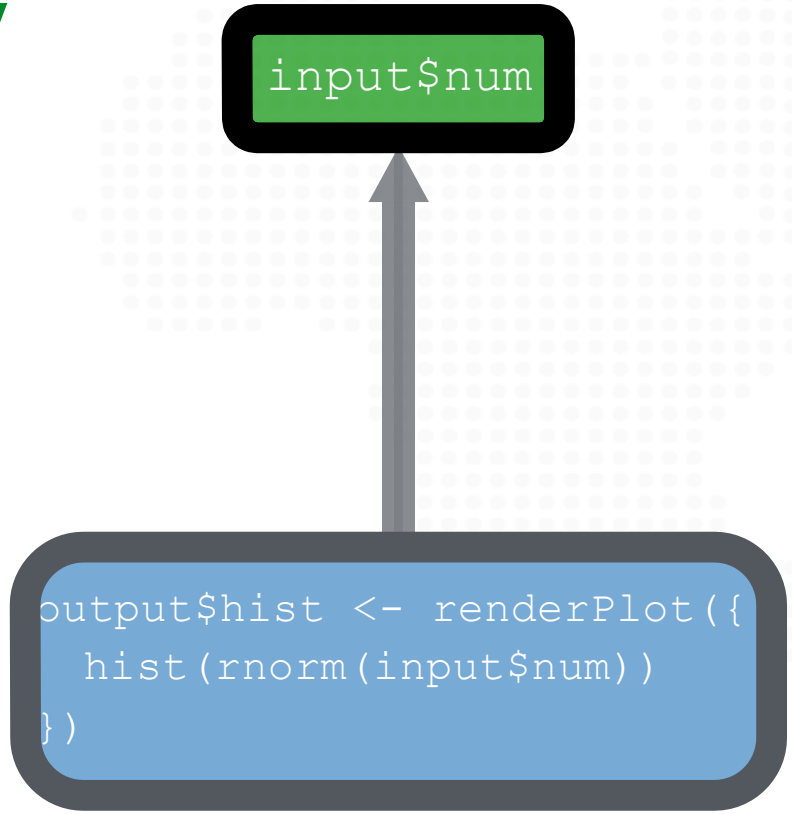
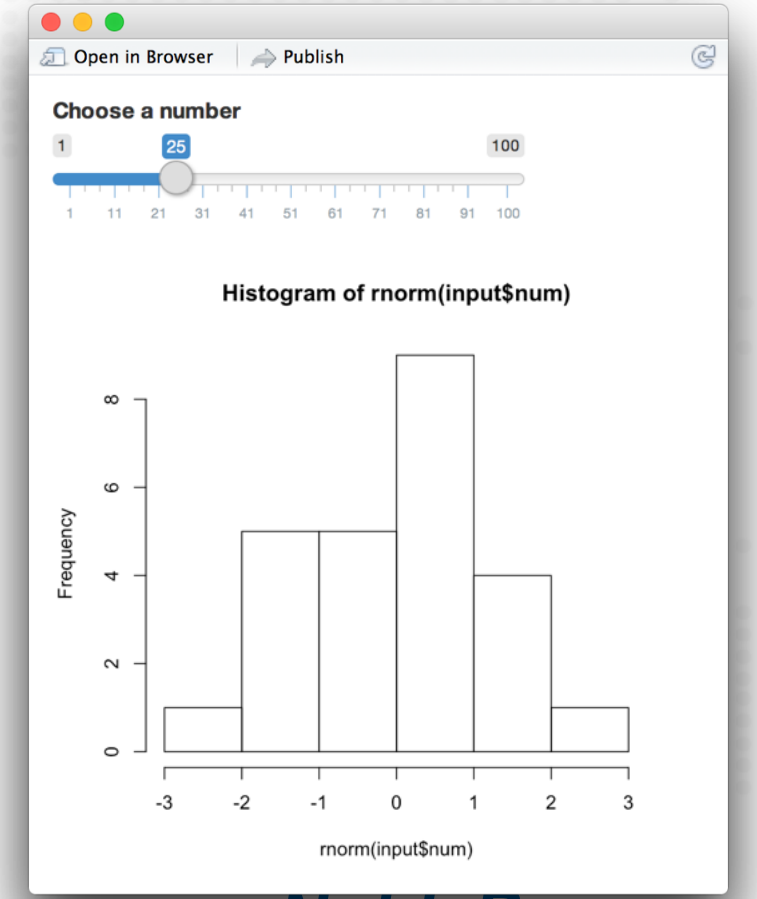
Think of reactivity in R as a two step process

1 **Reactive values notify**
the functions that use them
when they become invalid

2 The objects created by
reactive functions respond
(different objects respond differently)





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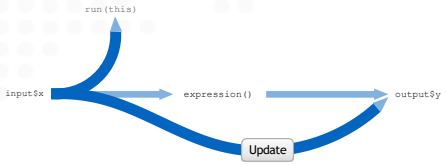
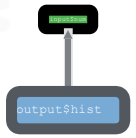
Recap: Reactive values



Reactive values act as the data streams that flow through your app.

The **input** list is a list of reactive values. The values show the current state of the inputs.

You can only call a reactive value from a function that is designed to work with one



Reactive values notify. The objects created by **reactive functions respond.**

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Reactive toolkit (7 indispensible functions)

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Reactive functions

1. Use a code chunk to build (and rebuild) an object
   - **What code** will the function use?

2. The object will respond to changes in a set of reactive values
   - **Which reactive values** will the object respond to?

Display output with render*()

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Render functions build output to display in the app

function	creates
`renderDataTable()`	An interactive table (from a data frame, matrix, or other table-like structure)
`renderImage()`	An image (saved as a link to a source file)
`renderPlot()`	A plot
`renderPrint()`	A code block of printed output
`renderTable()`	A table (from a data frame, matrix, or other table-like structure)
`renderText()`	A character string
`renderUI()`	a Shiny UI element

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render*()

Builds reactive output to display in UI

```
renderPlot(  { hist(rnorm(input$num)) })
```

object will respond to *every reactive value in the code*

code used to build (and rebuild) object

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render*()

Builds reactive output to display in UI

```
renderPlot(  { hist(rnorm(input$num)) })
```

When notified that it is invalid, the object created by a render*() function will rerun the entire block of code associated with it

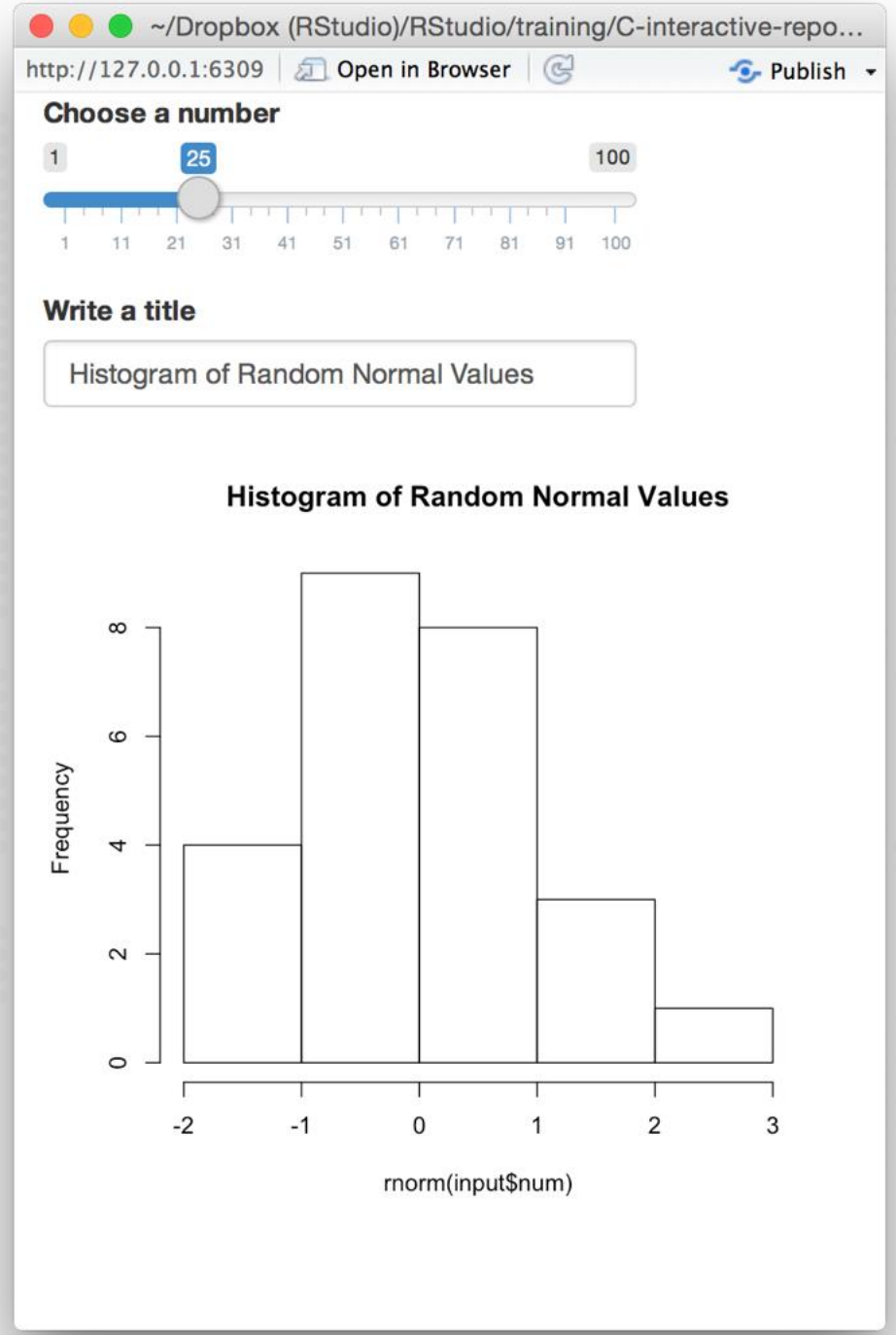
```
# 01-two-inputs

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)
```



```
# 01-two-inputs

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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)
```
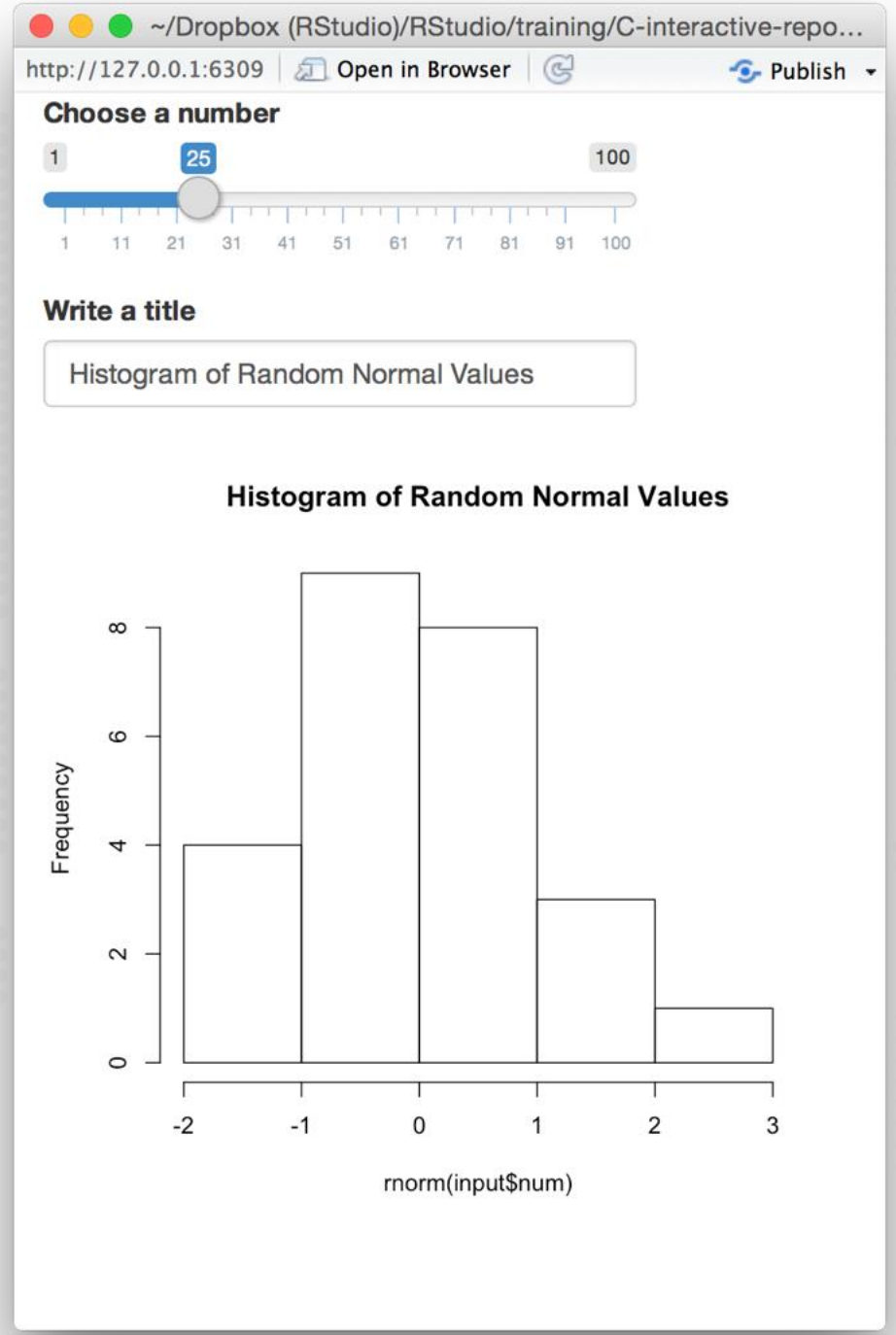
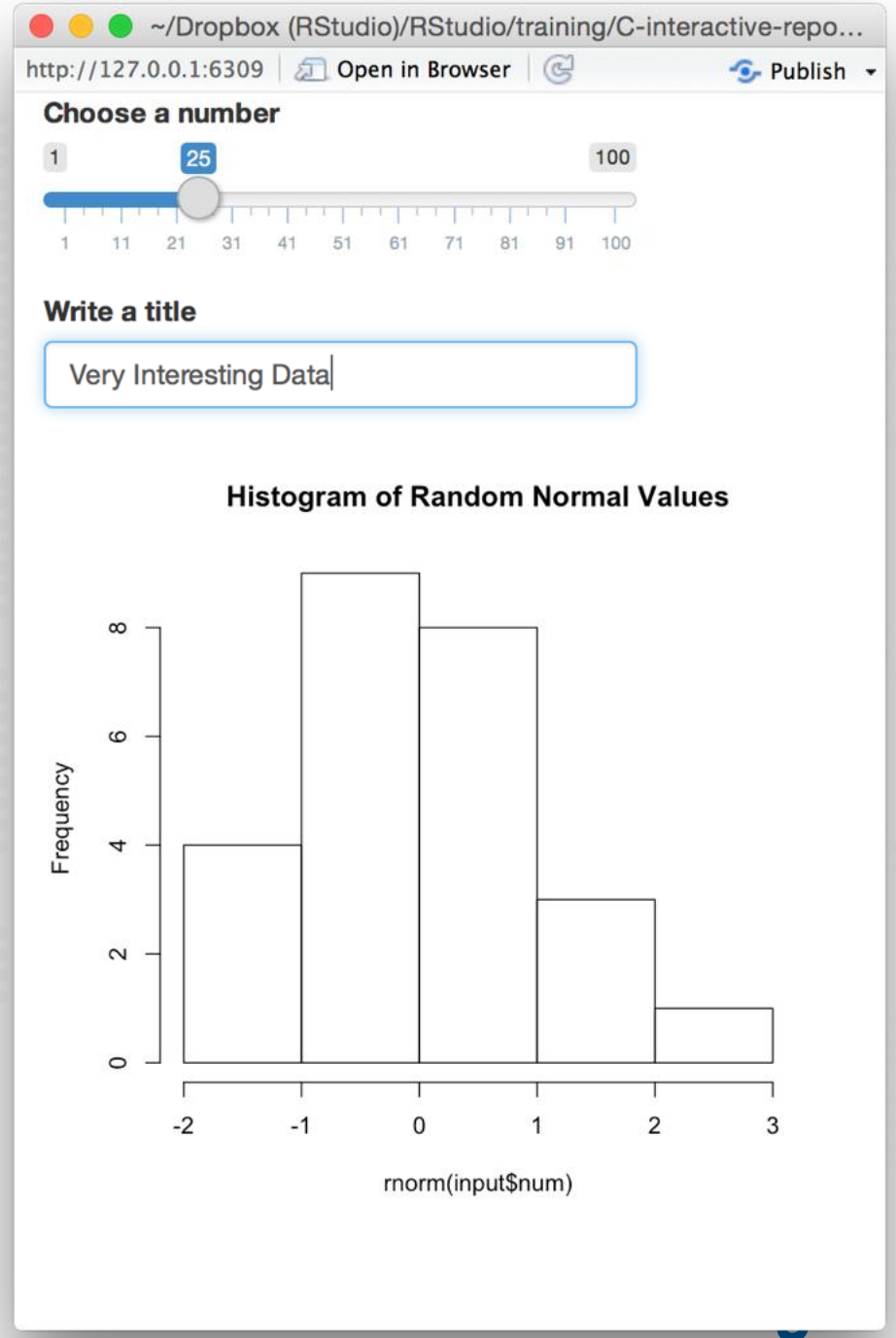



input$num

input$title

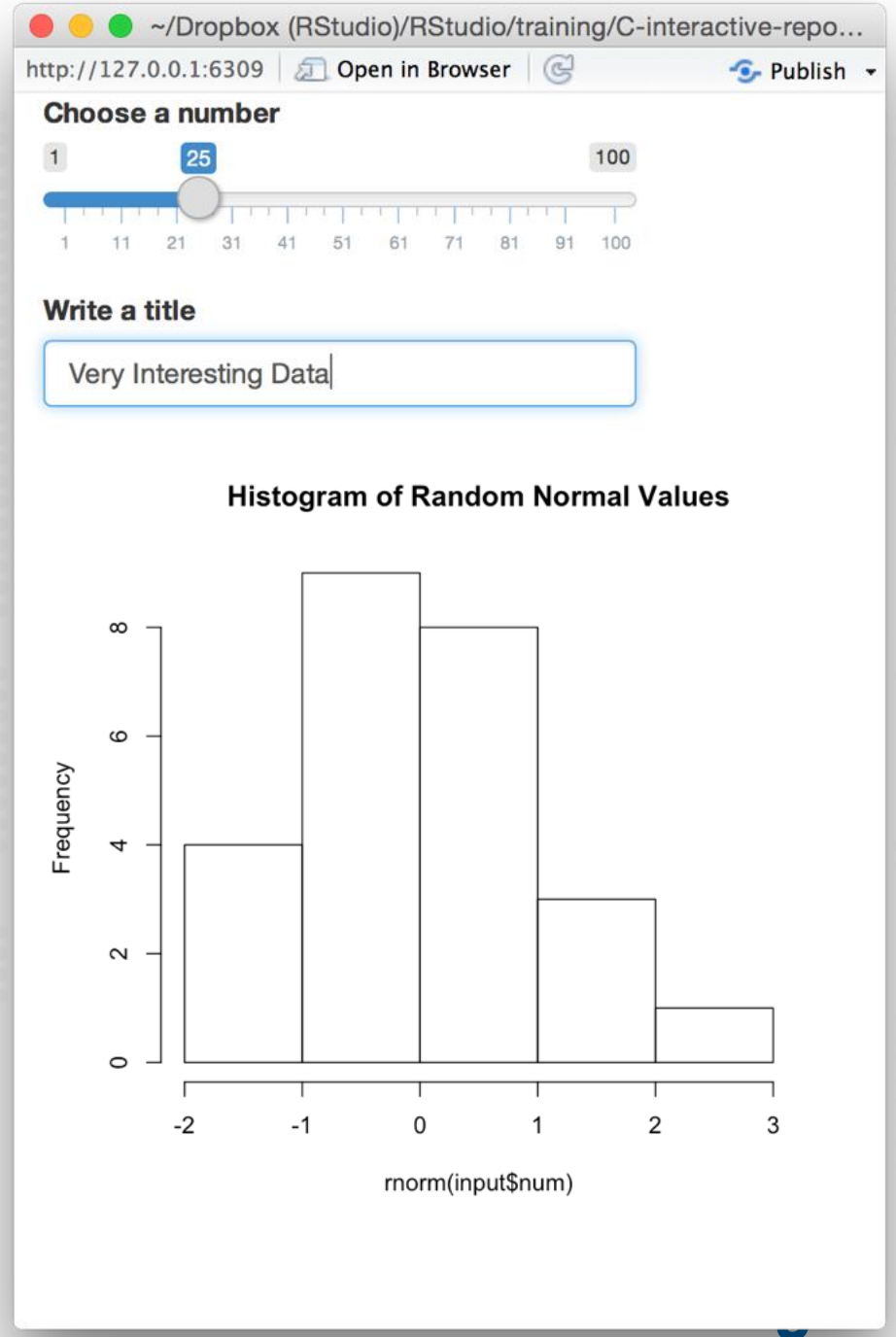
```
output$hist <-
 renderPlot({
 hist(rnorm(input$num),
   main = input$title)
```



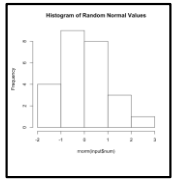
input$num

input$title

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



Recap: render*()



render*() functions make **objects to display**

`output$`

Always save the result to **output$**

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

render*() makes an observer object that has a **block of code** associated with it

```
renderPlot(  { hist(rnorm(input$num)) })
```

The object will **rerun the entire code block** to update itself whenever it is invalidated

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Modularize code with reactive()

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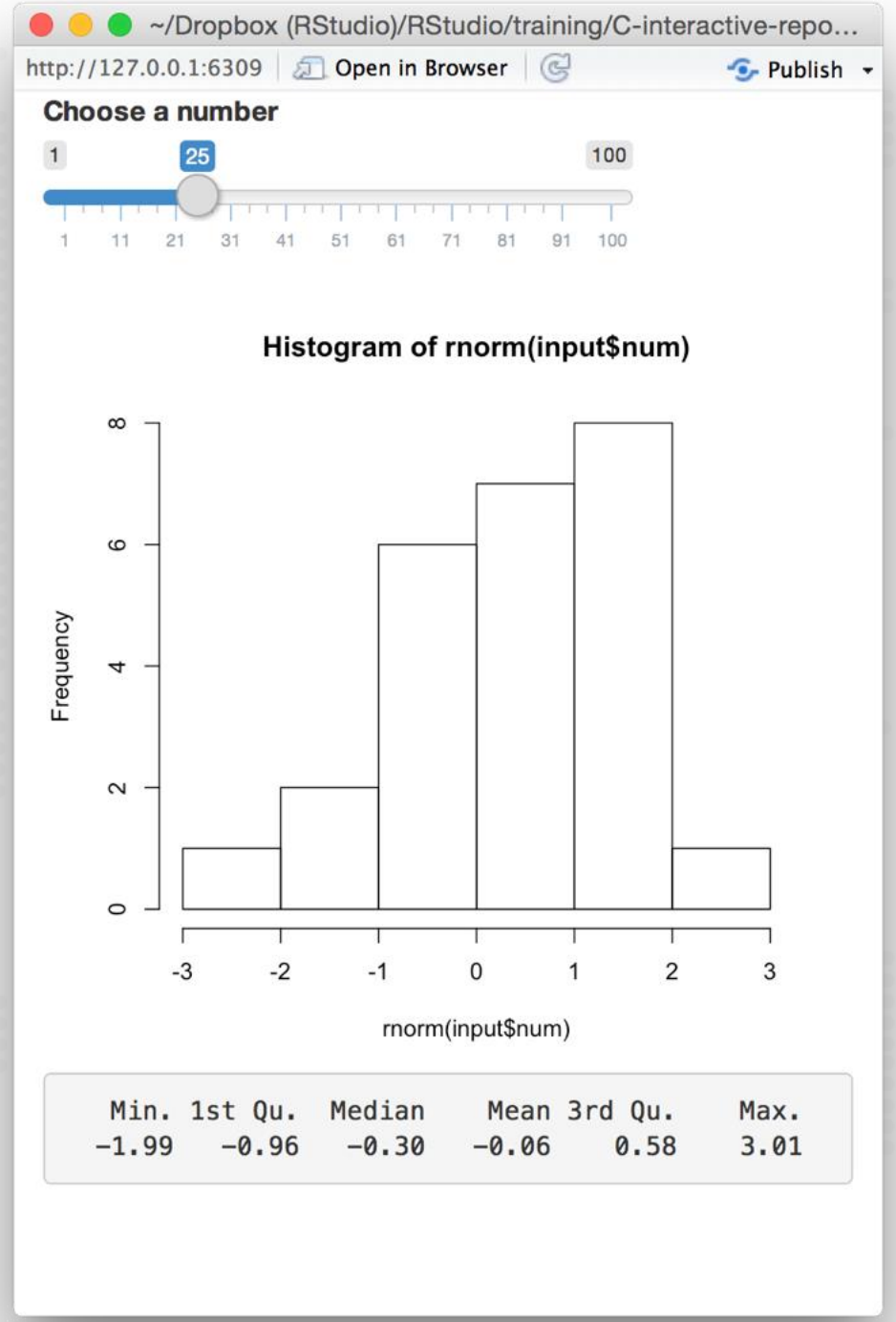
```
# 02-two-outputs

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)
```



```
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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)
```
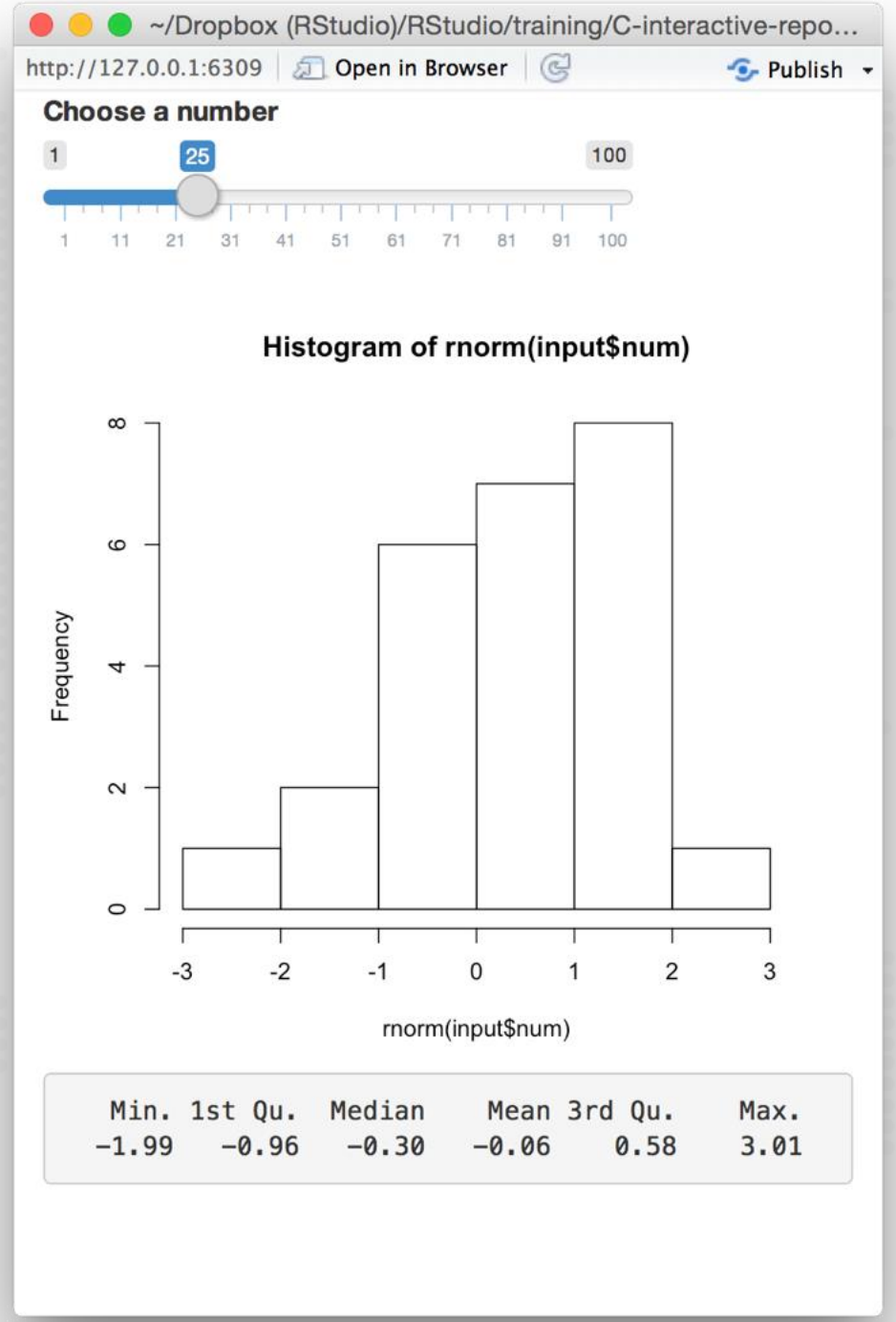
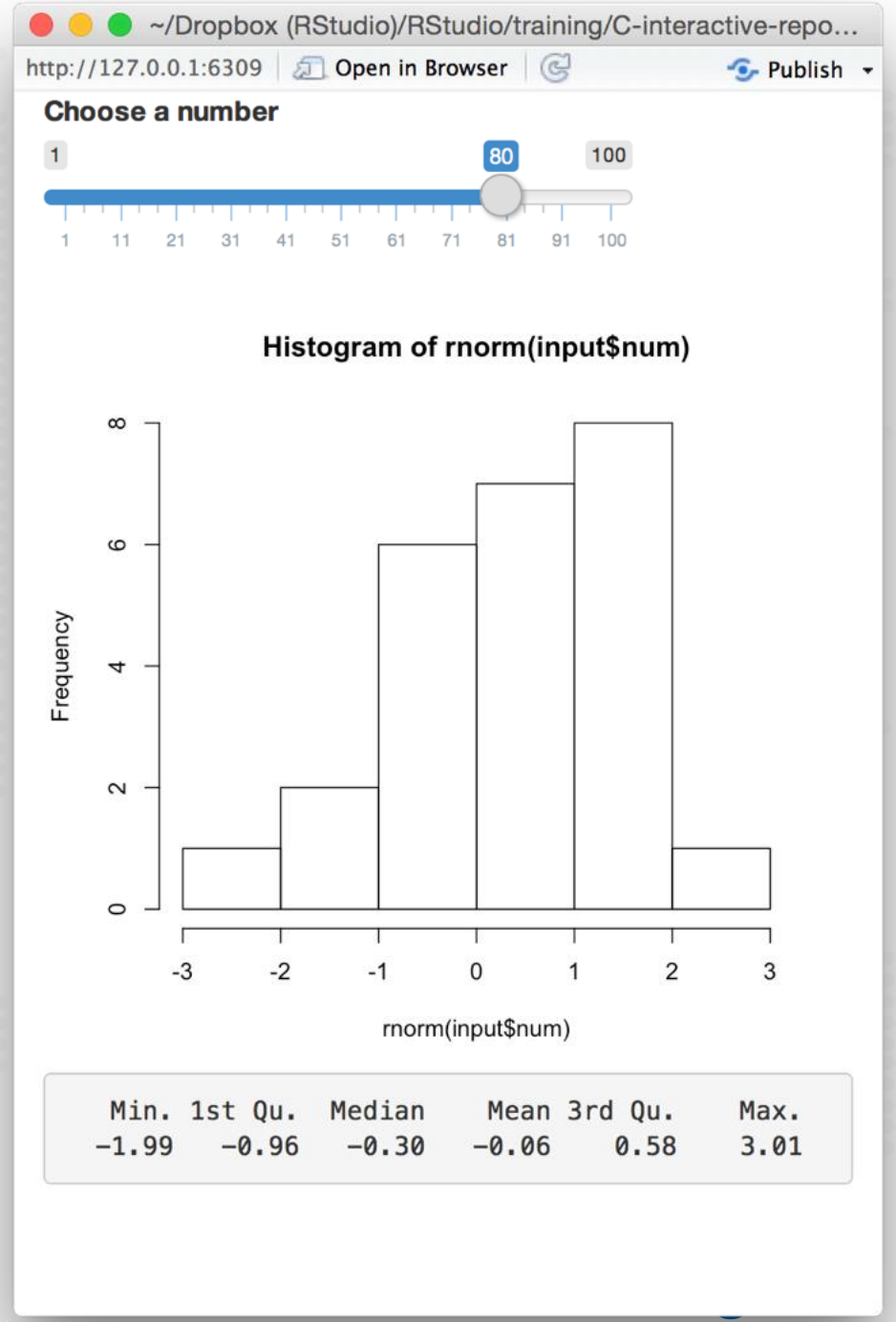



input$num

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

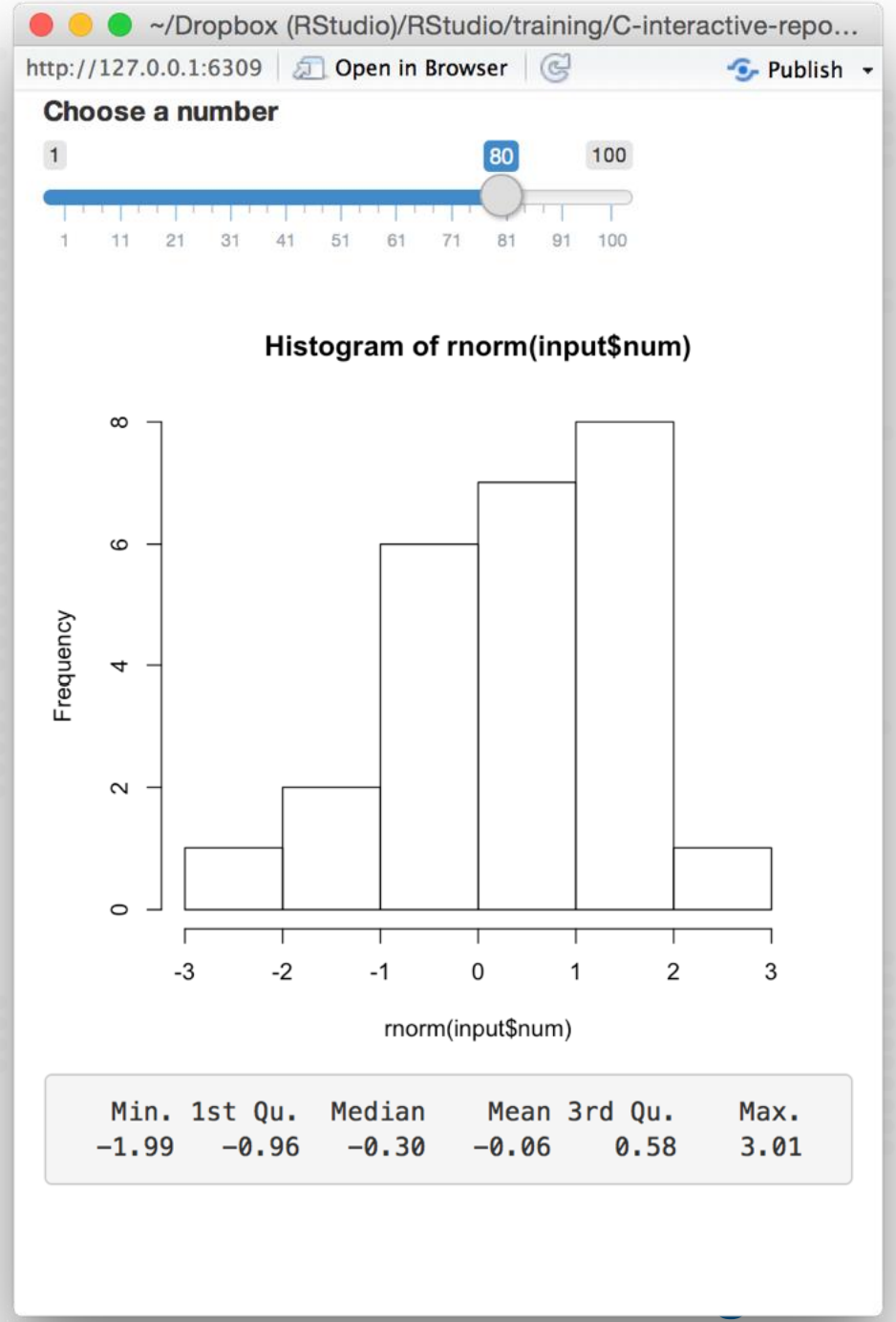
```
output$stats <-
  renderPrint({
  summary(rnorm(input$num))
  })
```



input$num

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

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

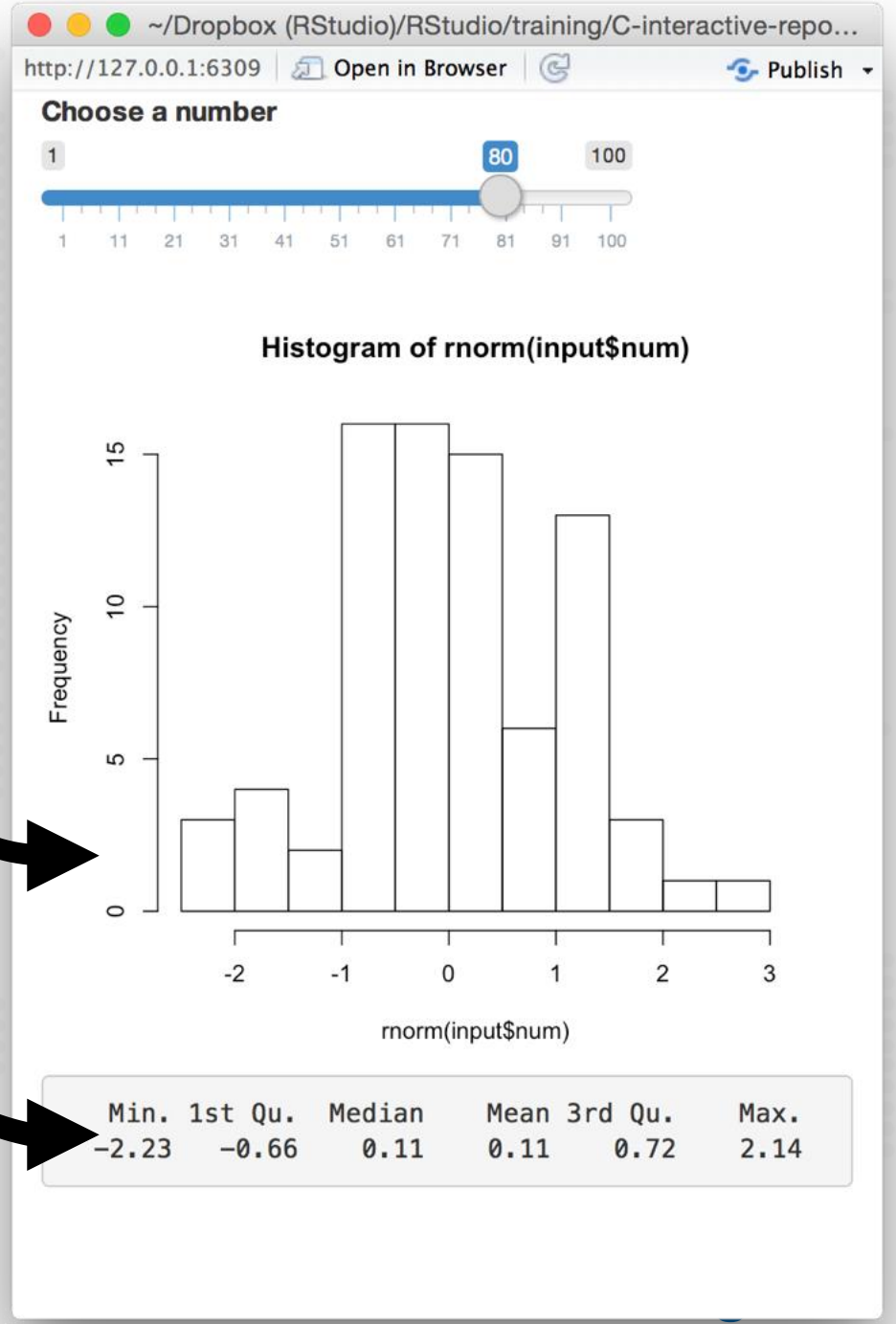


`input$num`

Can these describe the same data?

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

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

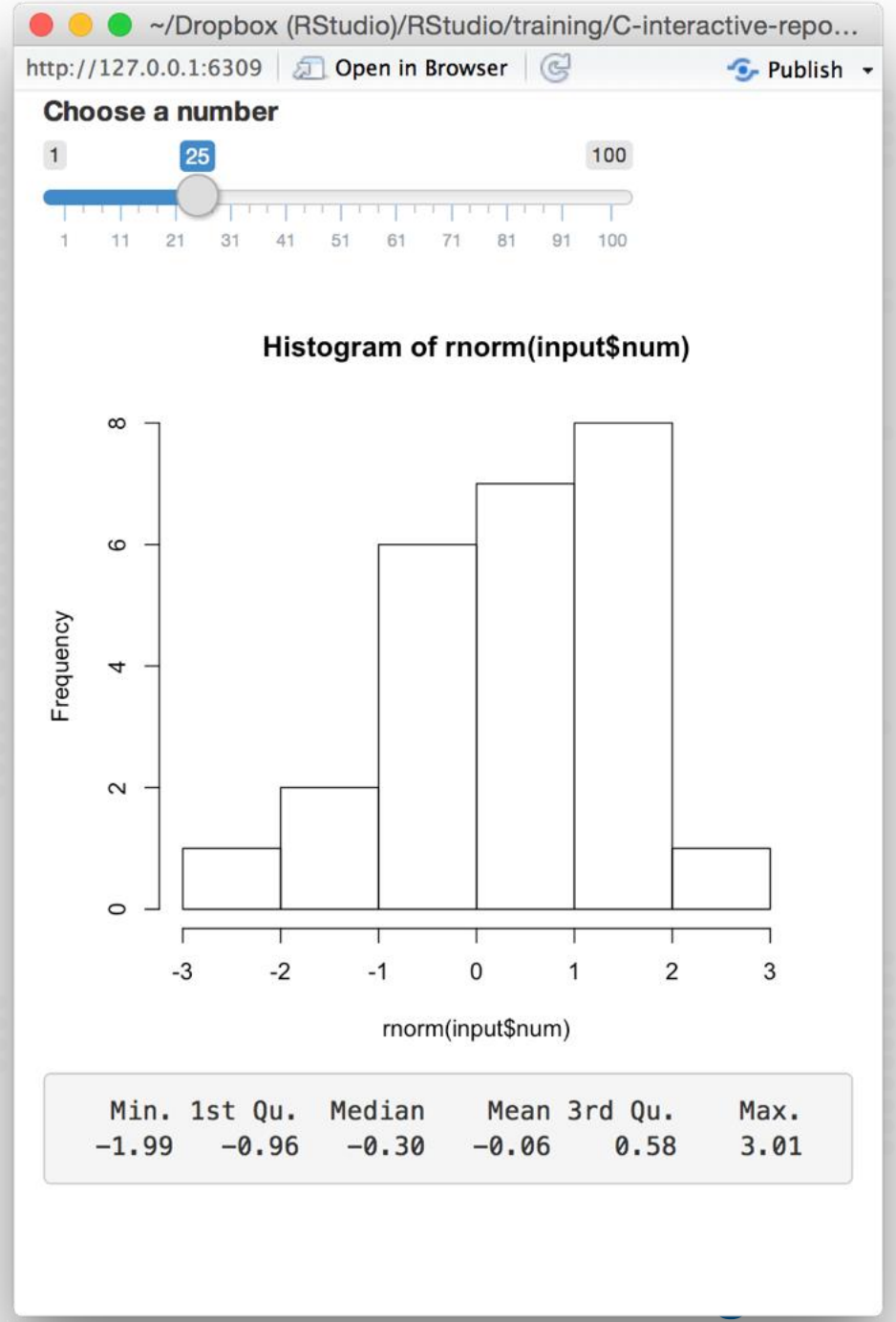


```
input$num
```

```
data <-? rnorm(input$num)
```

```
output$hist <-
   renderPlot({
     hist(data)
  })
```

```
output$stats  <-
   renderPrint({
     summary(data)
  })
```



reactive()

Builds a reactive object (reactive expression)

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

object will respond to *every reactive value in the code*

code used to build (and rebuild) object

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A reactive expression is special in two ways

```
data()
```

1. You call a reactive expression like a function

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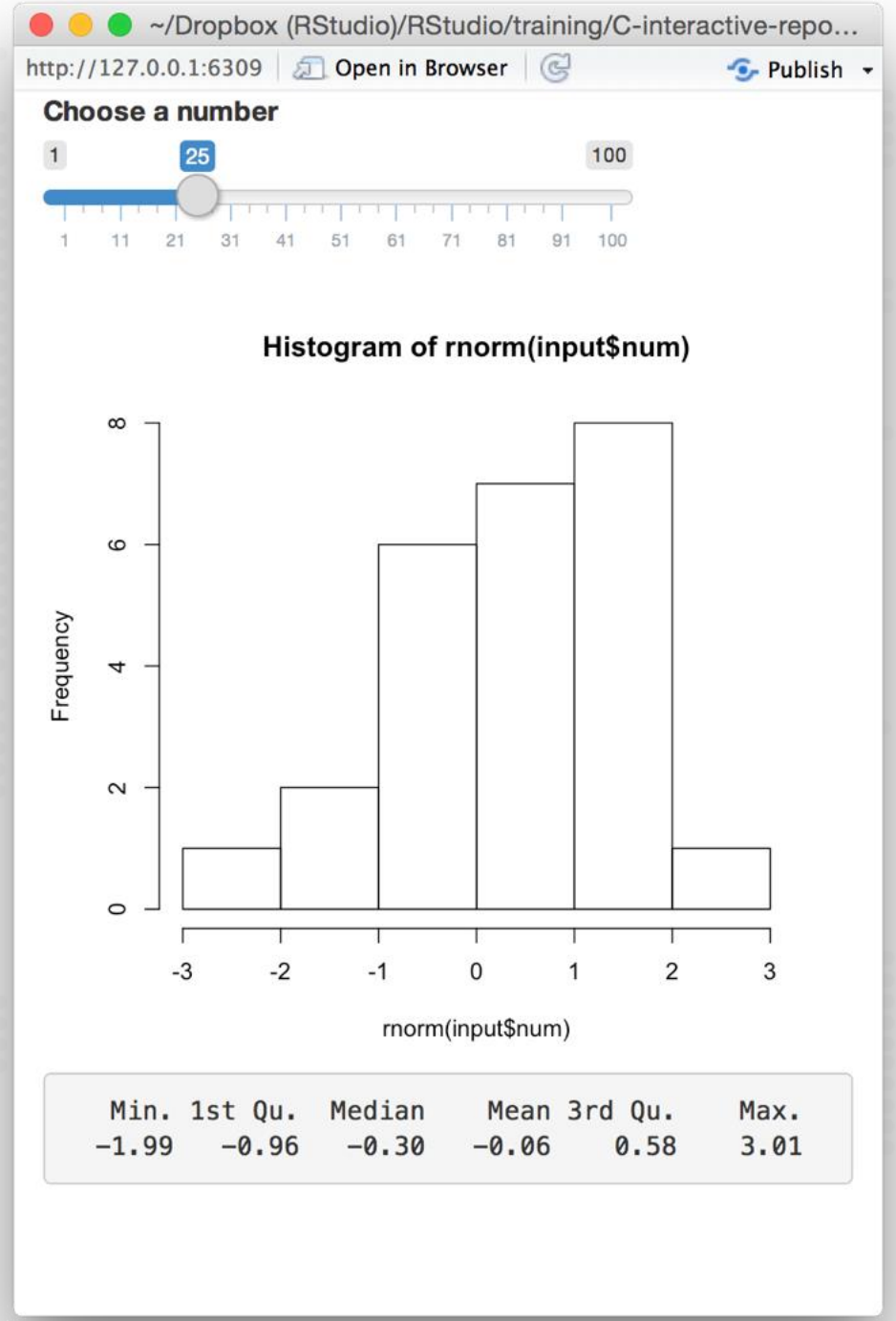
```
# 02-two-outputs

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 =
```



```
# 02-two-outputs

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ui <- fluidPage(
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    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(rnorm(input$num))
  })
  output$stats <-
    renderPrint({
    summary(rnorm(input$num))
  })
}

shinyApp(ui = ui, server =
```
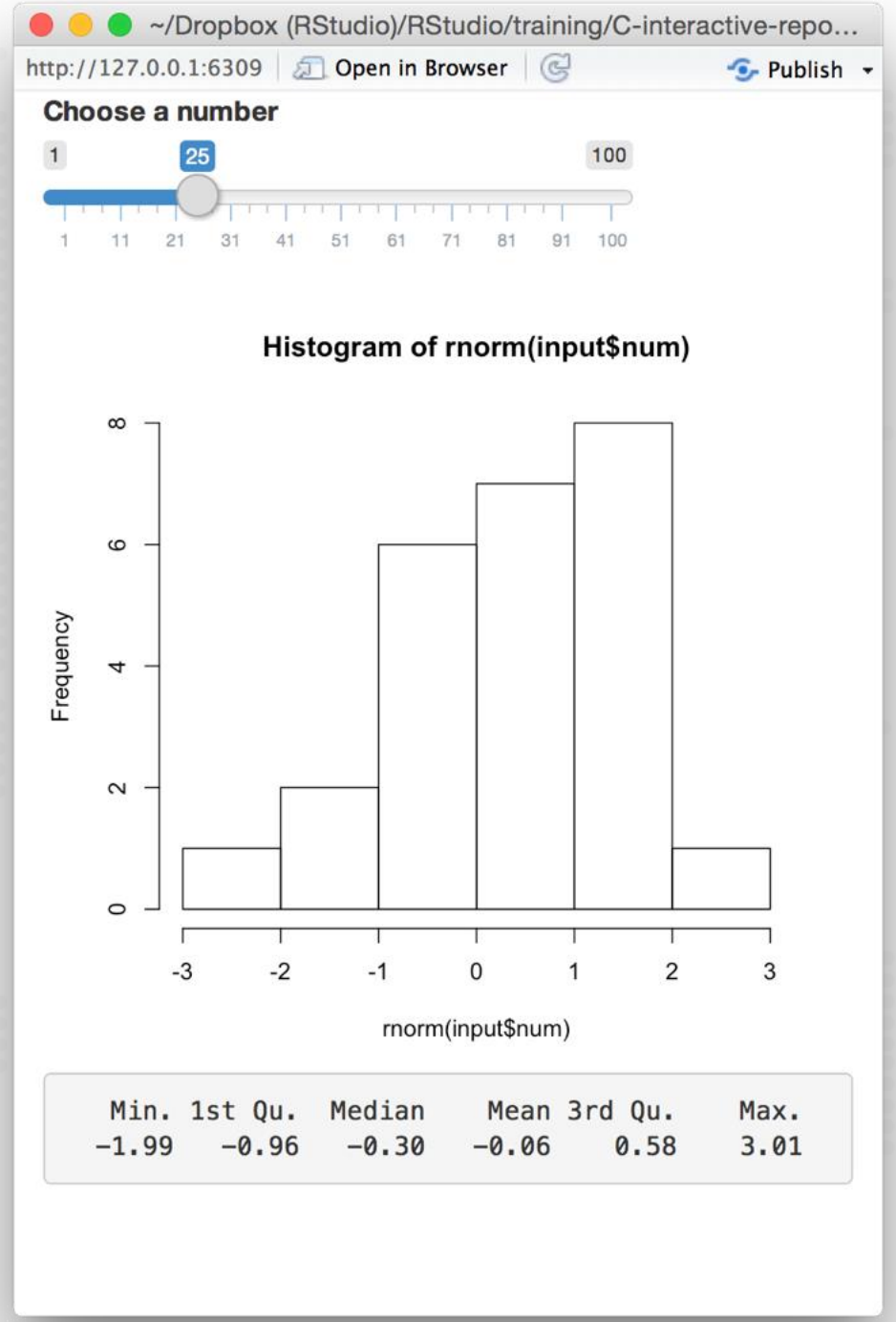
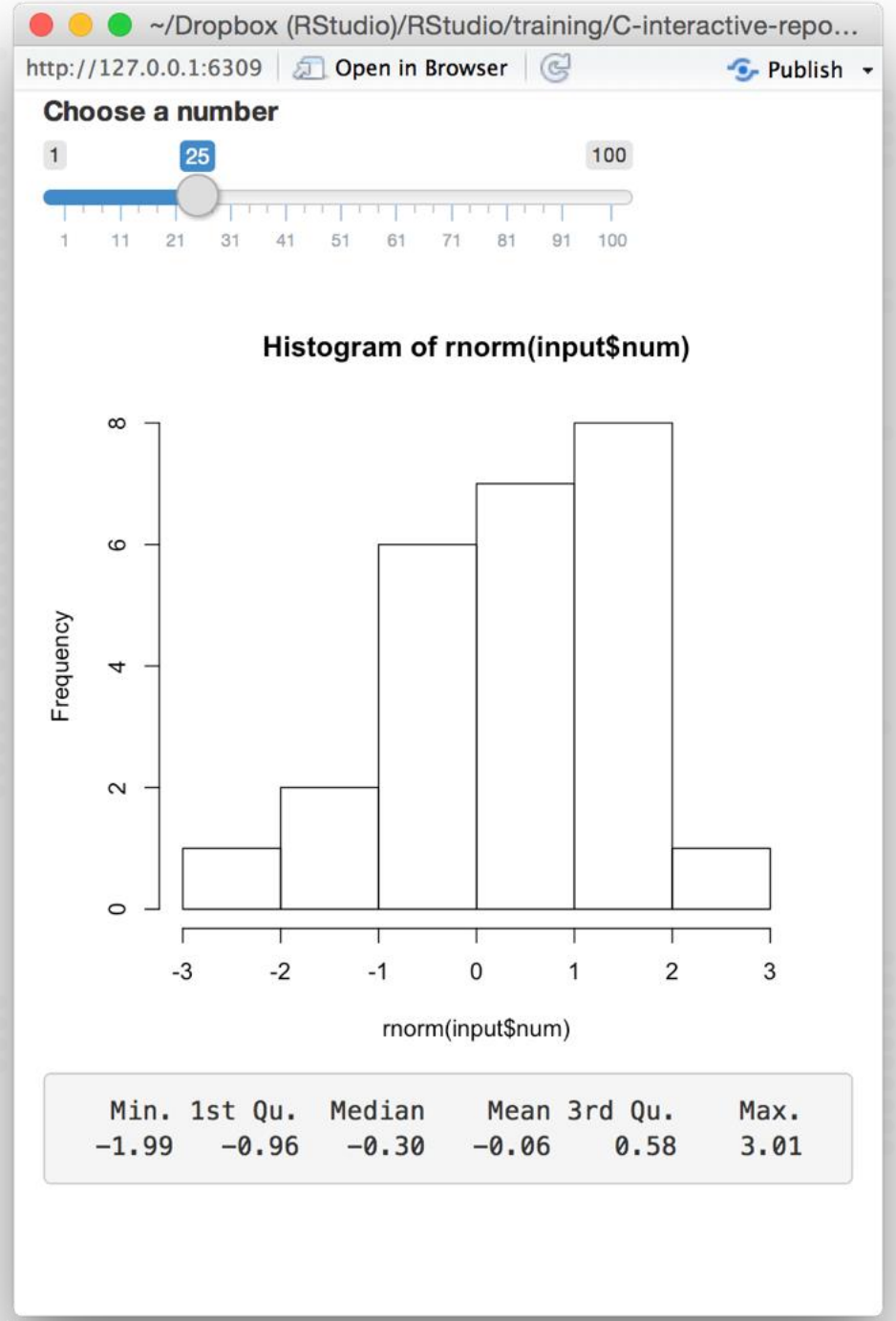
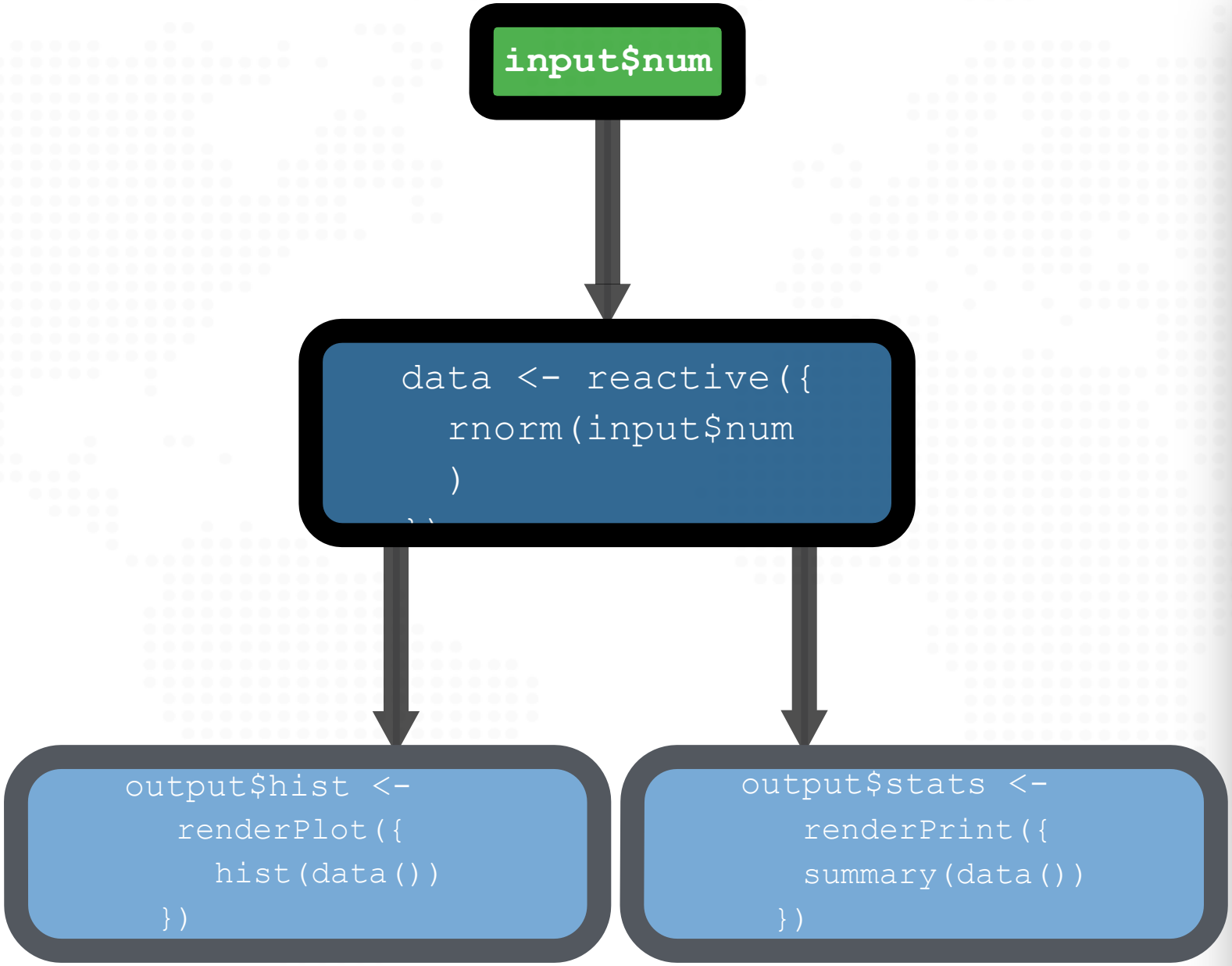
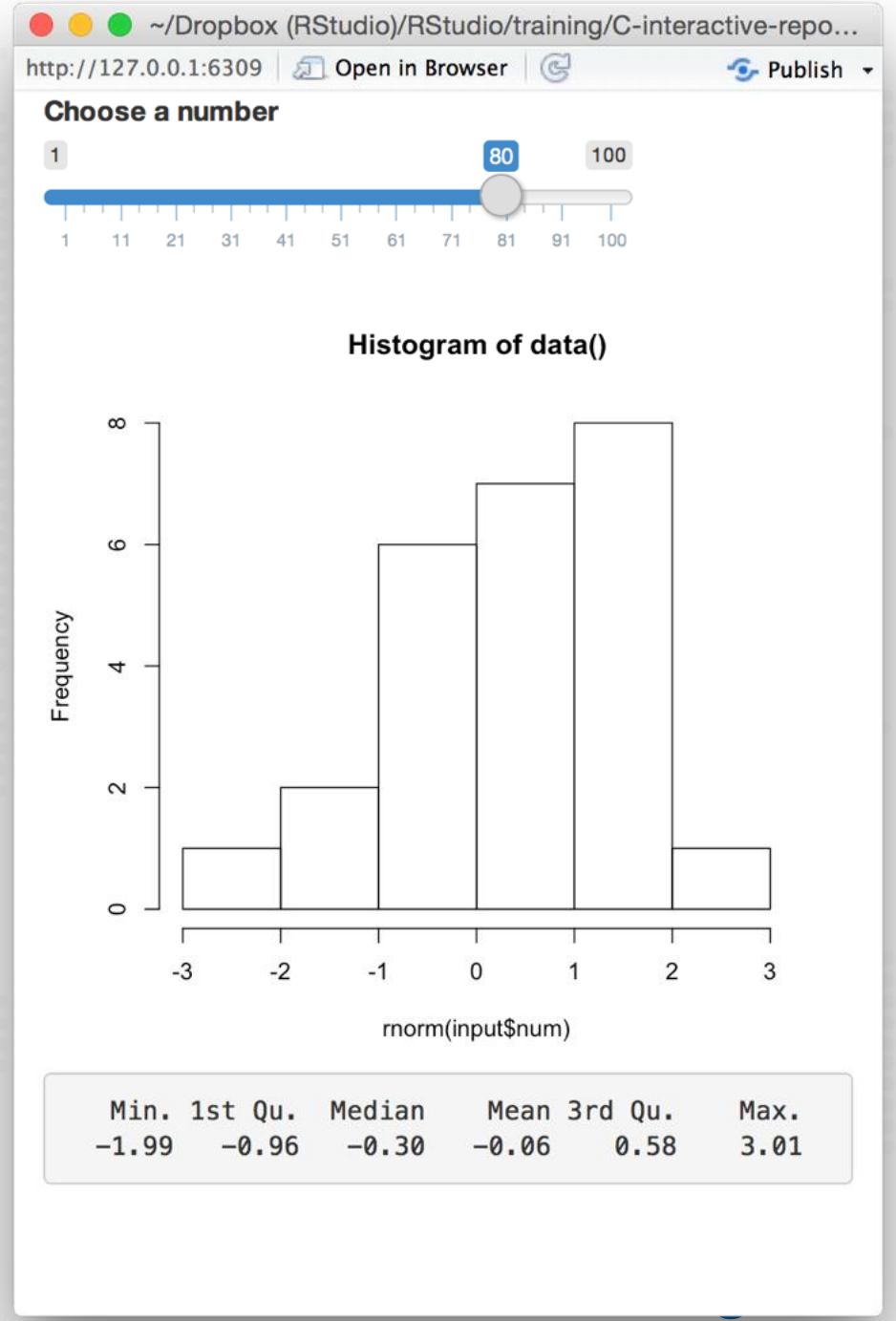
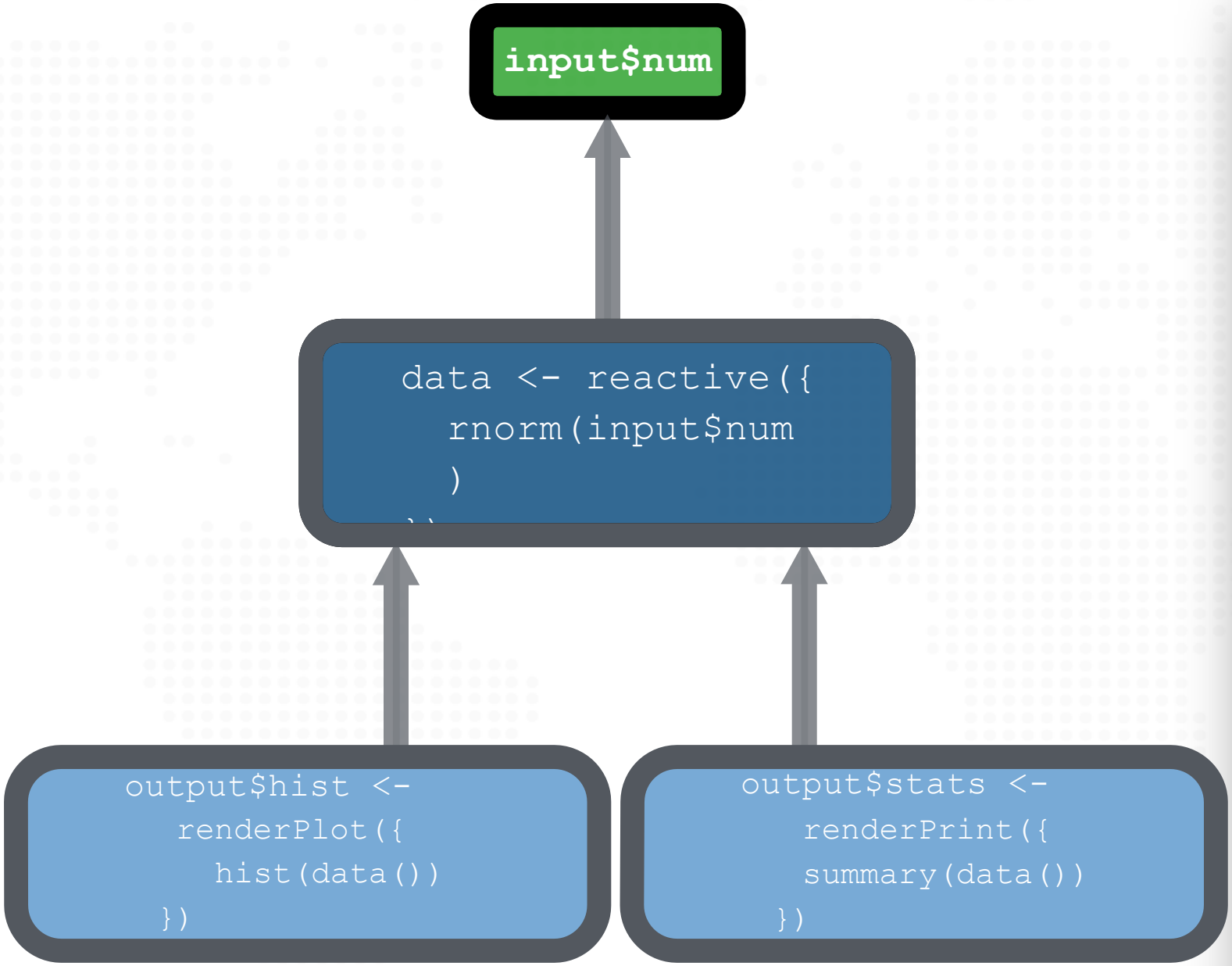



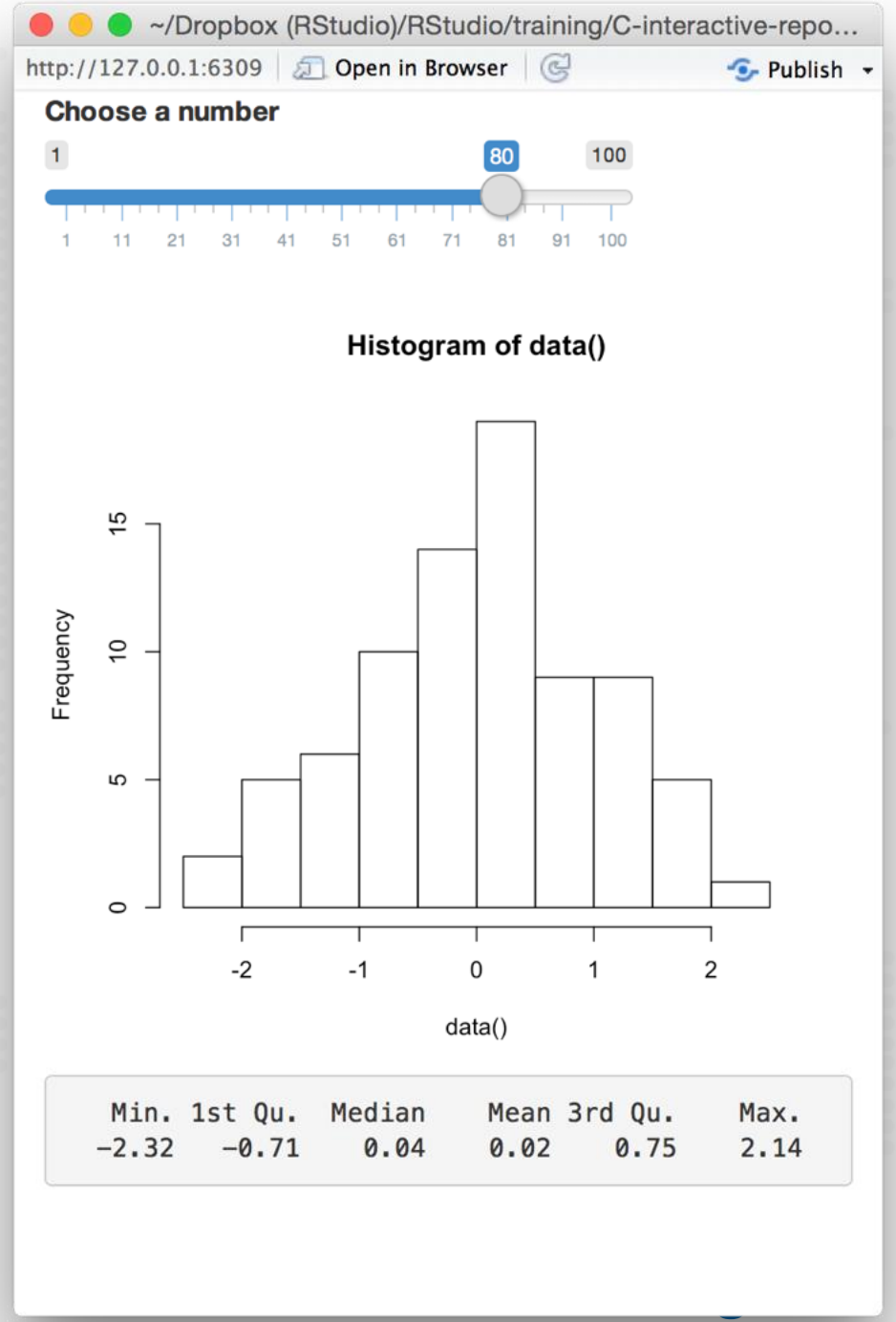
```
# 03-reactive

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 =
```











A reactive expression is special in two ways

```
data()
```

1. You call a reactive expression like a function

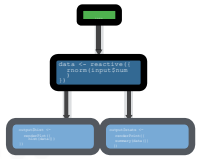
2. Reactive expressions **cache** their values
(the expression will return its most recent value,
unless it has become invalidated)

NobleProg

Recap: reactive()

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

reactive() makes an **object to use** (in downstream code)



Reactive expressions are themselves **reactive**. Use them to modularize your apps.

`data()`

Call a reactive expression like a **function**

2

Reactive expressions **cache** their values to avoid unnecessary computation

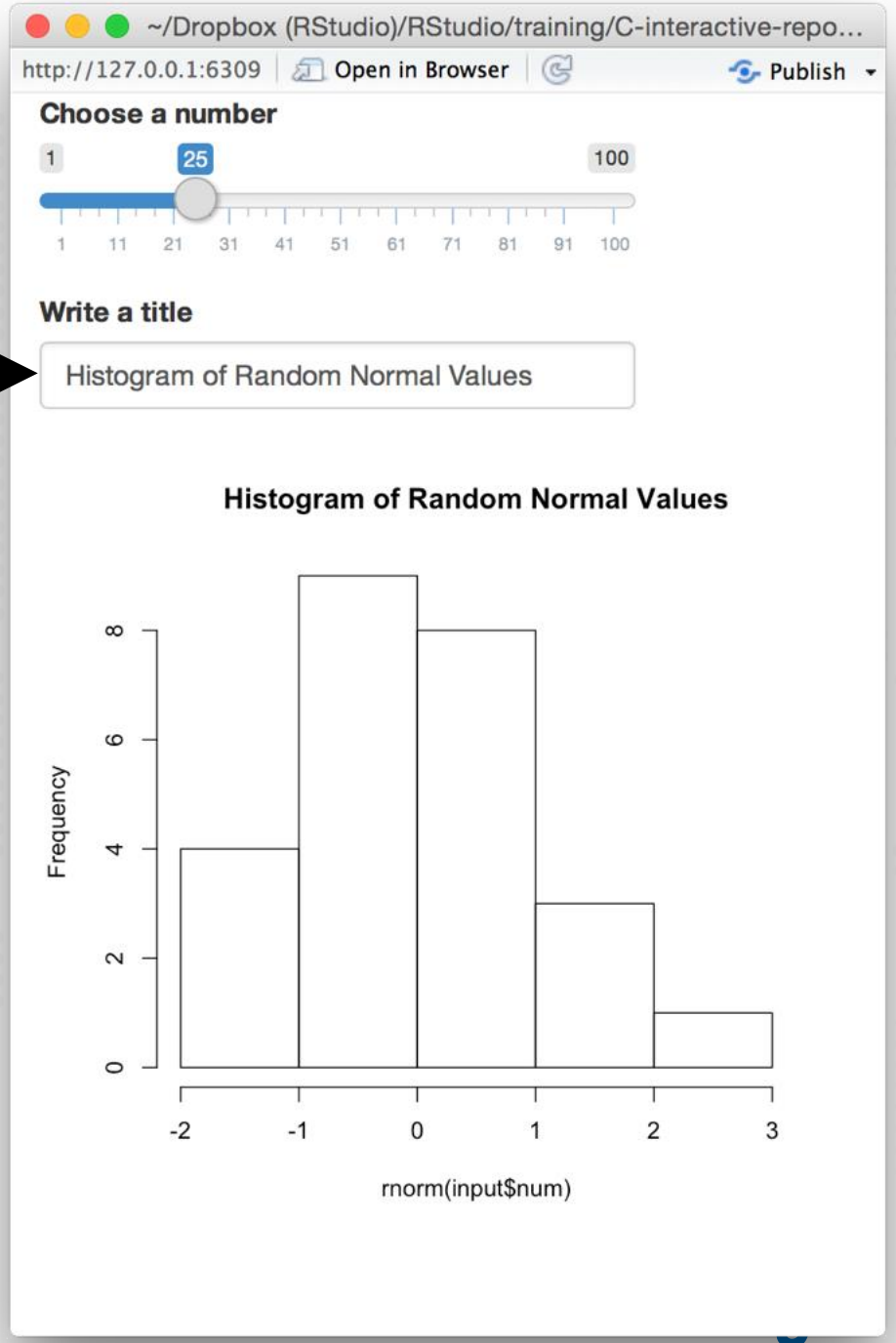
NobleProg

Prevent reactions with isolate()

NobleProg

```
# 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()

Returns the result as a non-reactive value

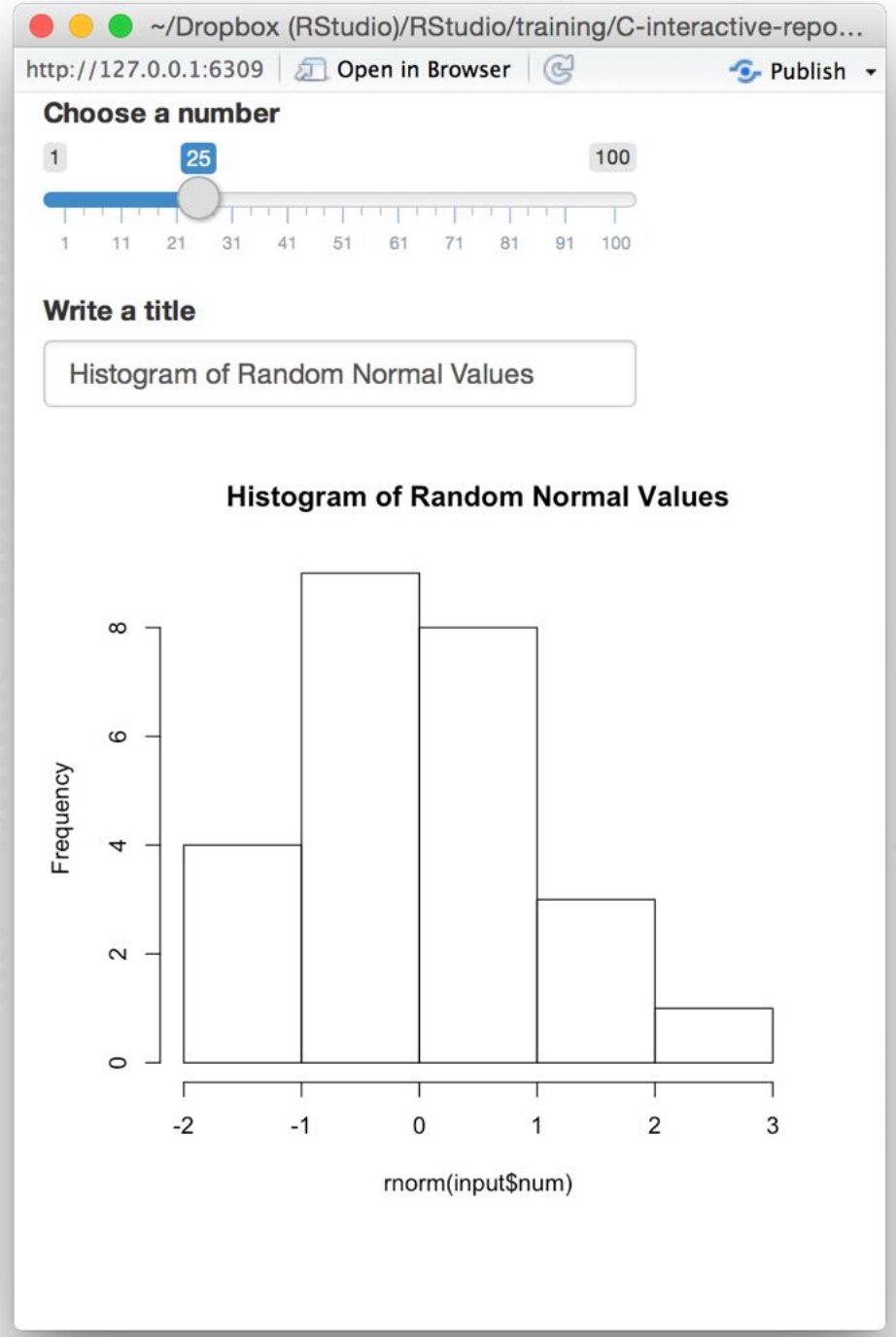
```
isolate({ rnorm(input$num) })
```

object will NOT respond to *any reactive value in the code*

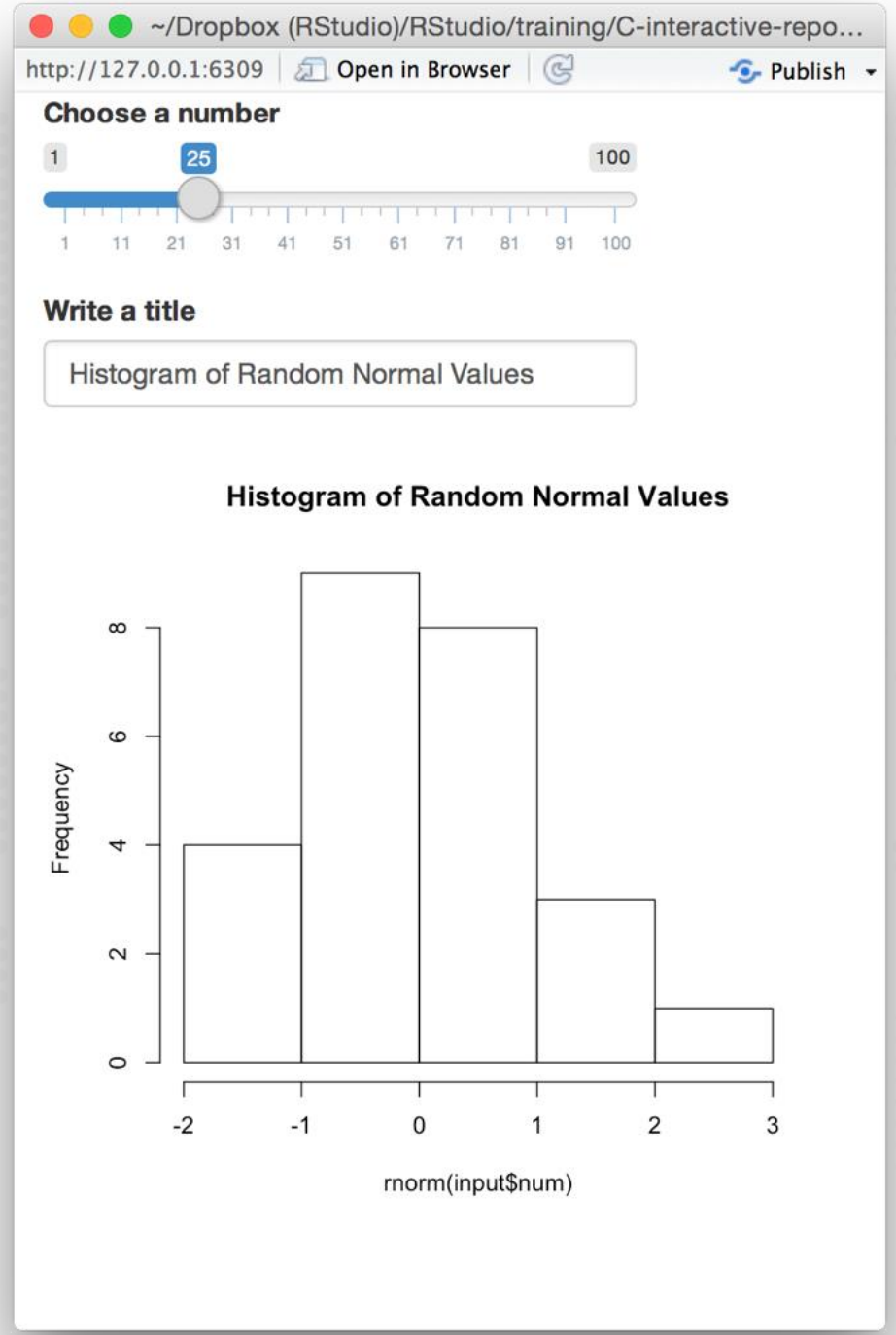
code used to build object

NobleProg

```
# 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)
```



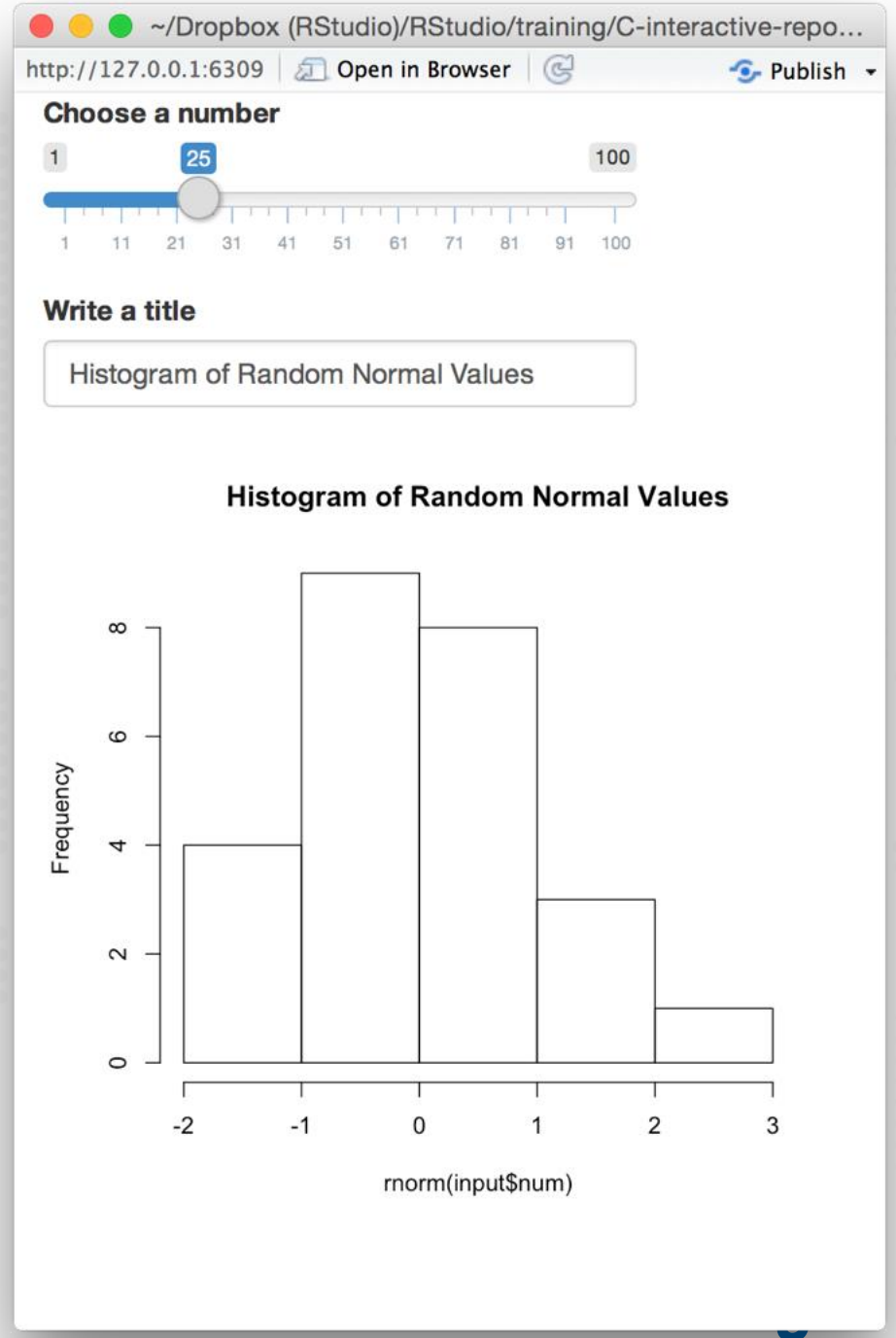
```
# 04-isolate

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)
```



input$num

input$title

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

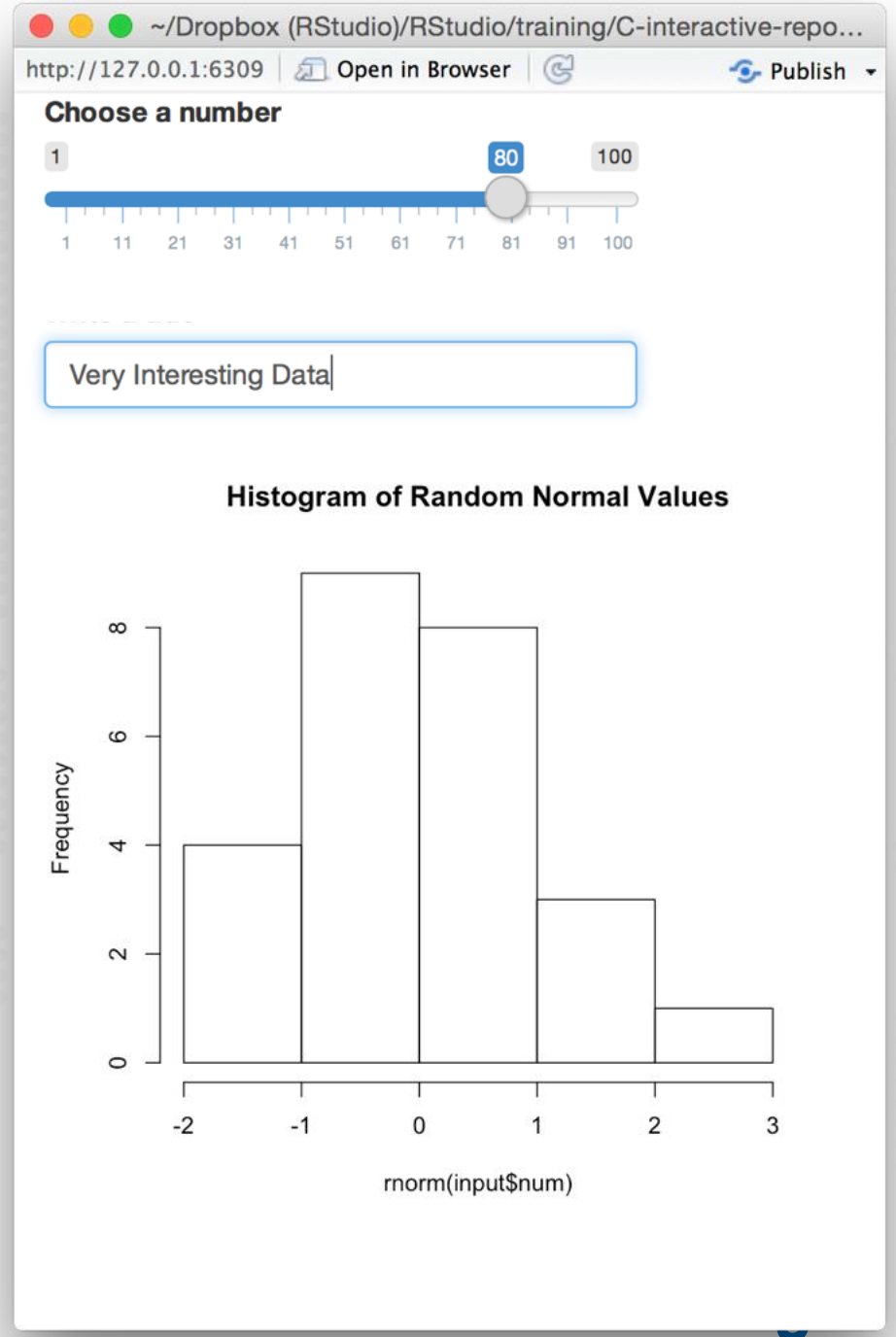


input$num

input$title

```
output$hist <-
  renderPlot({
  hist(rnorm(input$num),
    main =
```

```
})
```

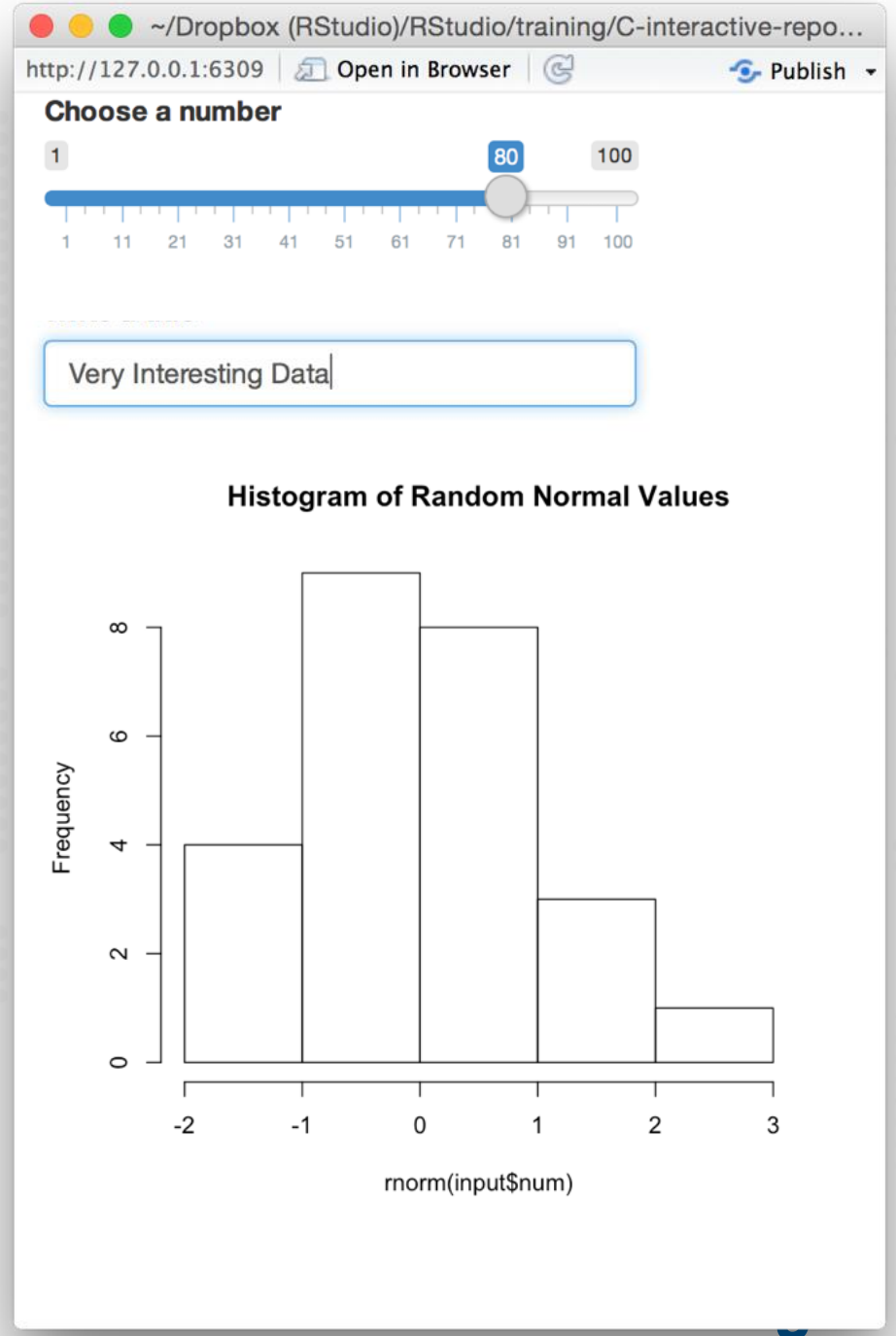


input$num

input$title

```
output$hist <-
  renderPlot({
  hist(rnorm(input$num),
    main =
```

```
})
```



Recap: isolate()

isolate() makes an **non-reactive object**

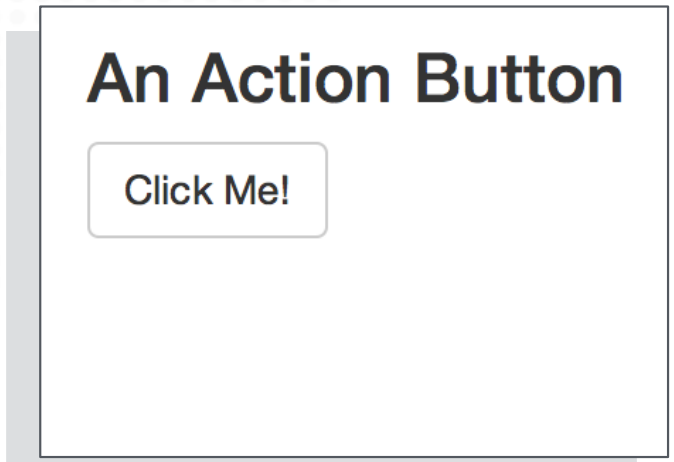
Use isolate() to treat reactive values like normal R values

NobleProg

Trigger code with observeEvent()

NobleProg

NobleProg



input function

input name (for internal use)

label to display

```
actionButton(inputId = "go", label = "Click Me!")
```

Notice: Id not ID

NobleProg

```
# 05-actionButton

library(shiny)

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

server <- function(input, output) {



}

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

observeEvent()

Triggers code to run on server

```
observeEvent(input$clicks, { print(input$clicks) })
```

reactive value(s) to respond to

(observer invalidates ONLY when this value changes)

code block to run whenever observer is invalidated

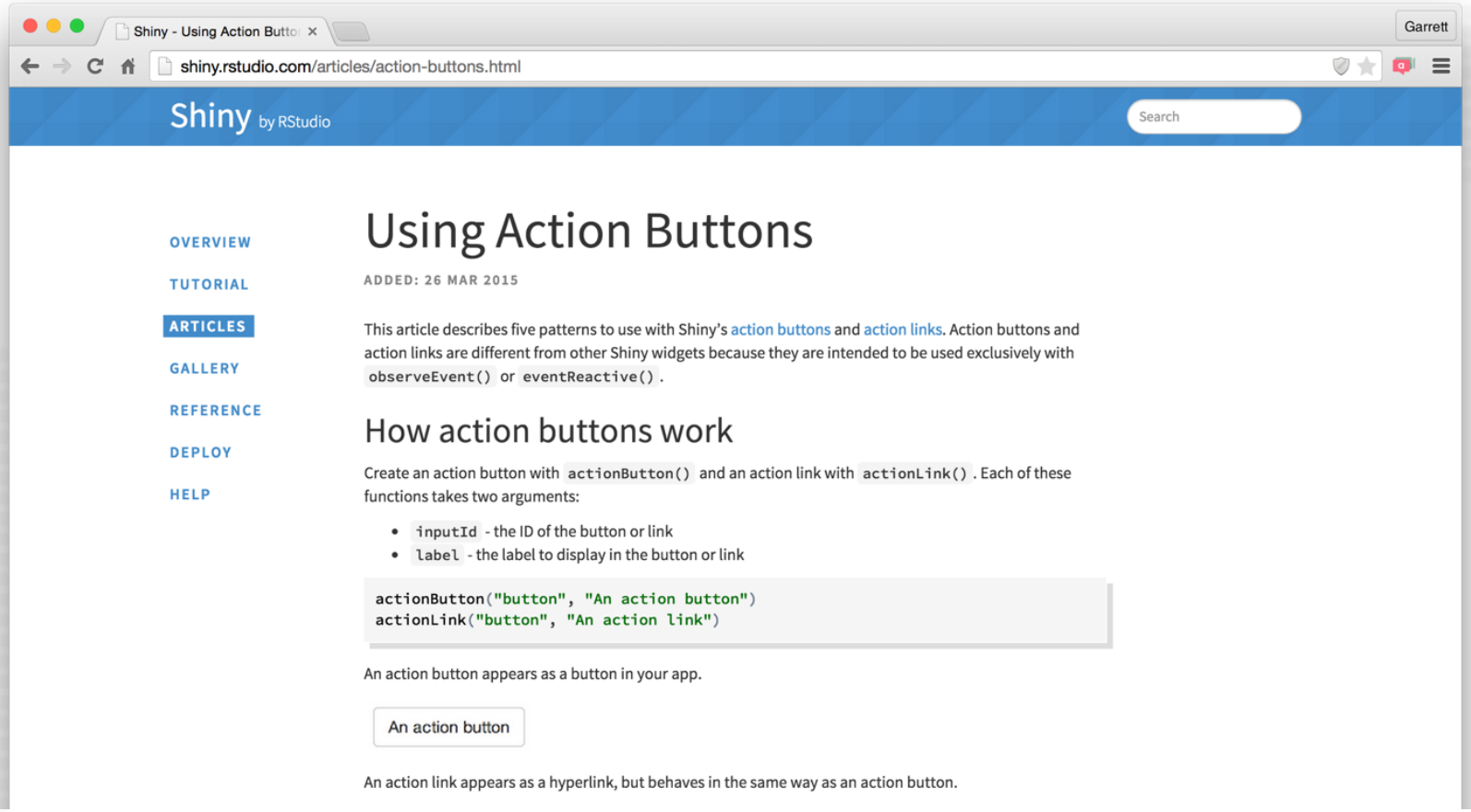
note: observer treats this code as if it has been isolated with isolate()

NobleProg

```
# 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)
```

Action buttons article

http://shiny.rstudio.com/articles/action-buttons.html



NobleProg

observe()

Also triggers code to run on server.

Uses same syntax as render*(), reactive(), and isolate()

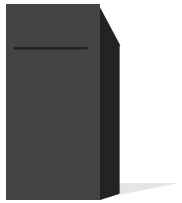
```
observe({ print(input$clicks) })
```

observer will respond to *every reactive value in the code*

code block to run whenever observer is invalidated

NobleProg

Recap: observeEvent()



observeEvent() **triggers code to run** on the server

```
observeEvent(input$clicks, { print(input$clicks) })
```

reactive value(s) to respond to

Specify **precisely** which reactive values should invalidate the observer

`observe()`

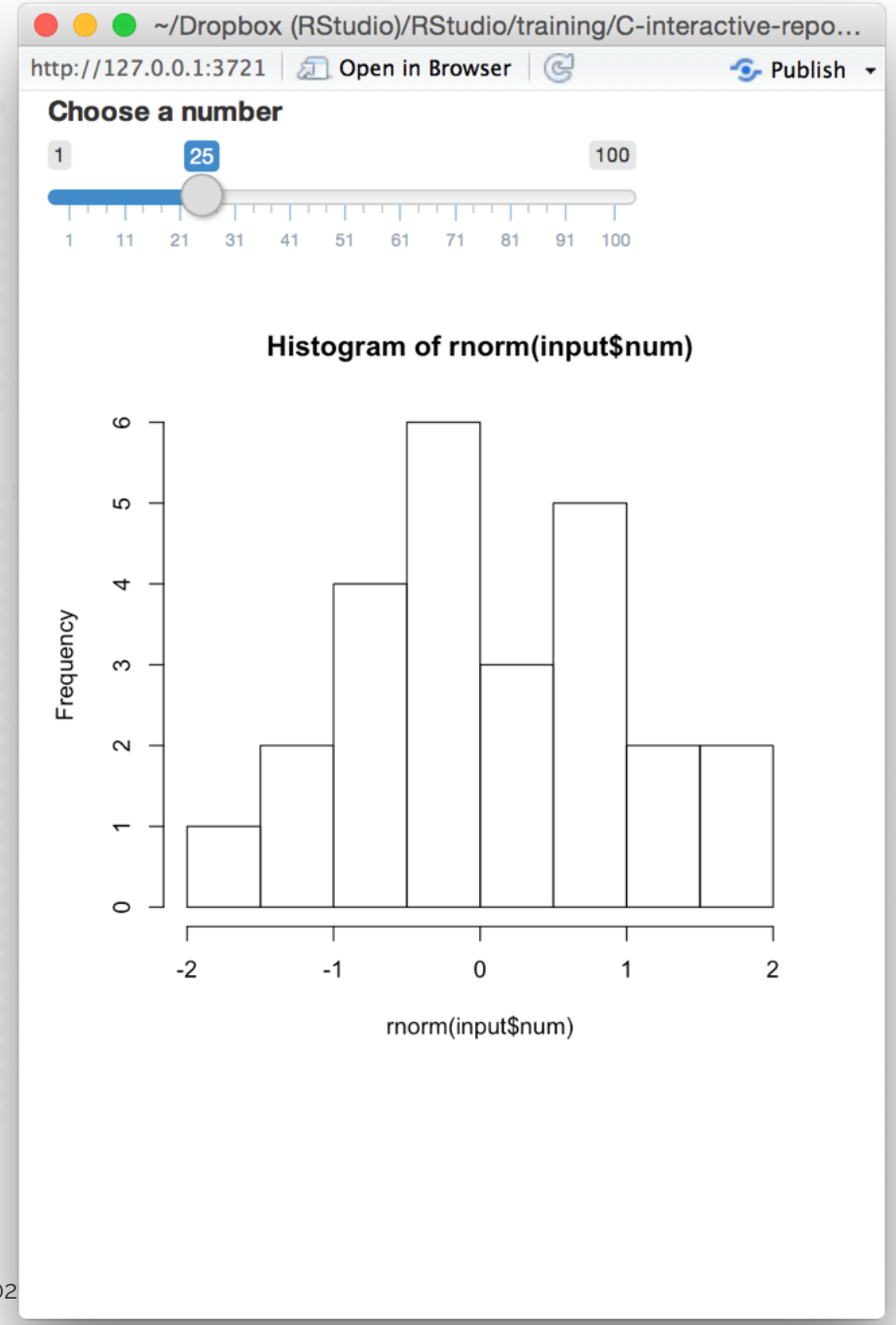
Use **observe()** for a more implicit syntax

NobleProg

Delay reactions with eventReactive()

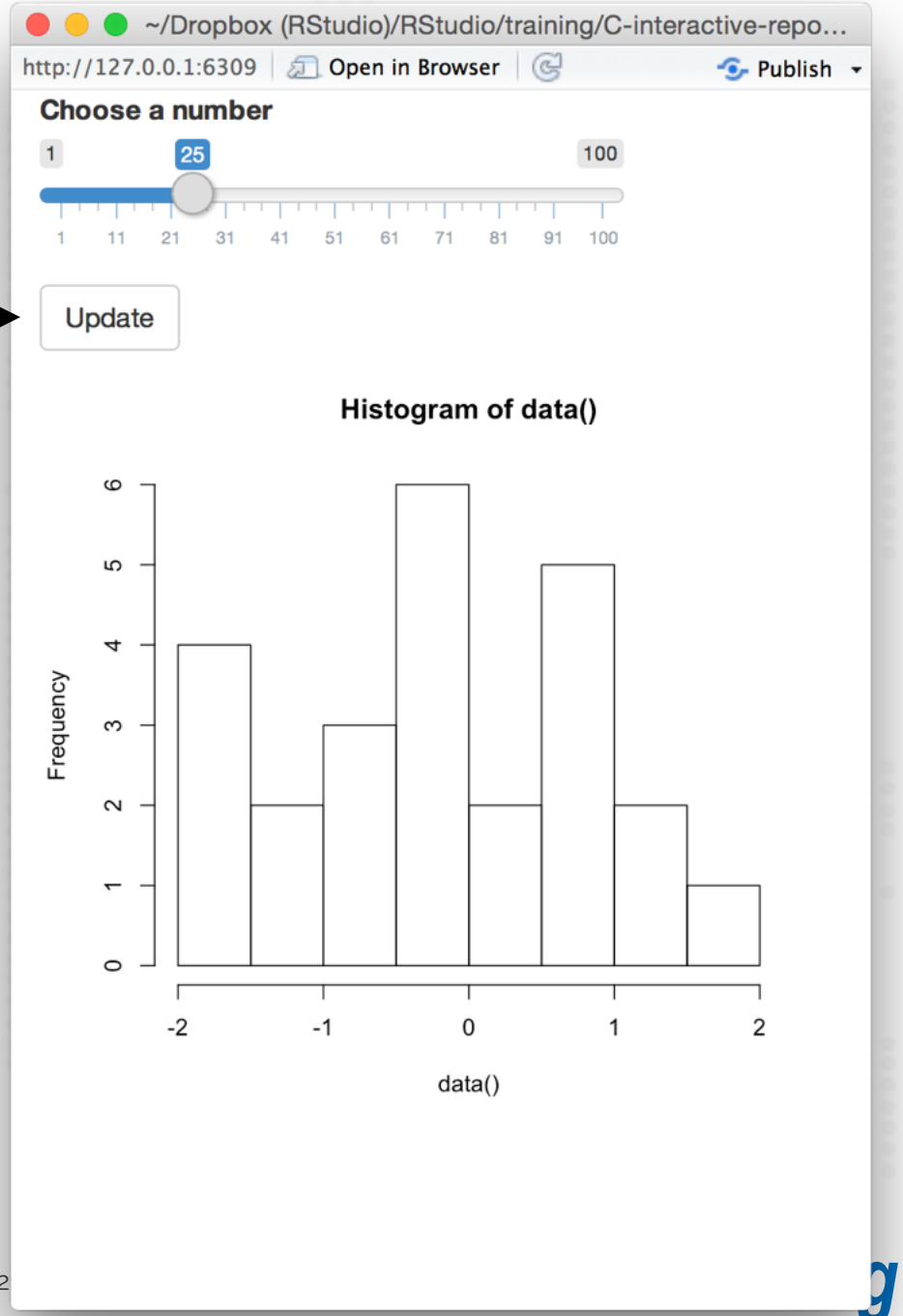
NobleProg

```
# 07-eventReactive

library(shiny)

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

server <- function(input, output)
{



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

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



```
# 07-eventReactive

library(shiny
)
ui <- fluidPage(
  sliderInput(inputId =
  "num",
    label = "Choose a number",
    value = 25, min = 1, max =
    100),
  actionButton(inputId =
    "go", label = "Update"),
)  plotOutput("hist")
server <- function(input, output)
{



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


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

Can we prevent the graph from updating until we hit the button?



eventReactive()

A reactive expression that only responds to specific values

```
data <- eventReactive(input$go,  { rnorm(input$num) })
```

reactive value(s) to respond to

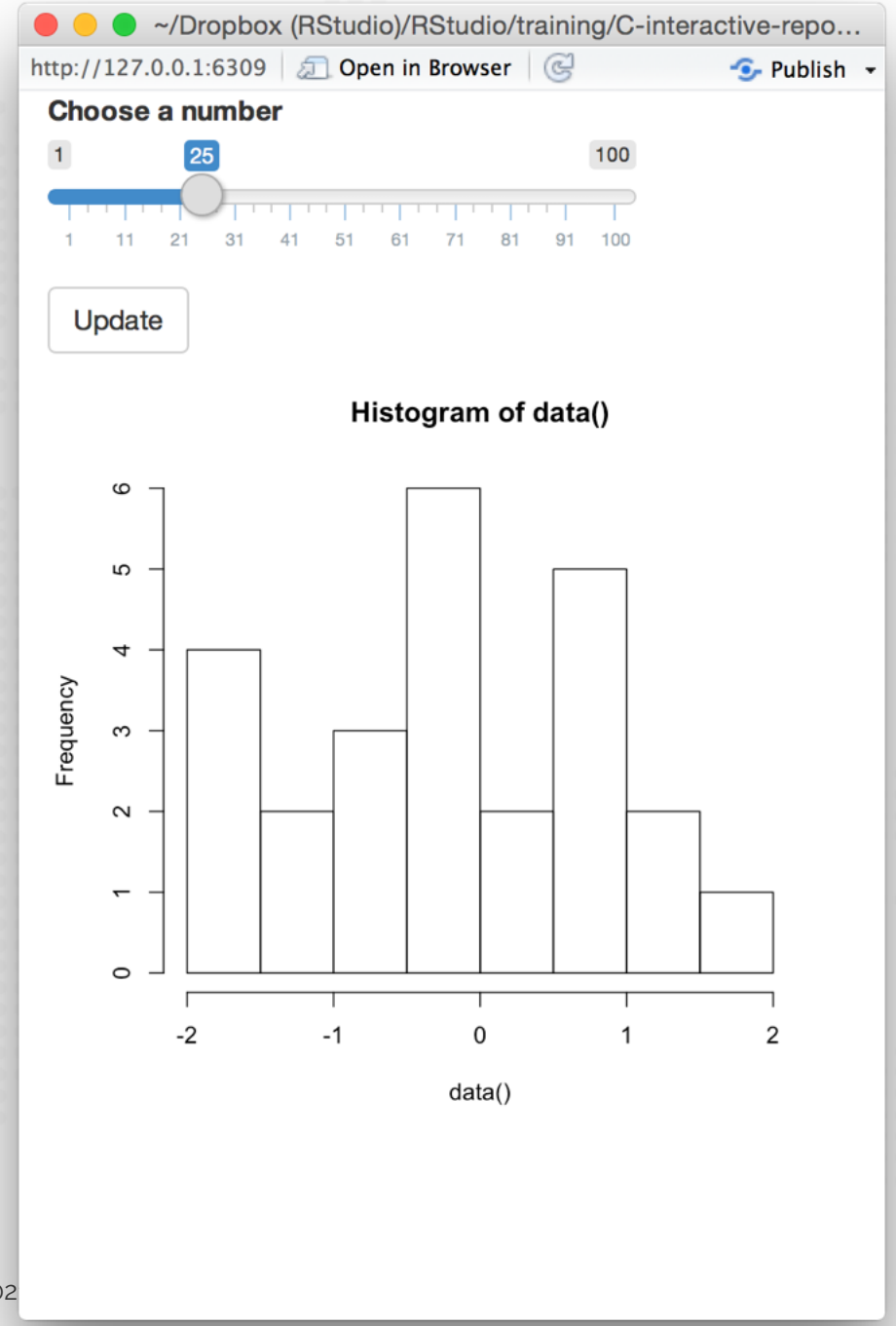
(expression invalidates ONLY when this value changes)

code used to build (and rebuild) object

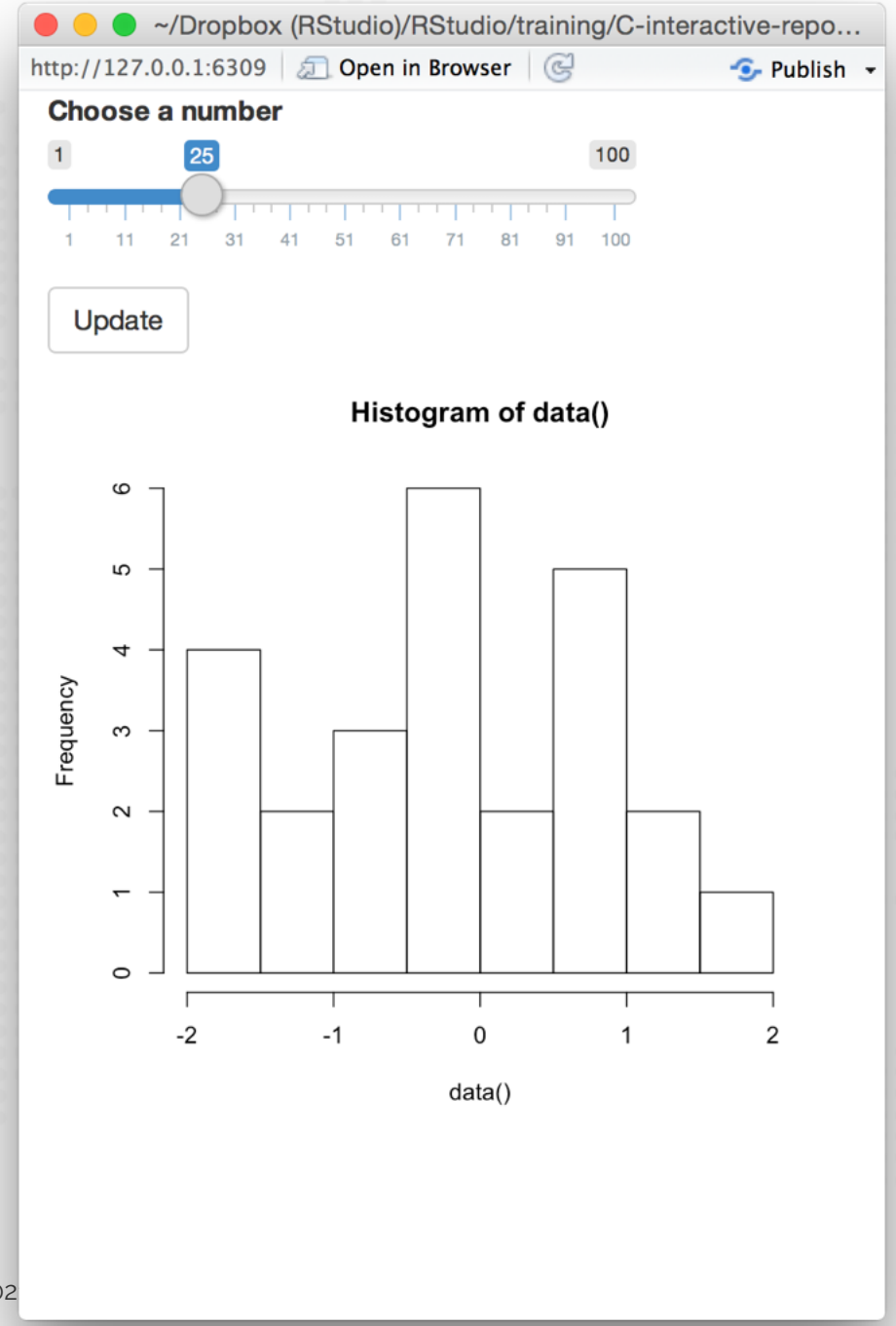
note: expression treats this code as if it has been isolated with isolate()

NobleProg

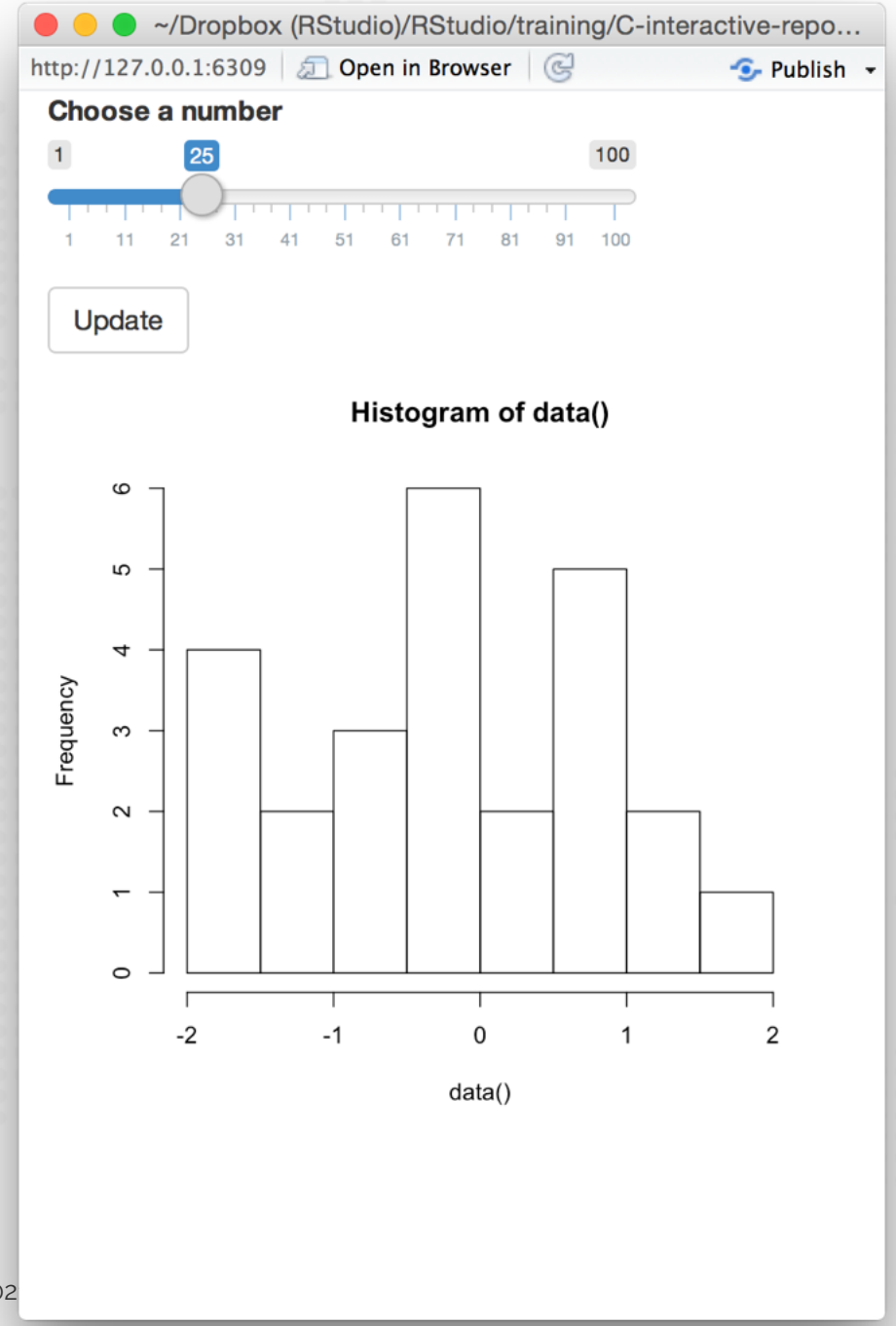
```
# 07-eventReactive

library(shiny)

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

server <- function(input, output) {

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

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



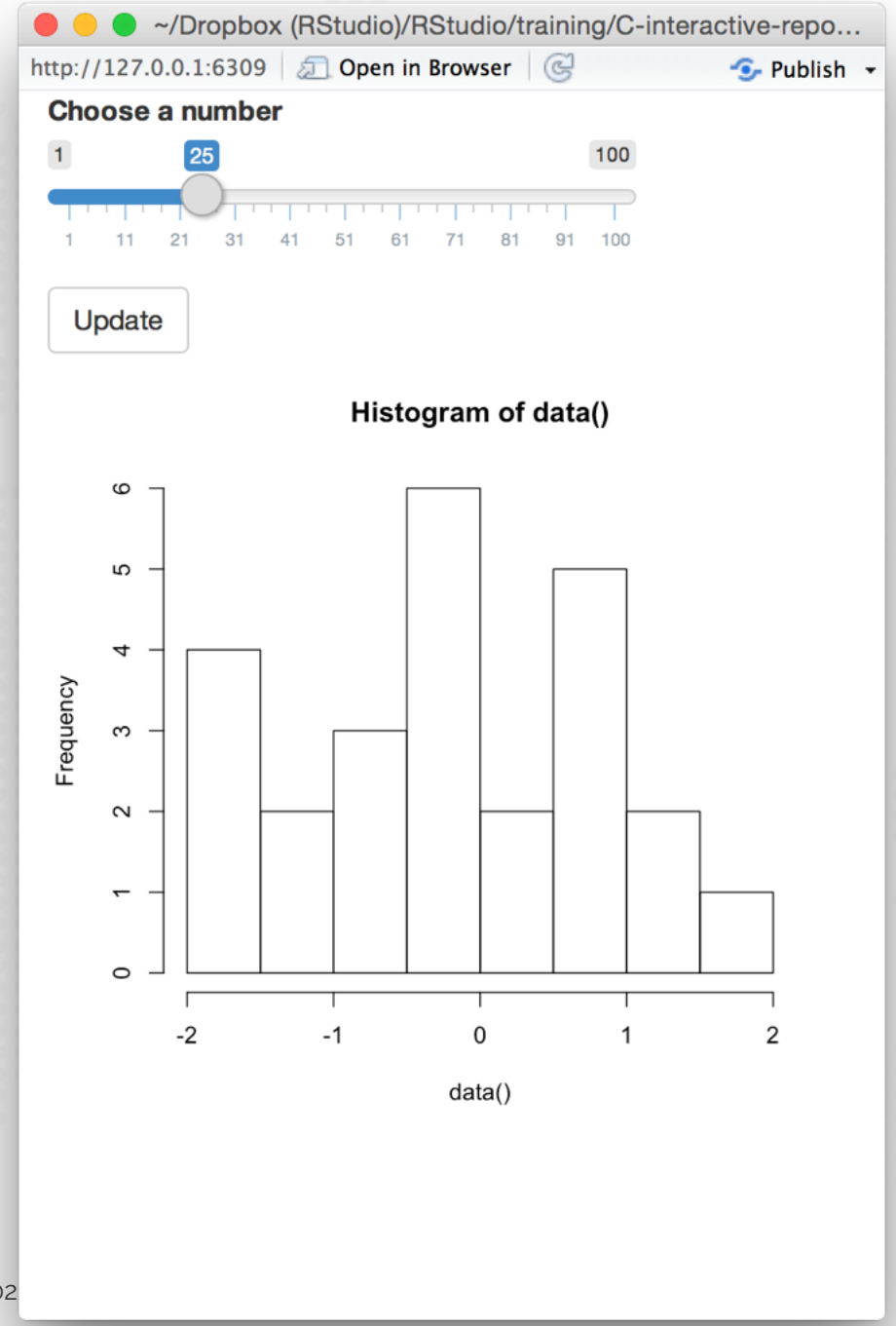
```
# 07-eventReactive

library(shiny)

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


  server <- function(input, output)
                                    {
  data <- eventReactive(input$go, {

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



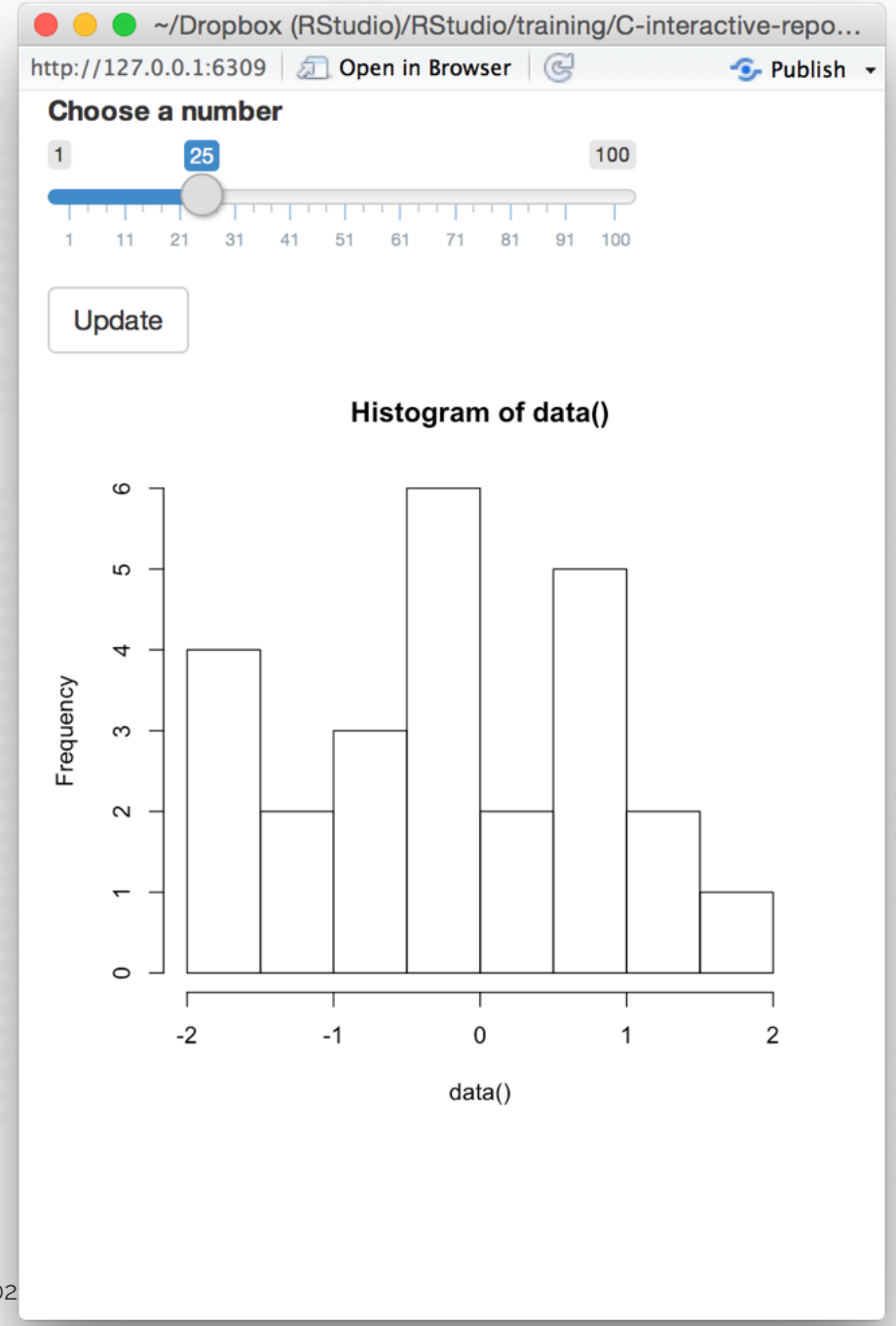
```
# 07-eventReactive

library(shiny)

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


  server <- function(input, output)
                                    {
  data <- eventReactive(input$go, {

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



```
# 07-eventReactive

library(shiny)

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

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

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



```
# 07-eventReactive

library(shiny)

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

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

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

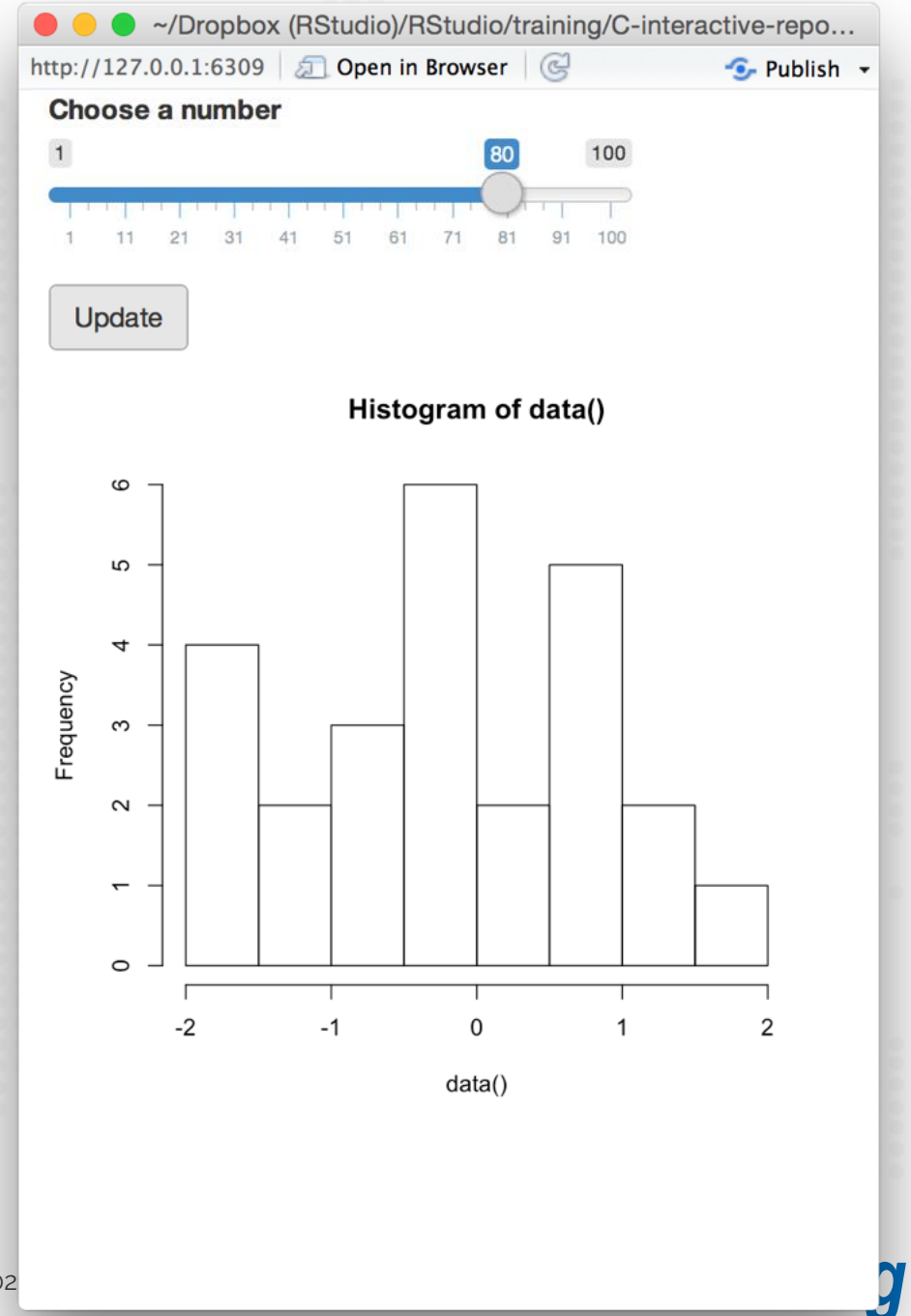


`input$num`

`input$go`

```
data <- eventReactive(input$go, {
  rnorm(input$num)
})
```

```
output$hist <-
  renderPlot({
    hist(data())
  })
```

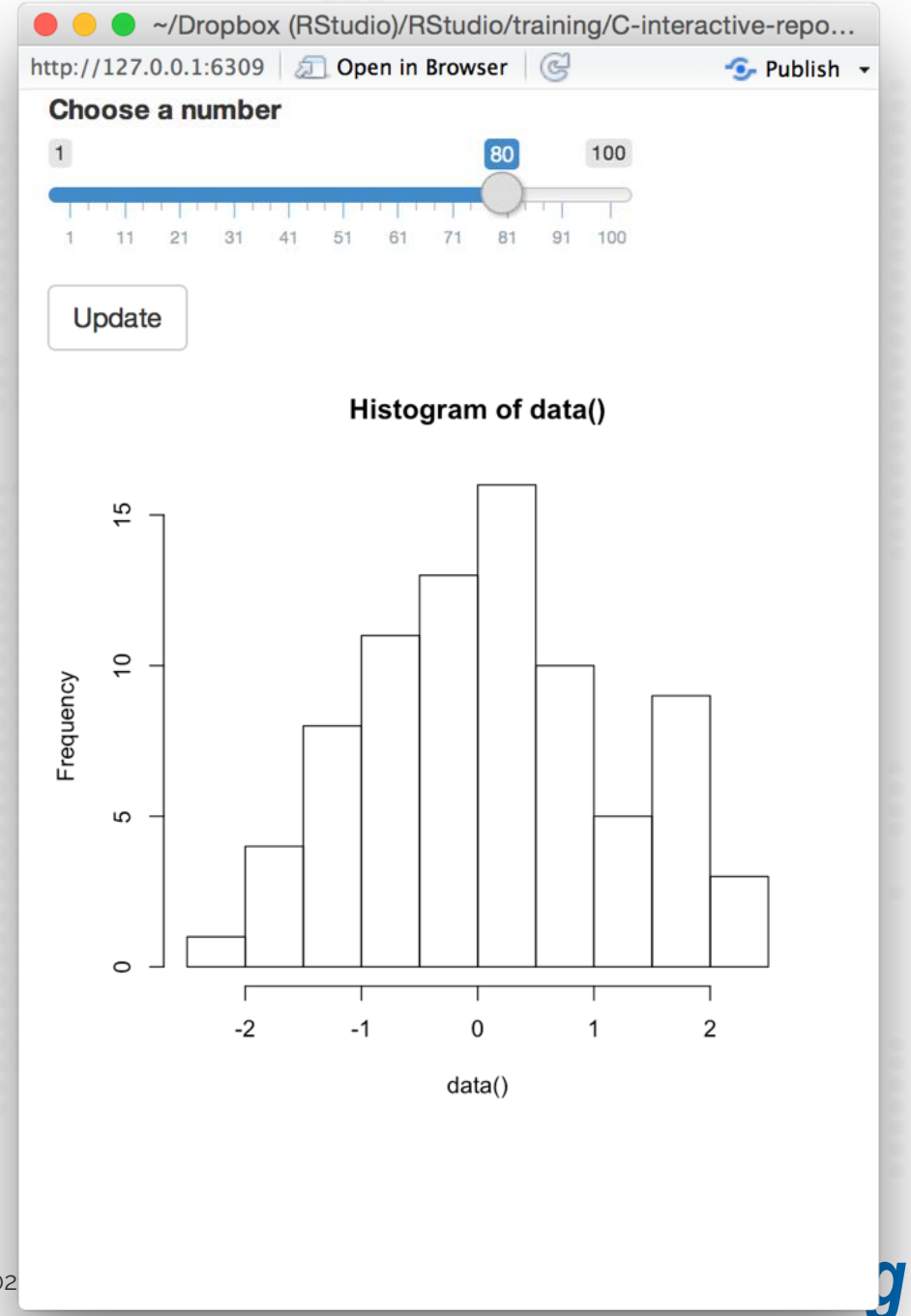


input$num

input$go

```
data <- eventReactive(input$go, {
  rnorm(input$num)
})
```

```
output$hist <-
  renderPlot({
    hist(data())
  })
```



Recap: eventReactive()

Update

Use eventReactive() to **delay reactions**

`data()`

eventReactive() creates a **reactive expression**

You can specify **precisely** which reactive values should invalidate the expression

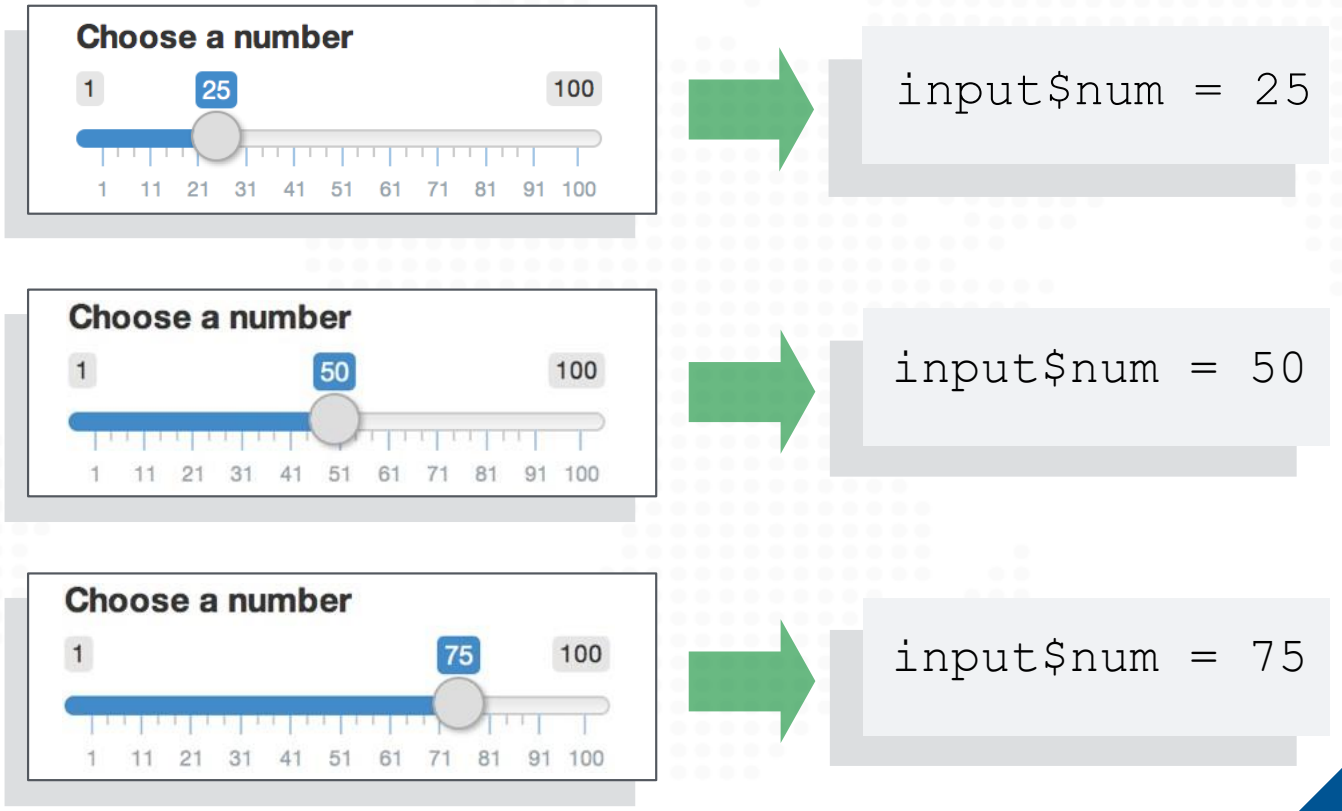
NobleProg

Manage state with reactiveValues()

NobleProg

Input values

The input value changes whenever a user changes the input.



You **cannot** set these values in your code

reactiveValues()

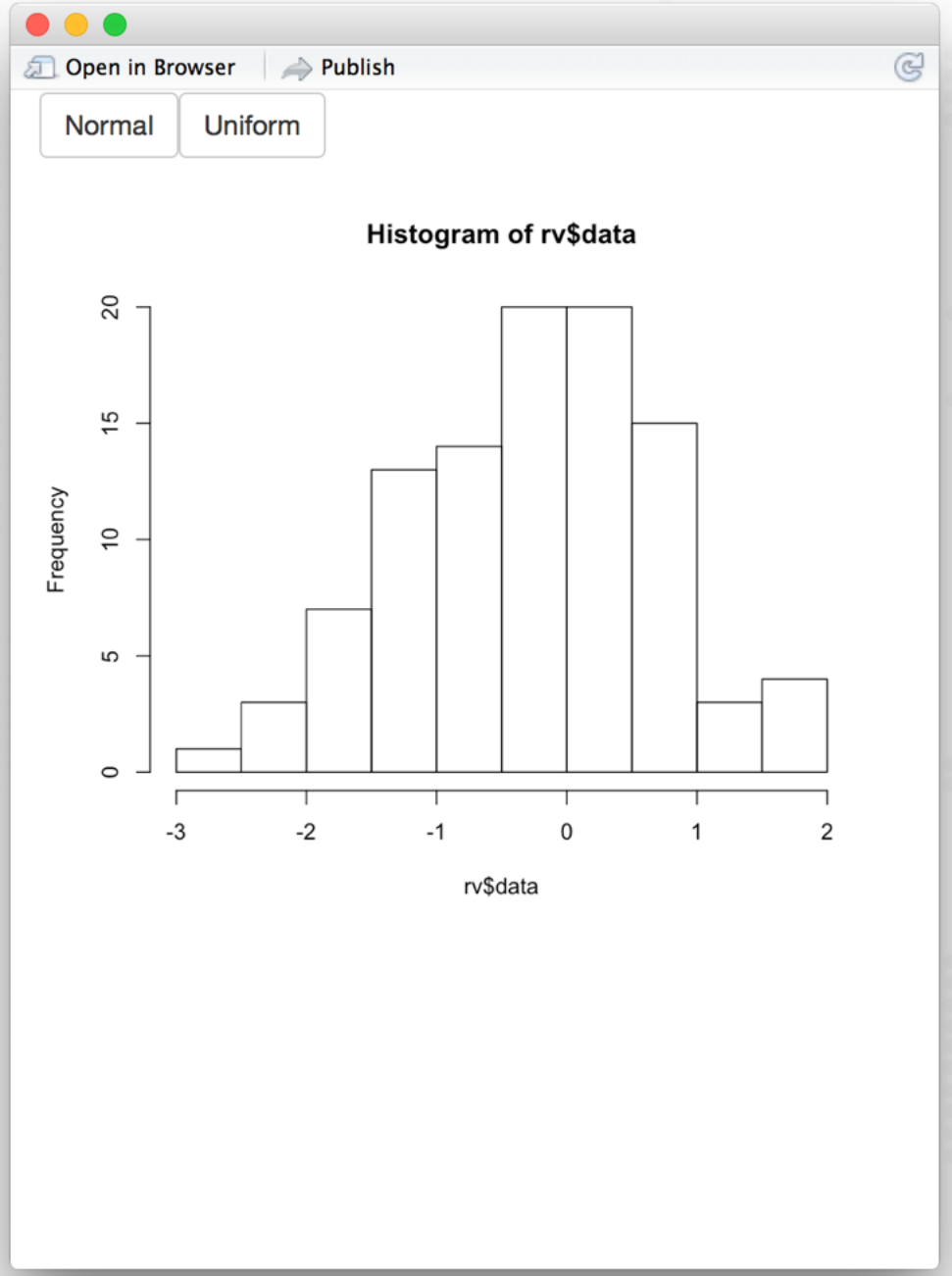
Creates a list of reactive values to manipulate programmatically

```
rv <- reactiveValues(data = rnorm(100))
```

(optional) elements to add to the list

NobleProg

```
library(shiny)

ui <- fluidPage(
  actionButton(inputId = "norm", label =
"Normal"),
  actionButton(inputId = "unif", label =
"Uniform"),
  plotOutput("hist")
)

server <- function(input, output) {

  rv <- reactiveValues(data = rnorm(100))

  observeEvent(input$norm, { rv$data <-
rnorm(100) })
  observeEvent(input$unif, { rv$data <-
runif(100) })

  output$hist <- renderPlot({
    hist(rv$data)
  })
}

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

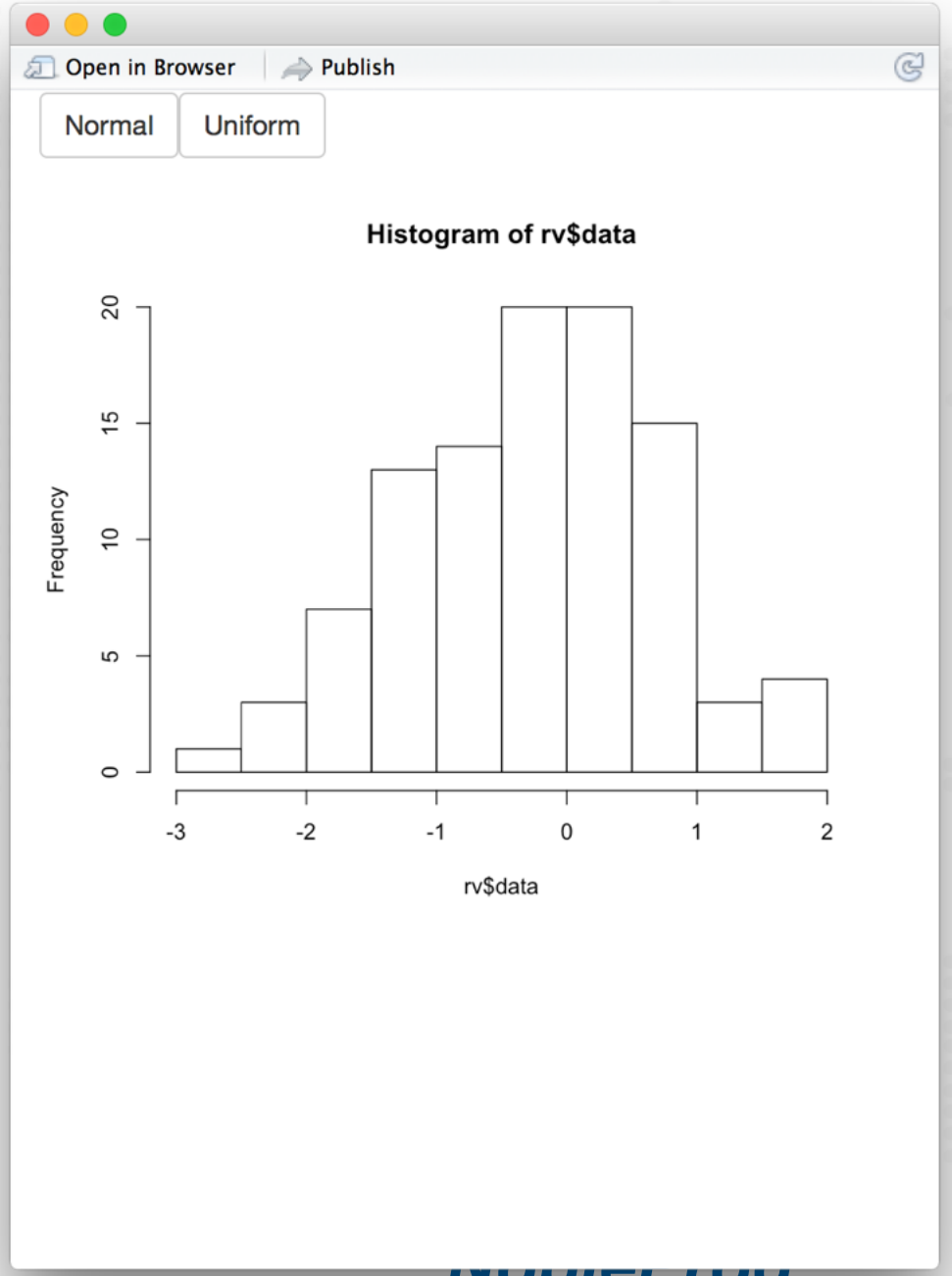


input$norm

rv$data
rnorm(100)

input$unif

```
output$hist <-
  renderPlot({
    hist(rv$data)
})
```

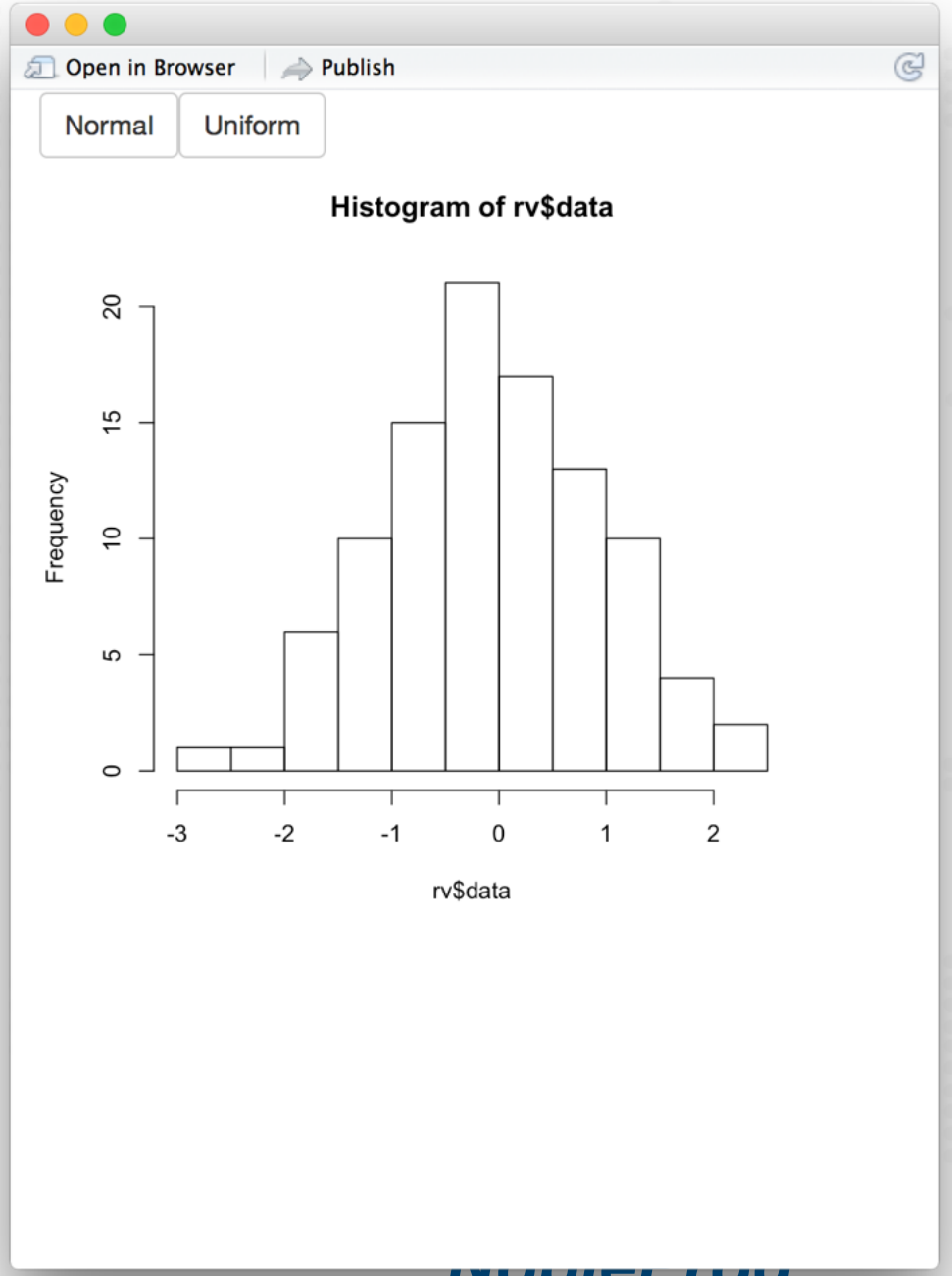


input$norm

rv$data
rnorm(100)

input$unif

```
output$hist <-
  renderPlot({
    hist(rv$data)
})
```

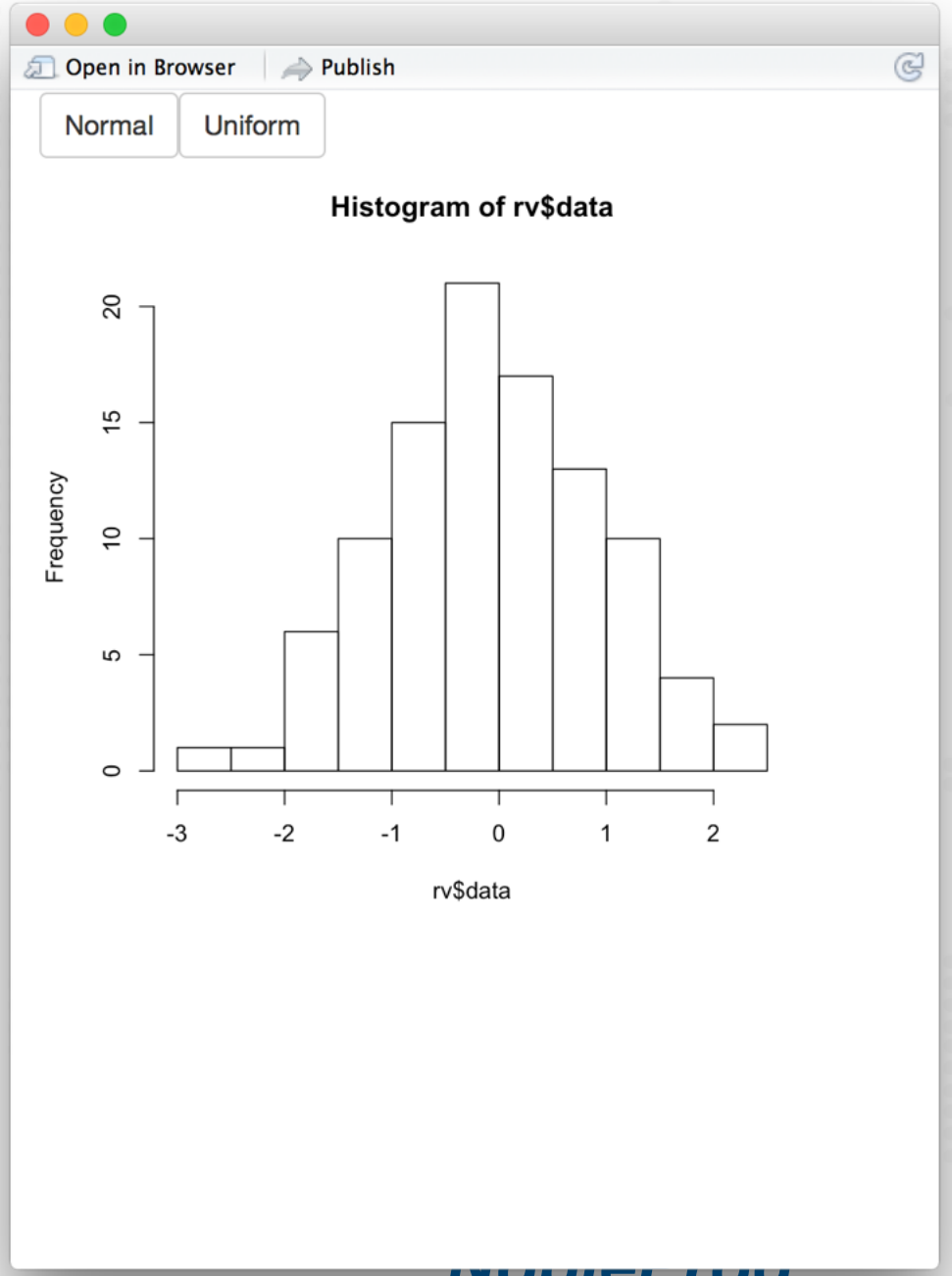


input$norm

rv$data
runif(100)

input$unif

```
output$hist <-
  renderPlot({
    hist(rv$data)
})
```

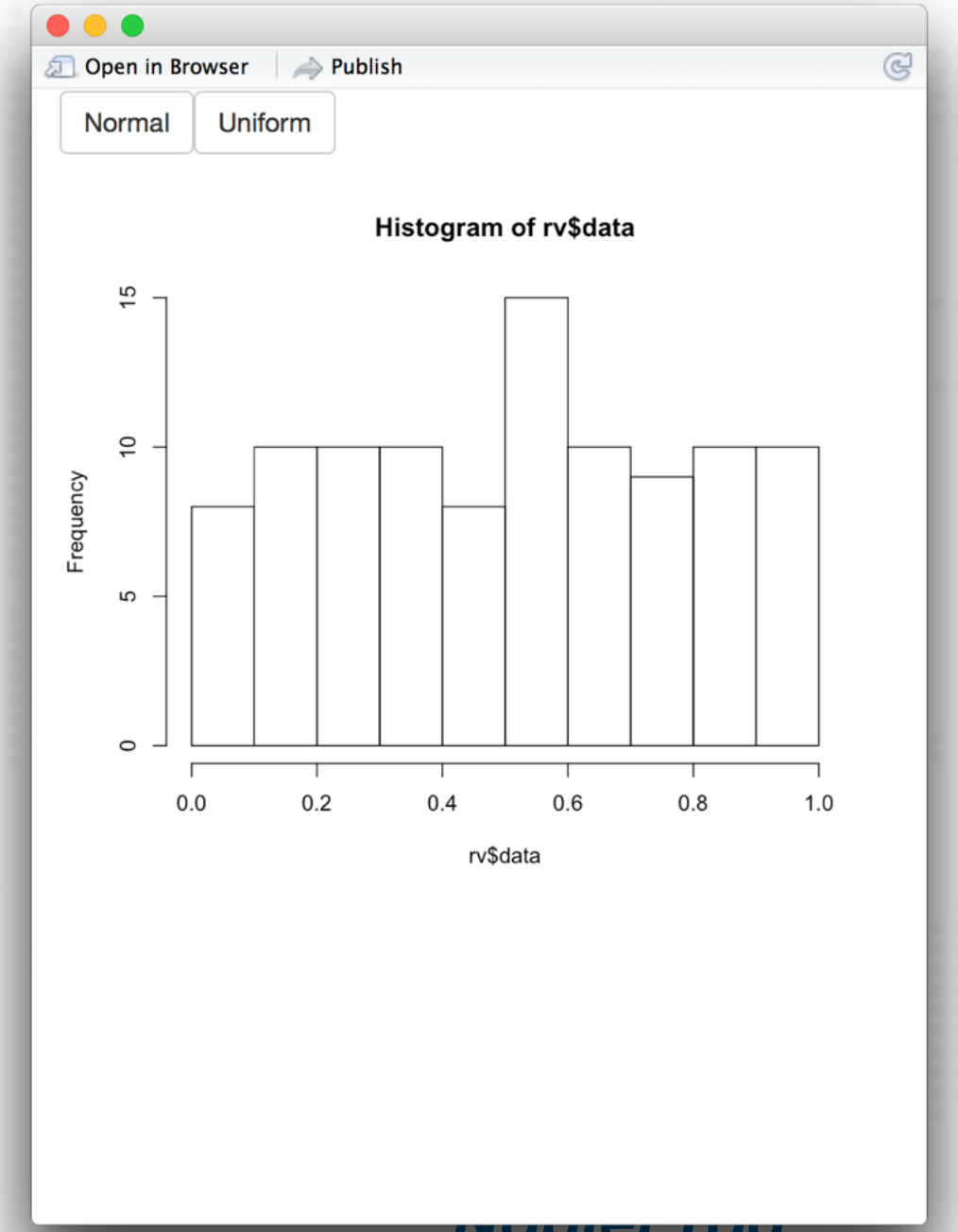


input$norm

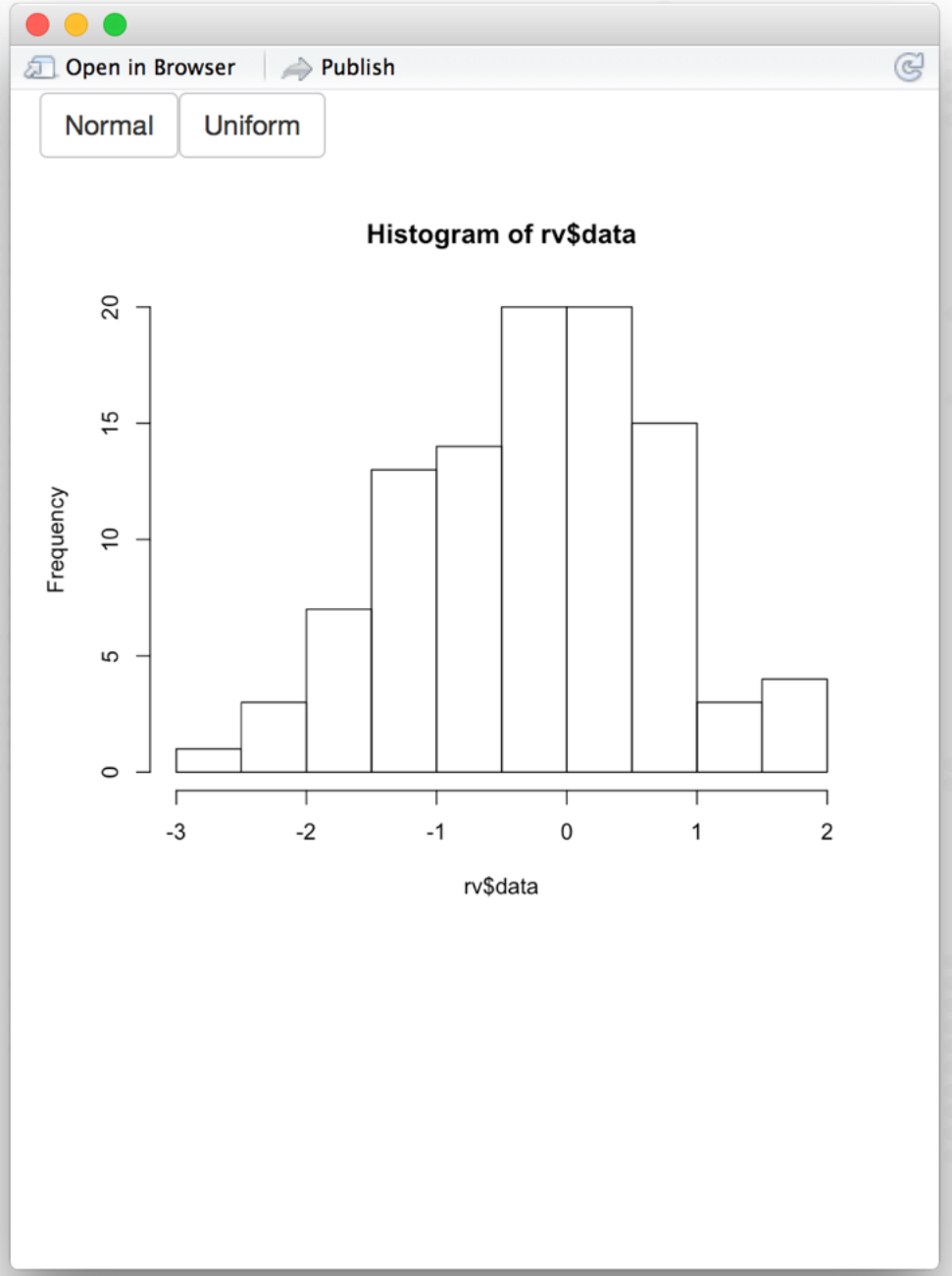
rv$data
runif(100)

input$unif

```
output$hist <-
  renderPlot({
    hist(rv$data)
})
```



```
library(shiny)

ui <- fluidPage(
  actionButton(inputId = "norm", label =
"Normal"),
  actionButton(inputId = "unif", label =
"Uniform"),
  plotOutput("hist")
)

server <- function(input, output) {

  rv <- reactiveValues(data = rnorm(100))

  observeEvent(input$norm, { rv$data <-
rnorm(100) })
  observeEvent(input$unif, { rv$data <-
runif(100) })

  output$hist <- renderPlot({
    hist(rv$data)
  })
}

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



Recap: reactiveValues()

reactiveValues() creates a list of **reactive values**

```
rv$data <-
```

You can manipulate these values (usually with observeEvent())

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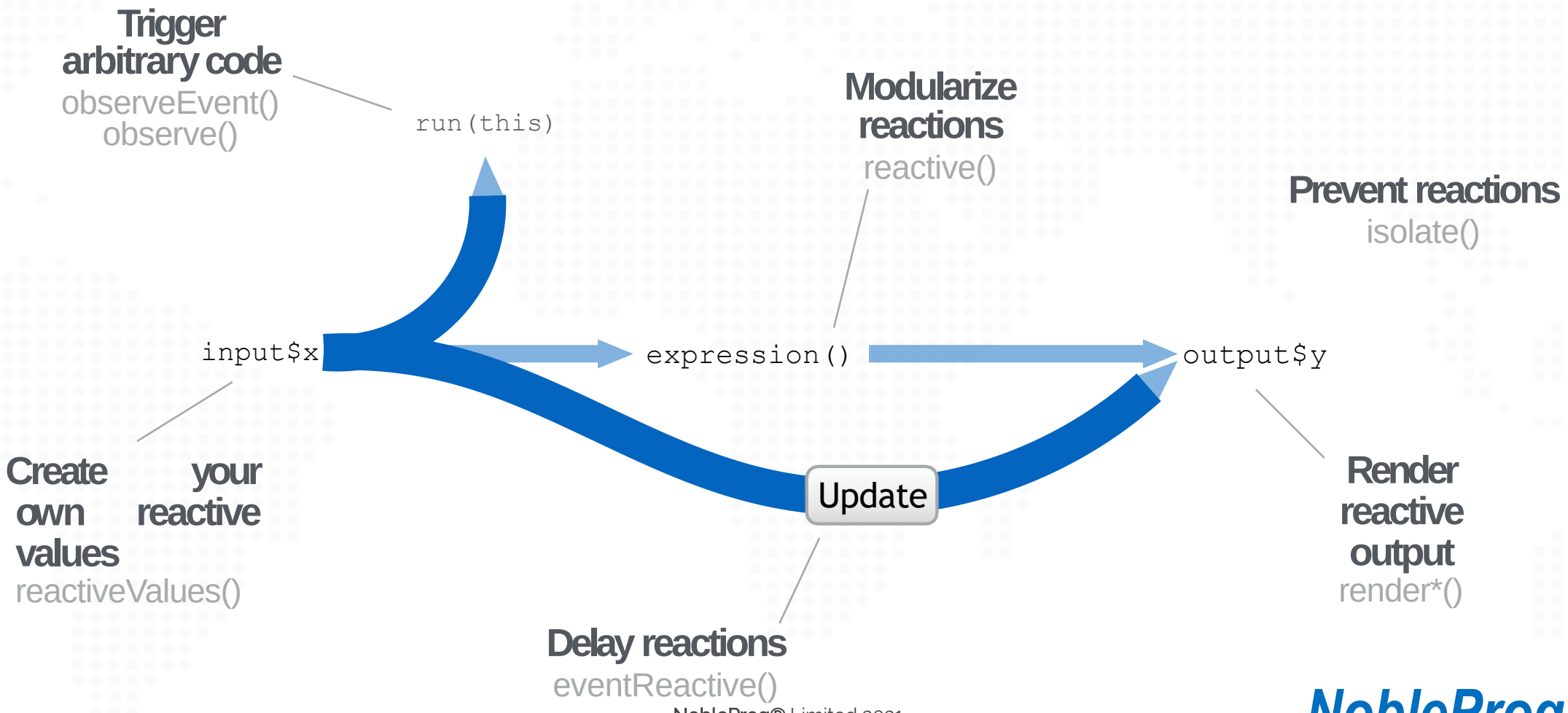
You now how to



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Performance Tips

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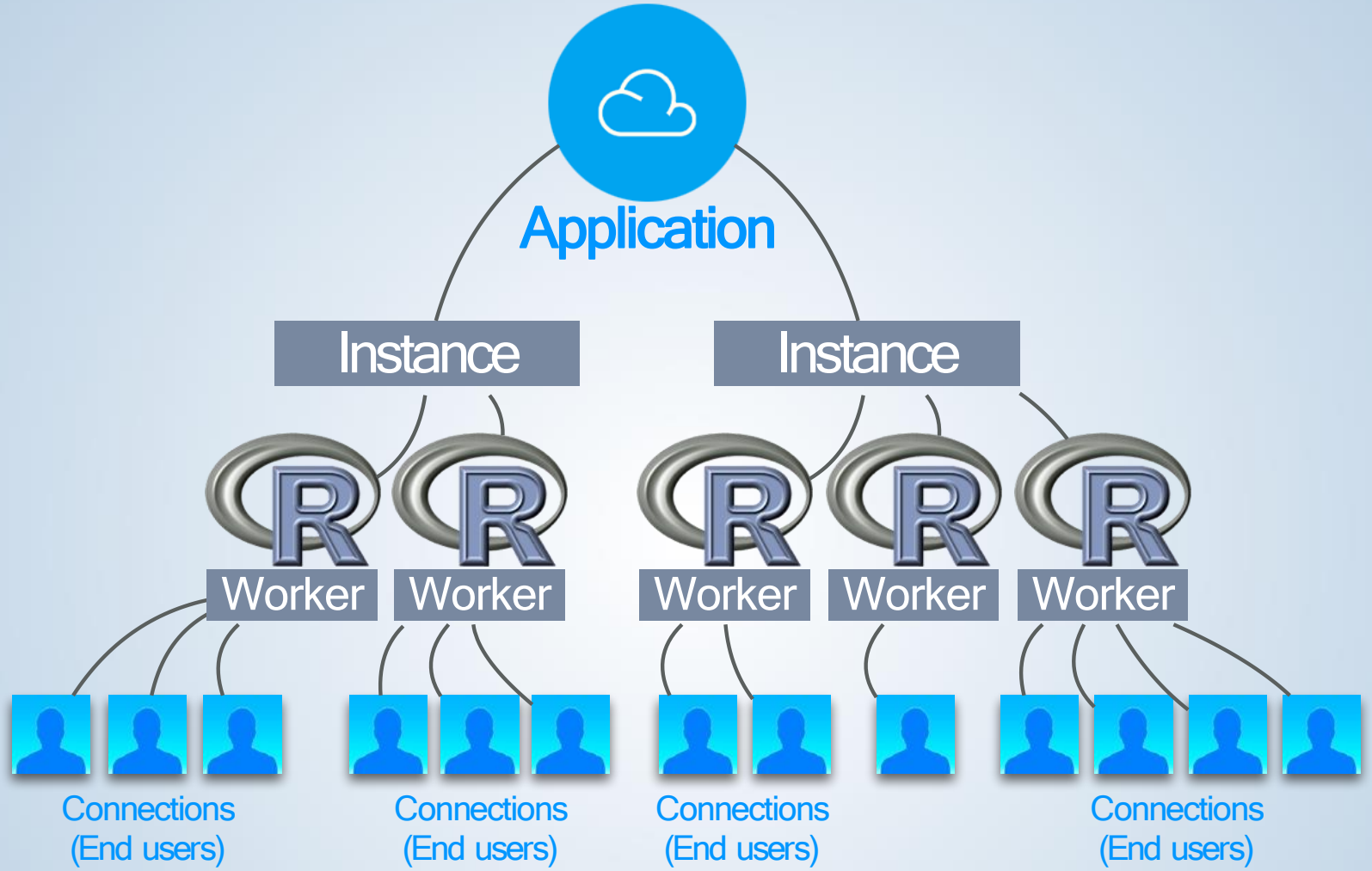
Application
Instance
Instance
Worker
Worker
Worker
Worker
Worker
Connections
(End users)
Connections
(End users)
Connections
(End users)
Connections
(End users)

RStudio

Reduce repetition

Place code where it will be re-run as little as necessary

```
library(shiny)

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

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

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

Code outside the server function will be run once per R session (worker)

Code inside the server function will be run once per end user (connection)

Code inside a reactive function will be run once per reaction (e.g. many times)

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Dynamic UI

```
ui <- fluidPage(
  numericInput("n", "Simulations", 10),
  actionButton("simulate", "Simulate")
)

server <- function(input, output, session) {
  observeEvent(input$n, {
    label <- paste0("Simulate ", input$n, " times")
    updateActionButton(inputId = "simulate", label = label)
  })
}
```


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Exercise

- Create a small application that allows the user to:
  - Select age range and gender
  - User clicks a „Submit“ button.
  - Returns the corresponding injuries from „injuries.tsv“ file.

- Add a file upload with a dynamic UI:
  - User uploads a file („injuries.tsv“).
  - Shiny reads the values of „gender“ and „age“ and generates the UI.
  - „Submit“ button + display values as above.