

# Advanced R: Building Shiny Apps

W. Evan Johnson, Ph.D.  
Professor, Division of Infectious Disease  
Director, Center for Data Science  
Rutgers University – New Jersey Medical School

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# What is Shiny?

Shiny is an R package that allows you to easily create rich, interactive web apps around your R functions and packages. Shiny allows you to take your work in R and disseminate it via a web browser so that anyone can use it. Shiny makes you look awesome by making it easy to produce polished web apps with a minimum amount of pain.

(Credit: Some of the images and slide text were taken and adapted from <https://mastering-shiny.org> and RStudio's Shiny tutorials)

# What is Shiny?

Shiny is designed primarily with data scientists in mind, and to that end, you can create pretty complicated Shiny apps with no knowledge of HTML, CSS, or JavaScript. On the other hand, Shiny doesn't limit you to creating trivial or prefabricated apps: its user interface components can be easily customized or extended, and its server uses reactive programming to let you create any type of back end logic you want.

# What is Shiny?

Some of the things people use Shiny for are:

- Create dashboards
- Replace hundreds of pages of PDFs with interactive apps
- Communicate complex models informative visualizations
- Provide self-service data analysis for common workflows
- Create interactive demos for teaching statistics and data science

In short, Shiny gives you the ability to pass on some of your R superpowers to anyone who can use the web.

# Getting Started

To create your first Shiny App you will need:

- Install R: Come on now!!
- Install RStudio (strongly recommended):  
<https://www.rstudio.com/products/rstudio/download>
- The R Shiny package: `install.packages("shiny")`
- Knowledge and experience in developing R packages (recommended)
- Git and GitHub (recommended): to share your Apps

# Getting Started

If you haven't already installed Shiny, install it now with:

```
install.packages("shiny")
```

If you've already installed Shiny, use the following to check that you have version 1.5.0 or greater:

```
packageVersion("shiny")
```

```
## [1] '1.7.4'
```

# Shiny Introduction

RStudio's Shiny Showcase is an exciting assembly of exciting apps!

Or we can start with a very simple example

```
library(shiny)  
runExample("01_hello")
```

# Shiny Introduction

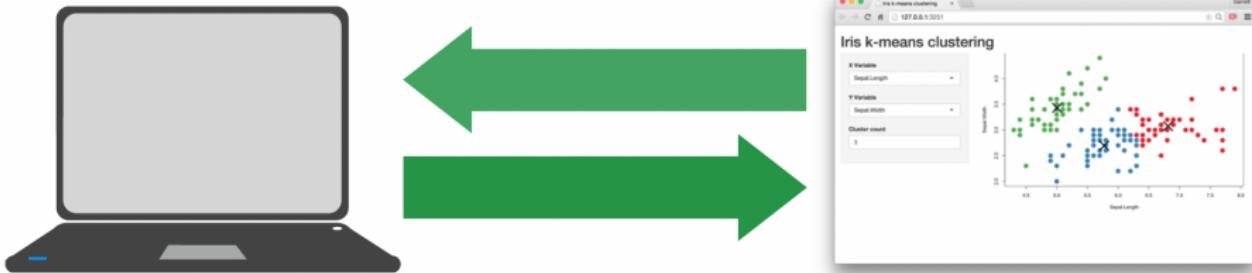
Or an example from Dr. Johnson's research:

```
devtools::install_github("combiomed/animalcules")
library(animalcules)
run_animalcules()
```

(Warning: this might take a while to load package dependencies!)

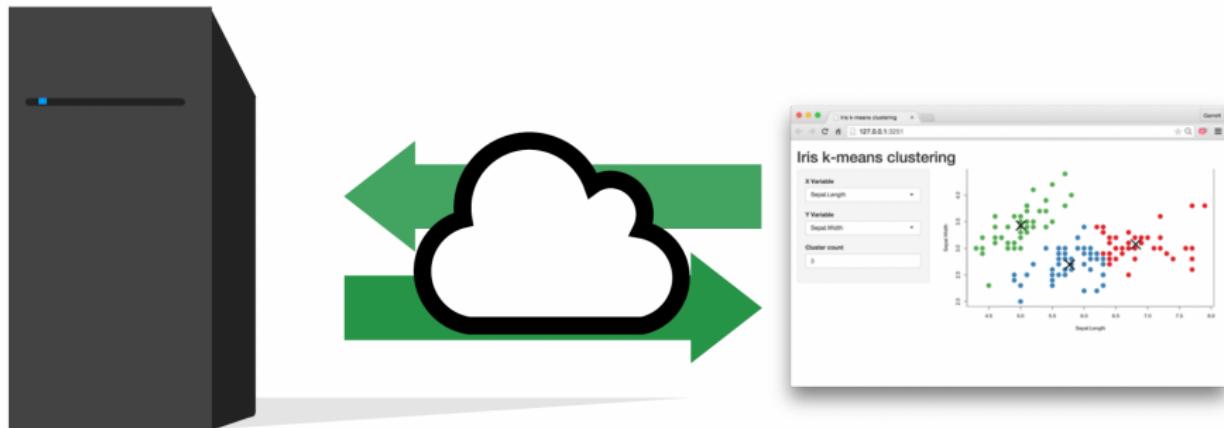
# Shiny Architecture

Every Shiny app is maintained by a computer running R



# Shiny Architecture

Every Shiny app is maintained by a computer running R



# Shiny Architecture



Server Instructions

User Interface (UI)

# Introduction to shiny development

Here we'll create a simple Shiny app, starting with the minimum boilerplate, followed by the two key components of every Shiny app: the UI (short for user interface) which defines how your app looks, and the server function which defines how your app works. Shiny uses **reactive** programming to automatically update outputs when inputs change.

## Template: shortest viable app

The simplest way to start an app is to create a new directory, and add a single file called app.R, with the following code:

```
library(shiny)

ui <- fluidPage()

server <- function(input, output) {}

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

# Close your app

# Close an app

The screenshot shows the RStudio interface with a Shiny application open. The left pane displays the server.R code:

```
1 # This is the server logic for a Shiny web application.
2 # You can find out more about building applications with
3 # Shiny here:
4 #
5 # http://shiny.rstudio.com
6 #
7
8 library(shiny)
9
10 shinyServer(function(input, output) {
11
12   output$distPlot <- renderPlot({
13
14     # generate bins based on input$bins from ui.R
15     x <- faithful[, 2]
16
17   })
18 })
19
20 #> [Top Level]:
```

The right pane shows the application's user interface with two red circular highlights. One highlight is on the 'Environment' tab in the top navigation bar, and another is on the 'Run' button in the toolbar below the console.

The application title is "Old Faithful Geyser Data". It features a slider for "Number of bins" ranging from 1 to 50, with a value of 30 selected. Below the slider is a histogram titled "Histogram of x" showing the frequency distribution of the variable x. The x-axis ranges from approximately -1 to 8, and the y-axis (Frequency) ranges from 0 to 25. The histogram bars are gray.

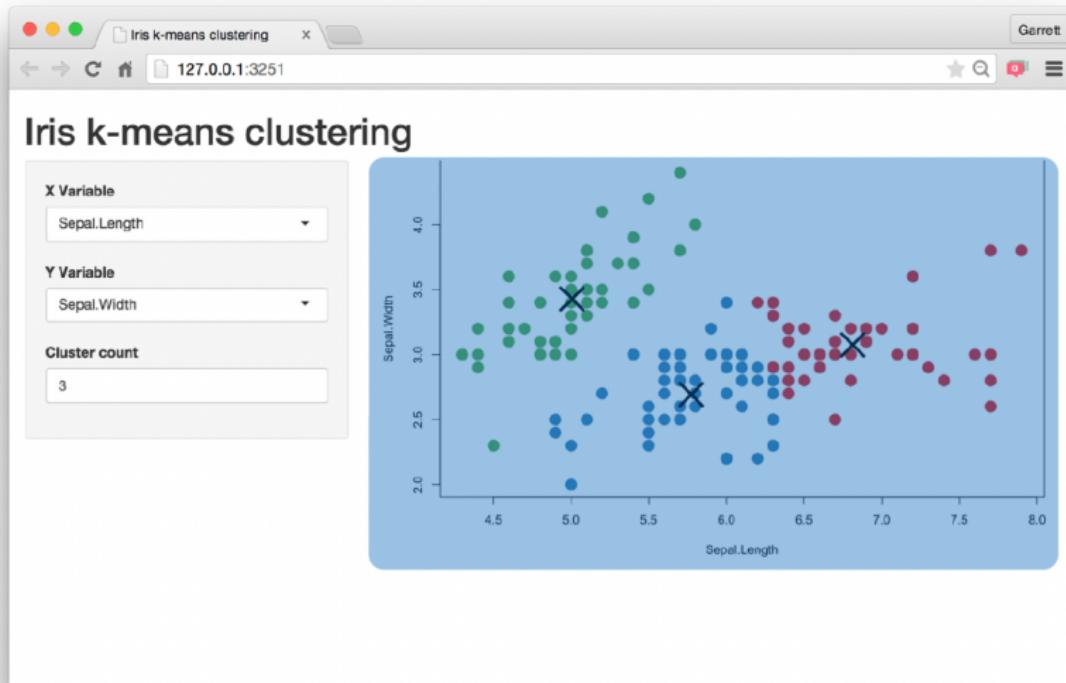
# Inputs and outputs

Build your app around **inputs** and **outputs**



# Inputs and outputs

Build your app around **inputs** and **outputs**



## Adding elements to the UI

Add elements to your app as arguments to `fluidPage()`

```
library(shiny)

ui <- fluidPage(
  # Input() functions,
  # Output() functions
)

server <- function(input, output) {}

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

## Adding elements to the UI

Add elements to your app as arguments to `fluidPage()`

```
library(shiny)

ui <- fluidPage("Hello World!")

server <- function(input, output) {}

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

# Input functions

Create an input with an **Input()** function.

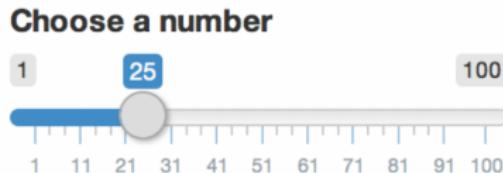
```
sliderInput(inputId = "num",
            label = "Choose a number",
            value = 25, min = 1, max = 100)
```

Here is the actual HTML code for this slider:

```
<div class="form-group shiny-input-container">
  <label class="control-label" for="num">Choose a number</label>
  <input class="js-range-slider" id="num" data-min="1" data-max="100"
    data-from="25" data-step="1" data-grid="true" data-grid-num="9.9"
    data-grid-snap="false" data-prettify-separator="," data-keyboard="true"
    data-keyboard-step="1.01010101010101"/>
</div>
```

# Shiny buttons

## Syntax



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

input name  
(for internal use)

Notice:  
Id not ID

label to  
display

input specific  
arguments

?sliderInput

# Input functions in an app

Create an input with an **Input()** function.

```
library(shiny)

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

server <- function(input, output) {}

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

# Shiny buttons

## Buttons

Action  
Submit

`actionButton()`  
`submitButton()`

## Single checkbox

Choice A

`checkboxInput()`

## Checkbox group

Choice 1  
 Choice 2  
 Choice 3

`checkboxGroupInput()` `dateInput()`

## Date range

2014-01-24 to 2014-01-24

`dateRangeInput()`

## File input

Choose File No file chosen

`fileInput()`

## Numeric input

1

`numericInput()`

## Date input

2014-01-01

`dateInput()`

## Radio buttons

Choice 1  
 Choice 2  
 Choice 3

`radioButtons()`

## Select box

Choice 1

`selectInput()`

## Sliders



`sliderInput()`

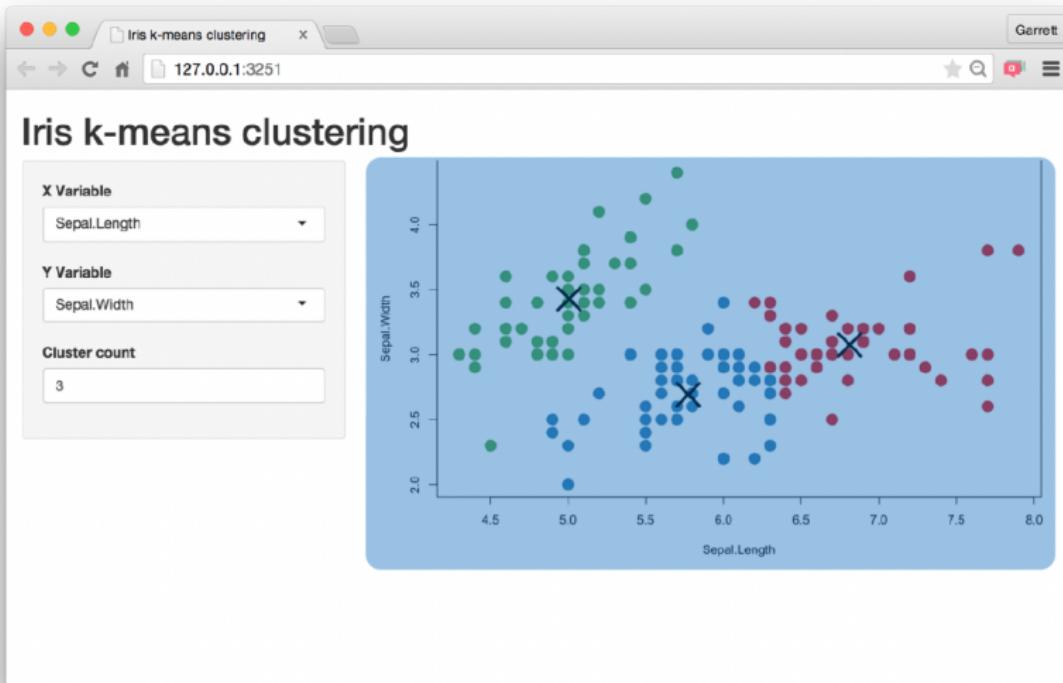
## Text input

Enter text...

`textInput()`

## Shiny outputs

Build your app around **inputs** and **outputs**



## Shiny outputs

Function	Inserts
dataTableOutput()	an interactive table
htmlOutput()	raw HTML
imageOutput()	image
plotOutput()	plot
tableOutput()	table
textOutput()	text
uiOutput()	a Shiny UI element
verbatimTextOutput()	text

## Adding outputs

Create an output with an **Output()** function.

```
library(shiny)

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

server <- function(input, output) {}

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

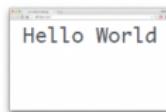
Note that you must build the output in the server first!

# Shiny outputs

# Recap

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

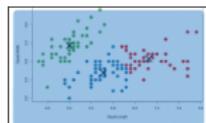
Begin each app with the template



Add elements as arguments to **fluidPage()**



Create reactive inputs with an **\*Input()** function



Display reactive results with an **\*Output()** function



Assemble outputs from inputs in the server function

# Building the server

There are 3 basic rules for your **server** function:

- ① Access input values with **input\$**
- ② Save objects to display as **output\$**
- ③ Build objects to display with **render()**

## Server inputs

You can access inputs from the UI using `input$`

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



```
input$num
```

The input value changes whenever a user changes the input.

Choose a number

A slider input with a blue handle and a grey track. The track has tick marks at intervals of 10, labeled 1, 11, 21, 31, 41, 51, 61, 71, 81, 91, and 100. The handle is positioned at the 25 mark, which is highlighted with a blue box. The text "25" is displayed in a blue box above the handle.



```
input$num = 25
```

Choose a number

A slider input with a blue handle and a grey track. The track has tick marks at intervals of 10, labeled 1, 11, 21, 31, 41, 51, 61, 71, 81, 91, and 100. The handle is positioned at the 50 mark, which is highlighted with a blue box. The text "50" is displayed in a blue box above the handle.



```
input$num = 50
```

Choose a number

A slider input with a blue handle and a grey track. The track has tick marks at intervals of 10, labeled 1, 11, 21, 31, 41, 51, 61, 71, 81, 91, and 100. The handle is positioned at the 75 mark, which is highlighted with a blue box. The text "75" is displayed in a blue box above the handle.



```
input$num = 75
```

## Server outputs

You can save your outputs to return to the UI using **output\$**

```
server <- function(input, output) {  
  output$hist <- # code  
}  
}
```

## Rendering server outputs

Build objects to display with `render()`

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

## Rendering server outputs

# render\*()

Builds reactive output to display in UI

```
renderPlot({ hist(rnorm(100)) })
```

type of object to build

code block that builds the object

## Rendering server outputs

Use the **render\***() function that creates the type of output you wish to make.

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

# Reactivity 101

The term **reactivity** refers to the idea that the inputs and outputs are connected to each other: when you change an input, you change all outputs that require the input.

Reactivity is an exciting characteristic, but can also get you in trouble!

# Recap: Server



Use the server function to assemble inputs into outputs. Follow 3 rules:

`output$hist <-`

1. Save the output that you build to `output$`

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

2. Build the output with a `render*` function

`input$num`

3. Access input values with `input$`



Create reactivity by using `Inputs` to build `rendered Outputs`

# Complete Shiny app

Now putting everything together:

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

## Multi-file apps:

Now lets get more organized, create a **ui.R** file

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

And a **server.R** file:

```
#server.R
library(shiny)
server <- function(input, output){
  output$hist <- renderPlot({
    hist(rnorm(input$num))
  })
}
```

## Multi-file apps:

And then finally the program file, **app.R**:

```
#app.R
library(shiny)

source("ui.R")
source("server.R")

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

## Building apps in R packages:

In an R package, create an `inst/shiny` directory and place the Shiny code there. Also:

- Write the package functions first!
- This includes all analytics AND plotting functions
- Shiny app should call functions, provide inputs, display results
- Operate on high-quality R data objects!

Also, see examples from Dr. Johnson's research, e.g.:

<https://github.com/compbioimed/animalcules>

# Session Info

```
## R version 4.2.3 (2023-03-15)
## Platform: aarch64-apple-darwin20 (64-bit)
## Running under: macOS Ventura 13.4
##
## Matrix products: default
## BLAS:    /Library/Frameworks/R.framework/Versions/4.2-arm64/Resources/lib/libRblas.0.dylib
## LAPACK:  /Library/Frameworks/R.framework/Versions/4.2-arm64/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats      graphics   grDevices utils      datasets   methods    base
##
## loaded via a namespace (and not attached):
## [1] compiler_4.2.3  fastmap_1.1.1   cli_3.6.1      tools_4.2.3
## [5] htmltools_0.5.5 rstudioapi_0.14 yaml_2.3.7    rmarkdown_2.22
## [9] knitr_1.43     xfun_0.39     digest_0.6.31  rlang_1.1.1
## [13] evaluate_0.21
```