Interactive Web frameworks in R. Shiny, Plotly

R Nano Course Series

01/31/2016

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Introduction

Interactive Analysis:

- High-dimensional data can be difficult to analyze.
- Interactive analysis and visualization can provide better understanding of variables and their significance.
- Explore relationship between multiple variables.

Web-based Content:

- View results beyond your own desktop.
- Share results with collaborators.
- Prepare web content for publication.

Introduction - Examples

Plotly Examples:

/Plotly_Examples/Example1/index.html

https://plot.ly/r/dashboard/

Shiny Examples:

http://webpopix.org:8080/old/tgi1/

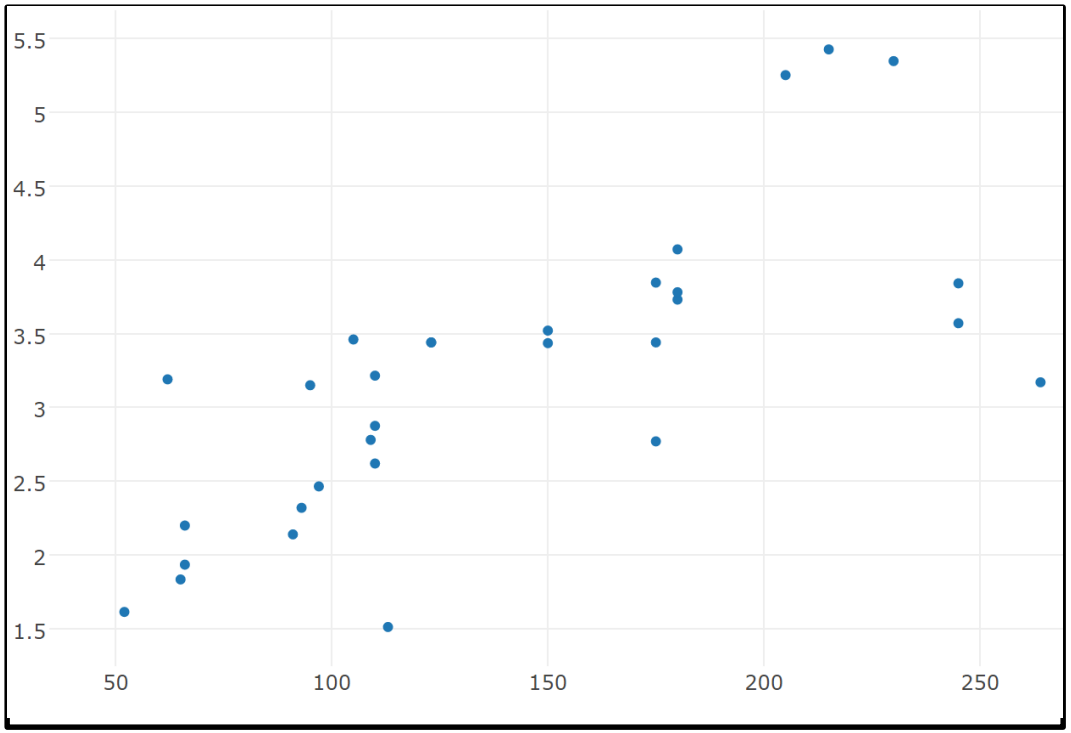
Plotly - https://plot.ly/

Plotting libraries for R, Matlab, Python, and JavaScript.

- Easy to use code for creating web-ready figures.
- Can be done with as little as one line of code.
- Available for free.
- Provides option to have your figures hosted on their cloud service for a fee. Payed version also gives access to online editing tool.

Plotly – Getting Started

```
install.packages("plotly")
library(plotly)
plot_ly(data=mtcars, x = mtcars$hp, y = mtcars$wt)
```



Plotly – index.html

- Figures generated by Plotly are output as an ‘index.html’ file which can be opened with any web browser.
- All data for the figure is stored in a self-contain folder that should be kept with the ‘index.html’ at all times.
- To make your figure available on the internet:
  1. Copy folder to your web hosting server.
  2. Create an account with Plotly for web publishing (fee).

Scatterplot

Why use Plotly instead of regular static figure?

1) Interactive Labels
2) Focus

```
plot_ly(data = diamonds, x = ~carat, y = ~price,
        color = ~carat, size = ~carat,
        text = ~paste("Price: $", price, '<br>Cut:', cut))
```

\Plotly_Examples\ScatterPlot\index.html

Box Plots

```
plot_ly(y = ~rnorm(50), type = "box") %>%
        add_trace(y = ~rnorm(50, 1))
```

Note: **%>%** is used for combining plots.

\Plotly_Examples\BoxPlot\index.html

Density Plot

```
data <- density(mtcars$mpg)
plot_ly(x=data$x,y=data$y,mode = 'lines', fill = 'tozeroy')
```

\Plotly_Examples\DensityPlot\index.html

\Plotly_Examples\RangePlot\index.html

3D Plot

```
plot_ly(z = ~volcano, type = "surface")
```

\Plotly_Examples\3dScatterPlot\index.html

\Plotly_Examples\SurfacePlot\index.html

\Plotly_Examples\3dCube\index.html

Combine Plots

```
data <- density(mtcars$mpg)
p1 <- plot_ly(x = data$x, y = data$y, mode = 'lines')
p2 <- plot_ly(x = data$x, y = data$y, mode = 'lines', color = 'red')
```

subplot(p1, p2)

\Plotly_Examples\CombinedPlot\index.html

ggplotly

```
p <- ggplot(diamonds, aes(x = carat, y = price)) +
      geom_point(aes(text = paste("Clarity:", clarity))) +
      geom_smooth(aes(colour = cut, fill = cut)) +
      facet_wrap(~ cut)

ggplotly(p)
```

\Plotly_Examples\ggplot\index.html

Reference

https://plot.ly/r/reference/

https://cpsievert.github.io/plotly_book/

https://plot.ly/api/

Shiny in R

- R package for creating Interactive Web Applications.
- Created by same developers who made Rstudio.
- No HTML, CSS, or JavaScript knowledge required.

Getting Started

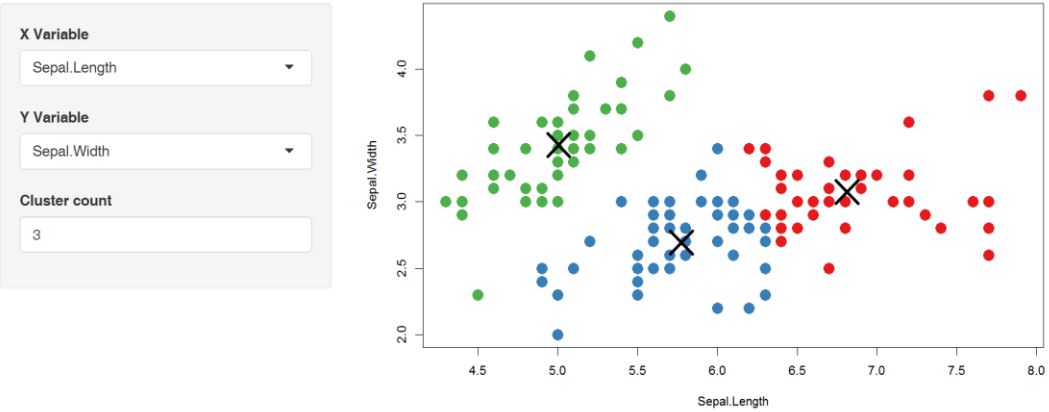
install.packages("shiny")

library(shiny)

Iris

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa
4.6	3.4	1.4	0.3	setosa
5	3.4	1.5	0.2	setosa
4.4	2.9	1.4	0.2	setosa
4.9	3.1	1.5	0.1	setosa
5.4	3.7	1.5	0.2	setosa
4.8	3.4	1.6	0.2	setosa
4.8	3	1.4	0.1	setosa
4.3	3	1.1	0.1	setosa

Iris k-means clustering



\Shiny_Examples\K-means\app.R

Basic Template

```
library(shiny)
ui <- fuildPage( )

server <- function(input,output){ }

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

View (Front) / Controller (Back)

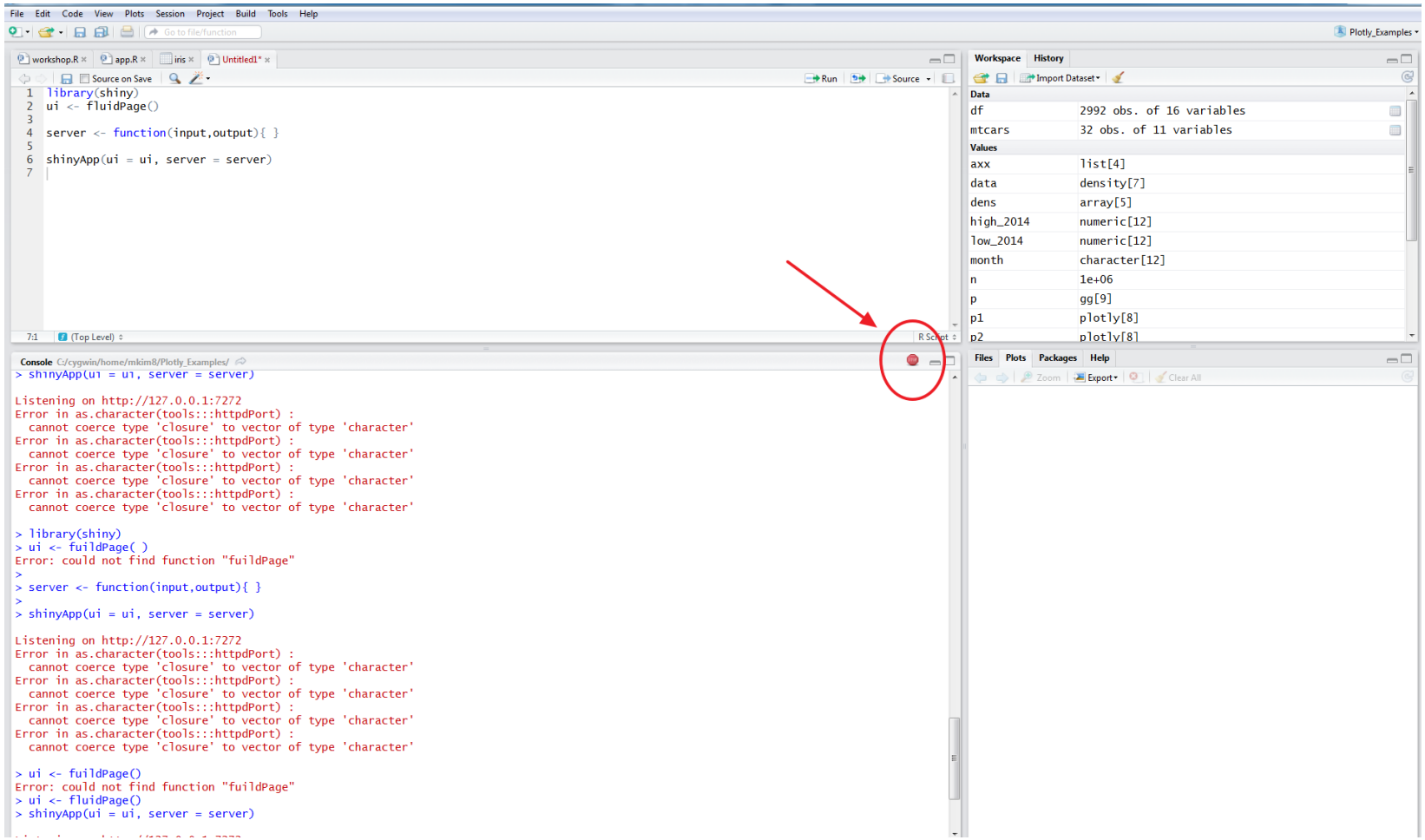
UI
(View)

ui <- fuildPage( )

Server
(Controller)

server <- function(input,output){ }

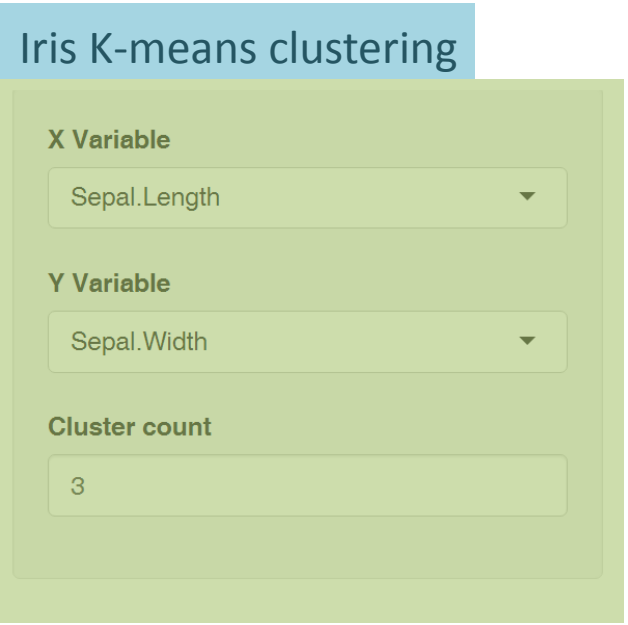
Close the app



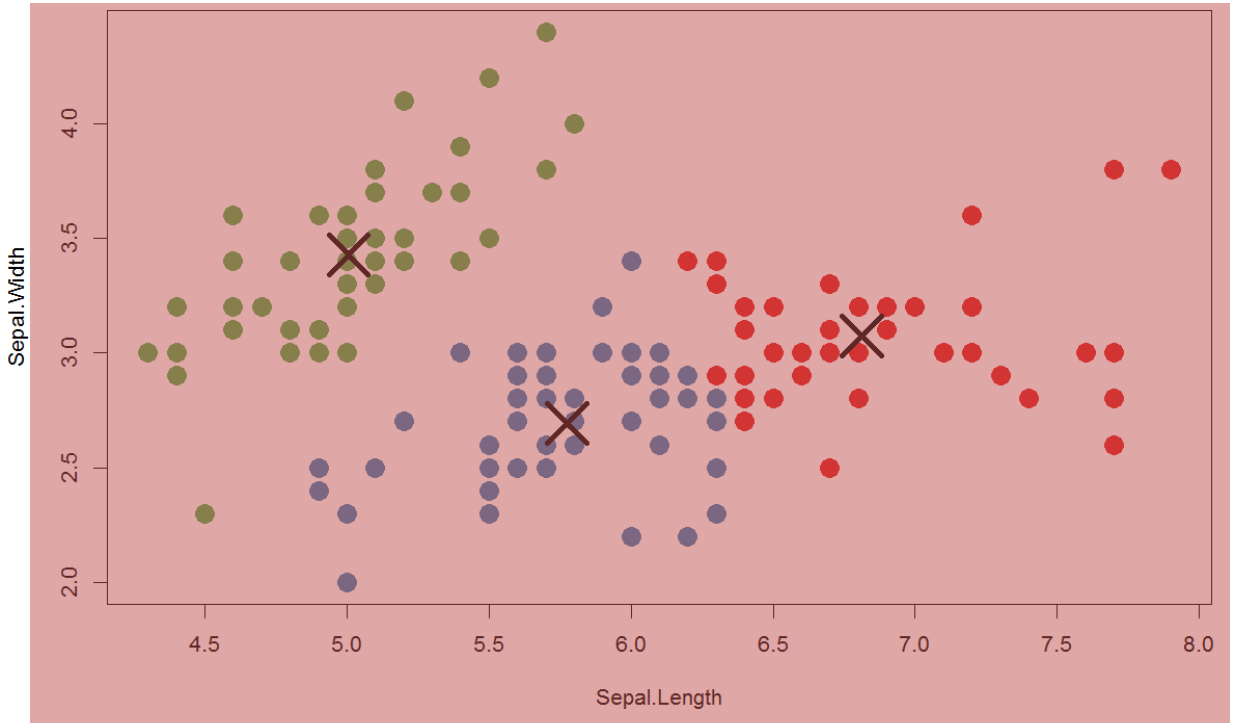
First element to UI

```
library(shiny)
ui <- fluidPage("Hello World")

server <- function(input,output){ }

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

UI Elements



Input Elements



Output Elements

UI Elements : Inputs and Outputs

```
ui <- fluidPage(
  headerPanel("Iris k-means clustering"),
  sidebarPanel(
    selectInput('xcol', 'X Variable', names(iris)),
    selectInput('ycol', 'Y Variable', names(iris),selected = names(iris)[[2]]),
    numericInput('clusters', 'Cluster count', 3, min = 1, max = 9)
  ),
  mainPanel(
    plotOutput('plot1')
  )
)
```

Iris K-means clustering

X Variable

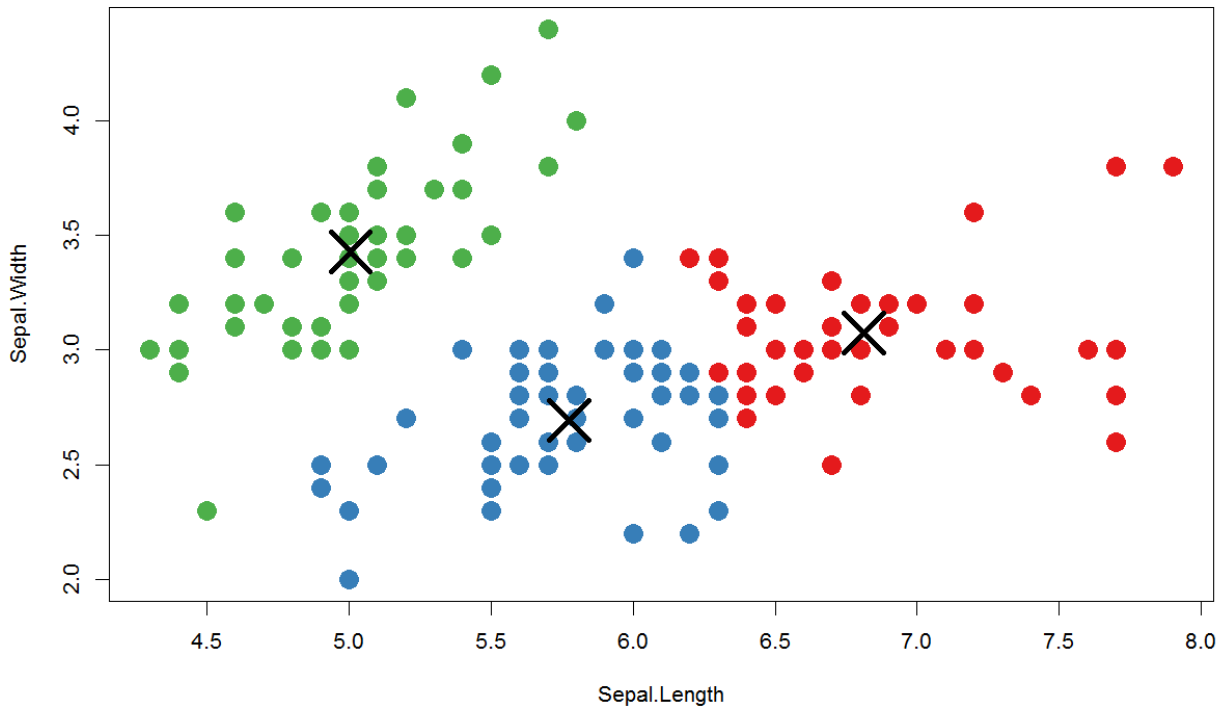
Sepal.Length

Y Variable

Sepal.Width

Cluster count

3



UI Elements : Inputs and Outputs

```
ui <- fluidPage(
  headerPanel("Iris k-means clustering"),
  sidebarPanel(
    selectInput('xcol', 'X Variable', names(iris)),
    selectInput('ycol', 'Y Variable', names(iris),selected = names(iris)[[2]]),
    numericInput('clusters', 'Cluster count', 3, min = 1, max = 9)
  ),
  mainPanel(
    plotOutput('plot1')
  )
)
```

Iris K-means clustering

X Variable

Sepal.Length

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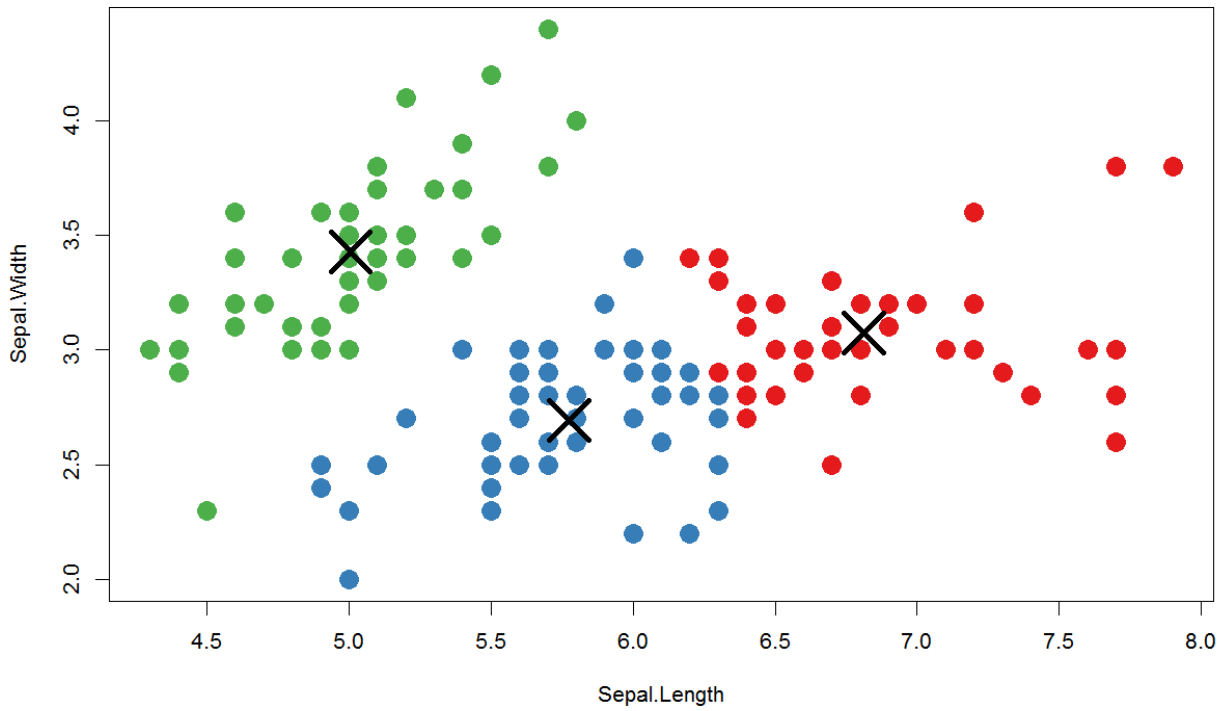
Sepal.Width

Cluster count

3



UI Element : Input

selectInput('xcol' , "X Variable" , names(iris))

input name (reference)

Display Label

Input Arguments

Iris K-means clustering

X Variable

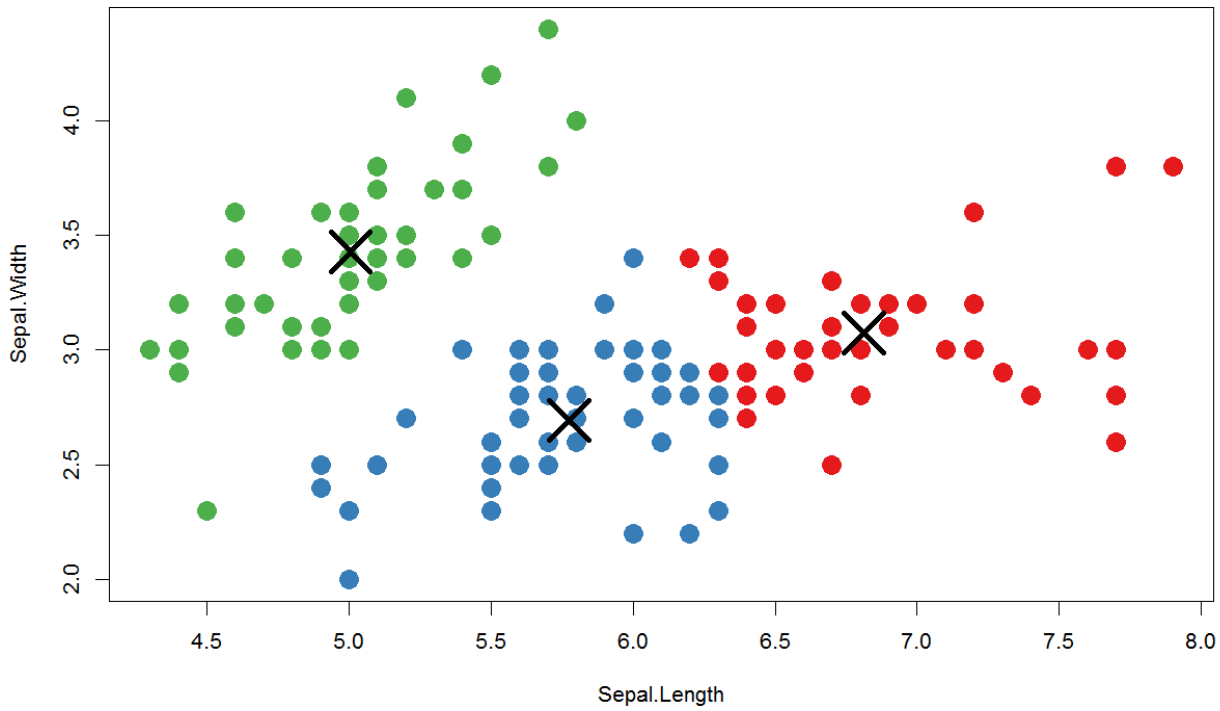
Sepal.Length

Y Variable

Sepal.Width

Cluster count

3



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()`

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()`

http://shiny.rstudio.com/reference/shiny/latest/

UI Elements : Inputs and Outputs

```
ui <- fluidPage(
  headerPanel("Iris k-means clustering"),
  sidebarPanel(
    selectInput('xcol', 'X Variable', names(iris)),
    selectInput('ycol', 'Y Variable', names(iris),selected = names(iris)[[2]]),
    numericInput('clusters', 'Cluster count', 3, min = 1, max = 9)
  ),
  mainPanel(
    plotOutput('plot1')
  )
)
```

UI Element : Output

Iris K-means clustering

X Variable

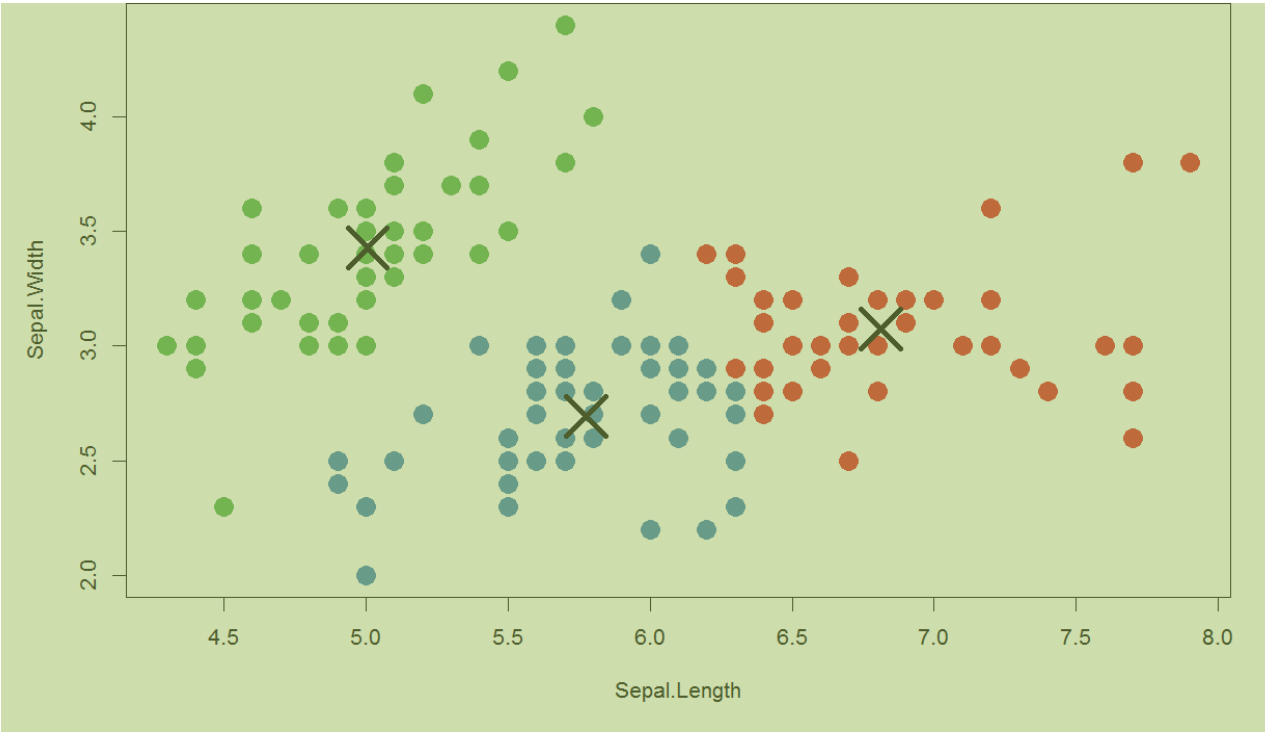
Sepal.Length

Y Variable

Sepal.Width

Cluster count

3



```
ui <- fluidPage(
  headerPanel("Iris k-means clustering"),
  sidebarPanel(
    selectInput('xcol', 'X Variable', names(iris)),
    selectInput('ycol', 'Y Variable', names(iris),selected = names(iris)[[2]]),
    numericInput('clusters', 'Cluster count', 3, min = 1, max = 9)
  ),
  mainPanel(
    plotOutput('plot1')
  )
)
```

UI Element : Output

```
plotOutput( 'plot1' )
```

Output Type

input name
(object reference)

UI Element : Output

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

http://shiny.rstudio.com/reference/shiny/latest/

UI Elements : Layout

```
ui <- fluidPage(
  headerPanel("Iris k-means clustering"),
  sidebarPanel(
    selectInput('xcol', 'X Variable', names(iris)),
    selectInput('ycol', 'Y Variable', names(iris),selected = names(iris)[[2]]),
    numericInput('clusters', 'Cluster count', 3, min = 1, max = 9)
  ),
  mainPanel(
    plotOutput('plot1')
  )
)
```

Without Layout

Iris k-means clustering

X Variable

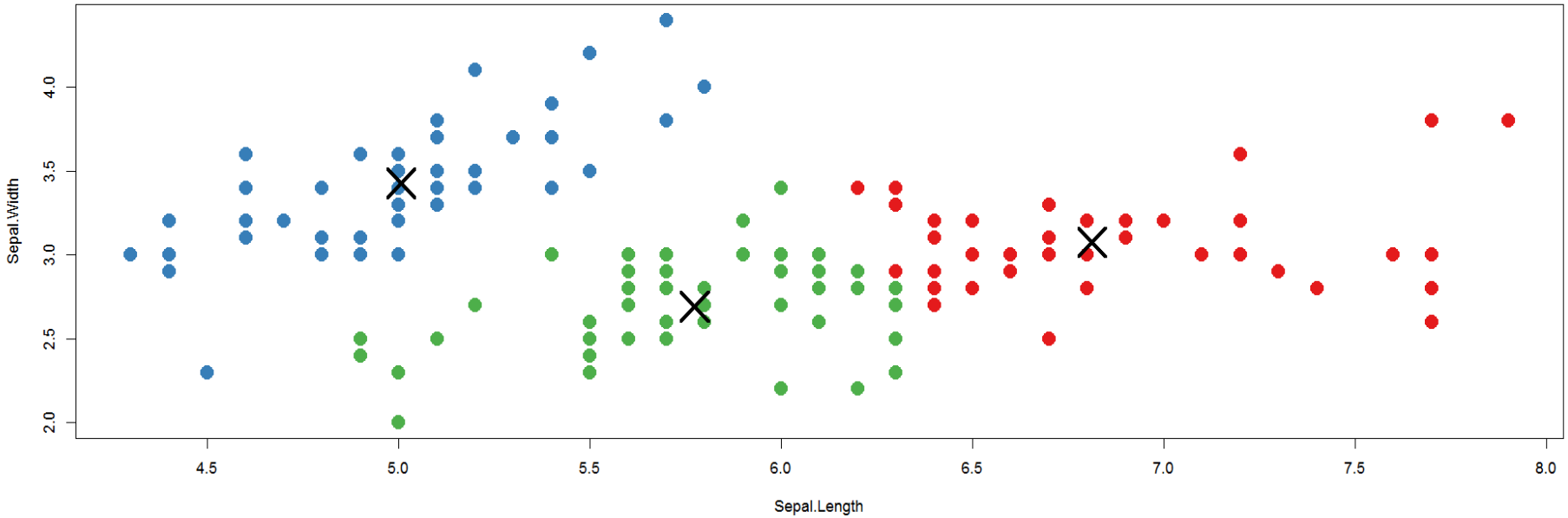
Sepal.Length

Y Variable

Sepal.Width

Cluster count

3



Layout

Iris K-means clustering

headerPanel( )

X Variable

Sepal.Length

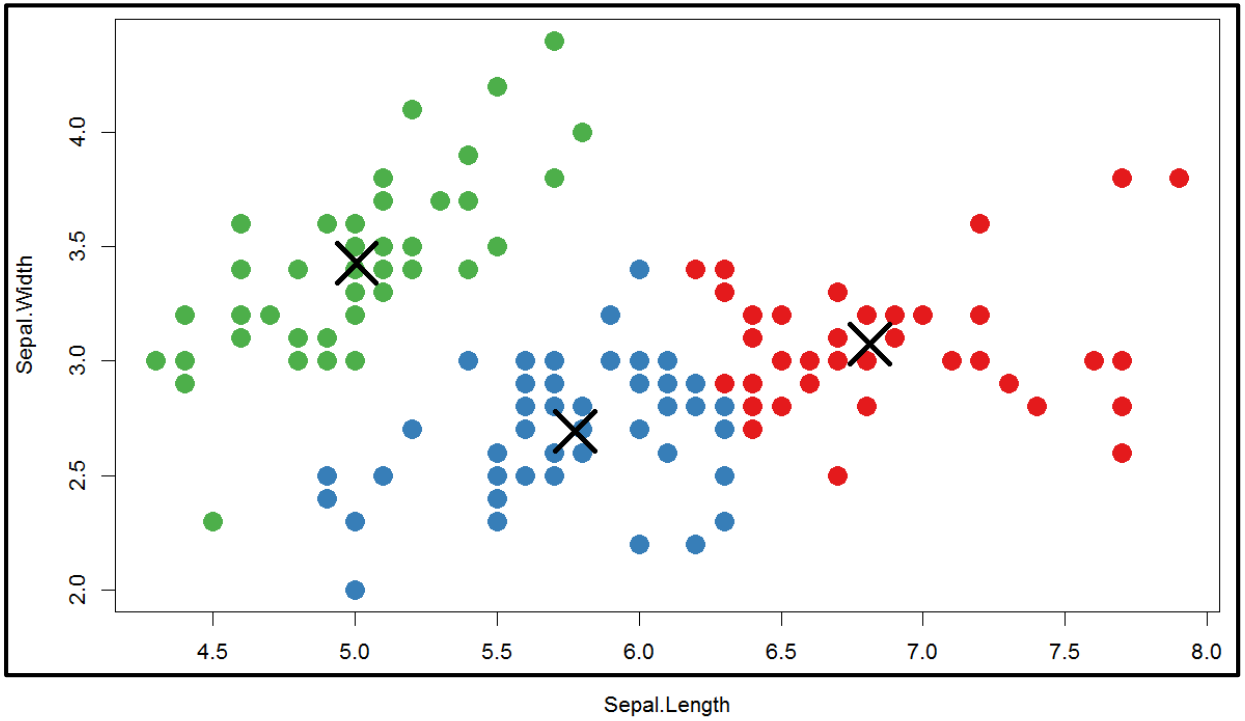
Y Variable

Sepal.Width

Cluster count

3

sidebarPanel( )



mainPanel( )

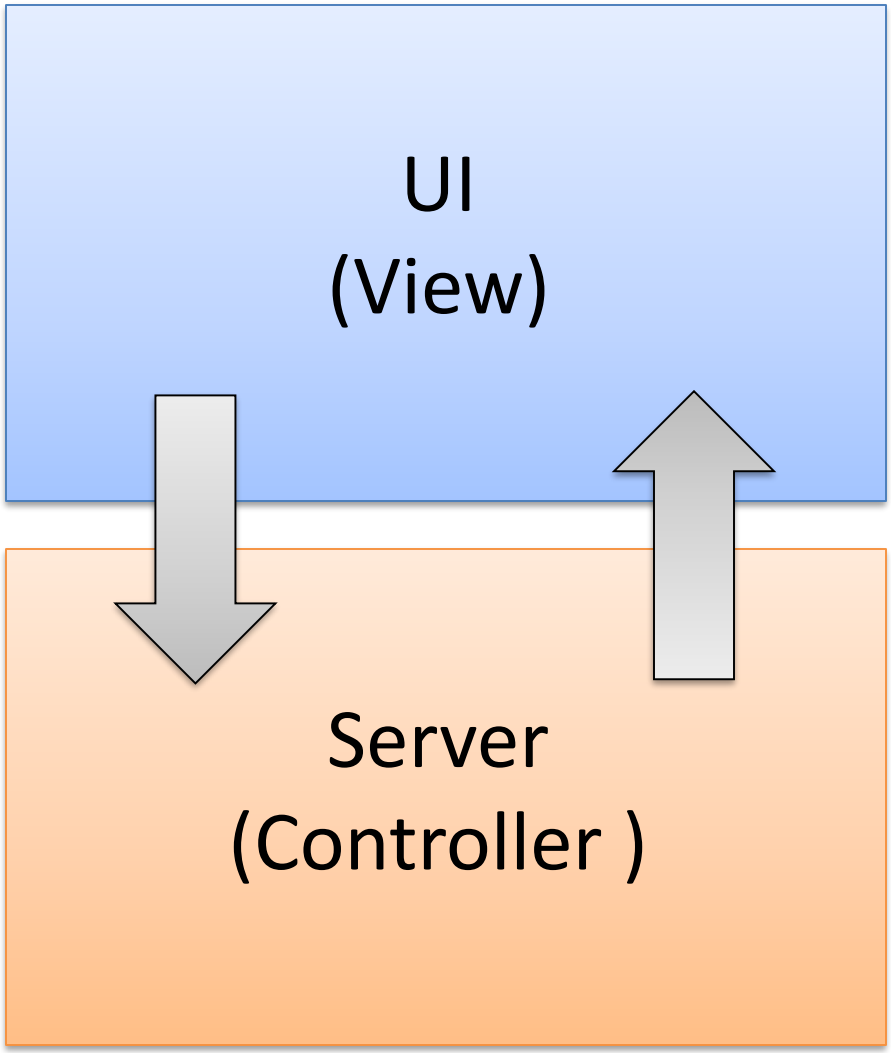
UI Elements: Commas

```
ui <- fluidPage(
  headerPanel("Iris k-means clustering") ,
  sidebarPanel(
    selectInput('xcol', 'X Variable', names(iris)) ,
    selectInput('ycol', 'Y Variable', names(iris),selected = names(iris)[[2]]) ,
    numericInput('clusters', 'Cluster count', 3, min = 1, max = 9)
  ) ,
  mainPanel(
    plotOutput('plot1')
  )
)
```

UI Elements

```
ui <- fluidPage(
  headerPanel("Iris k-means clustering"),
  sidebarPanel(
    selectInput('xcol', 'X Variable', names(iris)),
    selectInput('ycol', 'Y Variable', names(iris),selected = names(iris)[[2]]),
    numericInput('clusters', 'Cluster count', 3, min = 1, max = 9)
  ),
  mainPanel(
    plotOutput('plot1')
  )
)
```

View (Front) / Controller (Back)



ui <- fuildPage( )

server <- function(input,output){ }

Template

```
library(shiny)
ui <- fuildPage( )

server <- function(input,output){  }

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

Server Elements: Output

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

  output$plot1 <- renderPlot({
    par(mar = c(5.1, 4.1, 0, 1))
    plot(selectedData(), col = clusters()$cluster,pch = 20, cex = 3)
    points(clusters()$centers, pch = 4, cex = 4, lwd = 4)
  })

}
```

What gets sent to UI

output$plot1

plotOutput('plot1')

Use render*() to build objects

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

  output$plot1 <- renderPlot({
    par(mar = c(5.1, 4.1, 0, 1))
    plot(selectedData(), col = clusters()$cluster,pch = 20, cex = 3)
    points(clusters()$centers, pch = 4, cex = 4, lwd = 4)
  })

}
```

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

Server Elements: Output

```
server <- function( input , output ) {
  output$plot1 <- renderPlot({
      plot( )
  })
}
```

Type of Object

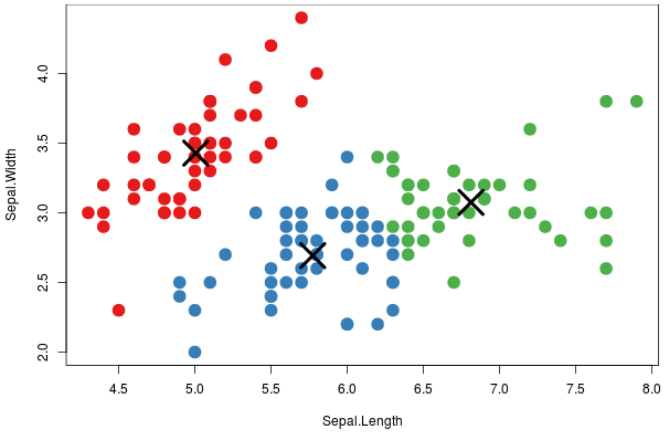
Code to build

Server Elements: Output

```
server <- function( input , output ) {
  output$plot1 <- renderPlot({

    par(mar = c(5.1, 4.1, 0, 1)) #Determines size of plot.
    plot(selectedData(), col = clusters()$cluster,pch = 20, cex = 3)
    points(clusters()$centers, pch = 4, cex = 4, lwd = 4)

  })
}
```



UI Elements

```
ui <- fluidPage(
  headerPanel("Iris k-means clustering"),
  sidebarPanel(
    selectInput('xcol', 'X Variable', names(iris)),
    selectInput('ycol', 'Y Variable', names(iris),selected = names(iris)[[2]]),
    numericInput('clusters', 'Cluster count', 3, min = 1, max = 9)
  ),
  mainPanel(
    plotOutput('plot1')
  )
)
```

Server Elements: Input

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

 selectedData <- reactive({
   iris[ , c( input$xcol , input$ycol )]
 })

}
```

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa
4.6	3.4	1.4	0.3	setosa
5	3.4	1.5	0.2	setosa
4.4	2.9	1.4	0.2	setosa
4.9	3.1	1.5	0.1	setosa
5.4	3.7	1.5	0.2	setosa
4.8	3.4	1.6	0.2	setosa
4.8	3	1.4	0.1	setosa
4.3	3	1.1	0.1	setosa

Use reactive({ })

How does the ‘server’ know changes were made to the input variables?

Using reactive({ input$variable }) tells server this a variable that will be <u>dynamically</u> updated.

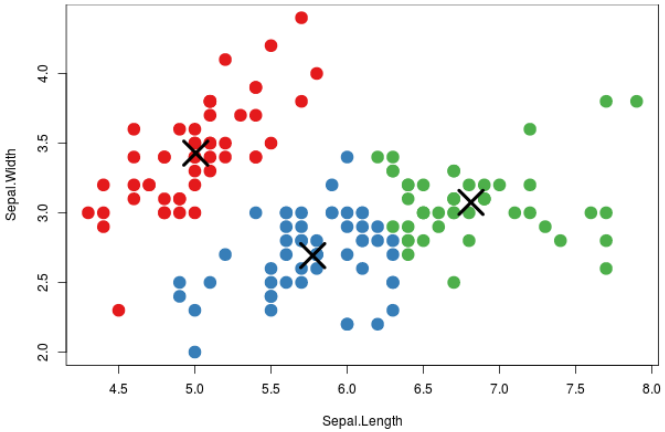
Server Elements: Input

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

 selectedData <- reactive({
   iris[ , c( input$xcol , input$ycol )]
  })

 clusters <- reactive({
   kmeans(selectedData(), input$clusters)
  })

}
```



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

  selectedData <- reactive({
      iris[, c(input$xcol, input$ycol)]
      })

  clusters <- reactive({
      kmeans(selectedData(), input$clusters)
      })

  output$plot1 <- renderPlot({
      par(mar = c(5.1, 4.1, 0, 1))
      plot(selectedData(), col = clusters()$cluster, pch = 20, cex = 3)
      points(clusters()$centers, pch = 4, cex = 4, lwd = 4)
      })

}
```

Basic Template

```
ui <- fuildPage( )

server <- function(input,output){ }

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

ui.R and server.R

ui <- fuildPage( )

server <- function(input,output){ }

shinyApp(ui = ui, server = server)

ui.R

```
library(shiny)
fluidPage(
   sliderInput()
   plotOutput()
)
```

server.R

```
library(shiny)
function(intput, output) {
    output$plot <- renderPlot({})
}
)
```

Sharing Online

Option 1 – Private Web Server

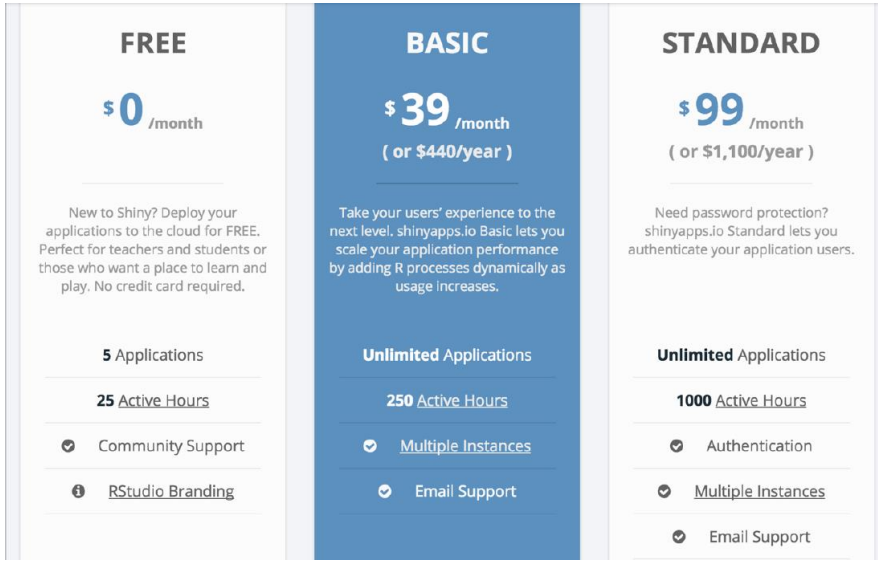
Shiny Server :

www.rstudio.com/products/shiny/shiny-server/

Option 2 – shinyapps.io

Publish Shiny Apps Online :

http://shiny.rstudio.com/articles/shinyapps.html



References

http://shiny.rstudio.com/tutorial/

http://shiny.rstudio.com/reference/shiny/latest/

http://shiny.rstudio.com/articles/