Intermediate Programming in R Part II

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August 16-17, 2018

What do we want to be able to do?

- Communicate findings effectively
- Document findings
- Make process reproducible
- Share process

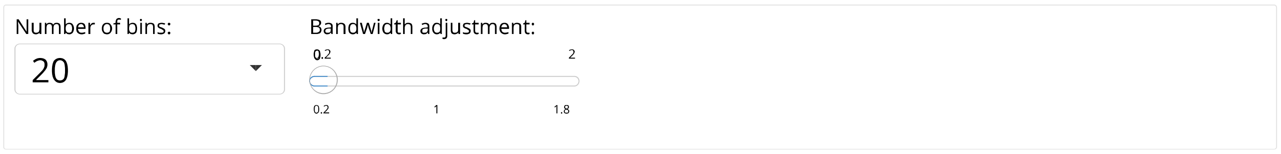
Where do we start?

- Review of Key Concepts
- R Markdown Basics
  - Code Chunks
  - Images/Equations/Misc.
- R Markdown Options
  - Documents: PDF, HTML
  - Presentations: Slides
  - Interactive Components
- R Shiny Applications/Presentations

What is R Shiny?

- R Shiny Package (http://shiny.rstudio.com/) allows for creation of interactive "web" applications in R
- Developed by RStudio
- Basically a folder with 2 R scripts:
  - ui.R (User Interface)
  - server.R (R functions that run/respond to UI)
- Requires no HTML, CSS, or JavaScript!

Example App



Why use R Shiny?

- If you know R, not too bad to learn
- Can be great way to
  - Share data analysis results
  - Allow user to explore data
  - Explain statistical concepts/teach

Ex: Multiple Linear Regression Idea

Explanatory Variable (x)

Response Variable (y)

☐ Fit Regression Equation?

Fitted Regression Equation

How to Develop R Shiny Apps

- Explore online repositories/resources for existing apps!
- Create a basic app
- Customize apps
- Learn solutions to common issues when creating apps
- Deploy the app

Available Apps

- Many available resources!!
- Apps I've created (http://www4.stat.ncsu.edu/~post/ShinyWorkshop/apps.html)
- Plenty of good examples
  - Shiny Showcase (https://www.rstudio.com/products/shiny/shiny-user-showcase/)
  - Shiny Gallery (https://shiny.rstudio.com/gallery/)
  - Stat Concepts (https://github.com/gastonstat/shiny-introstats/)
  - More Stat Concepts (https://www.researchgate.net/publication/298786680_Web_Application_Teaching_Tools_for_Statistics_Using_R_and_Shiny
  - Cal Poly (http://www.statistics.calpoly.edu/shiny)
- Take a few minutes to explore some apps!

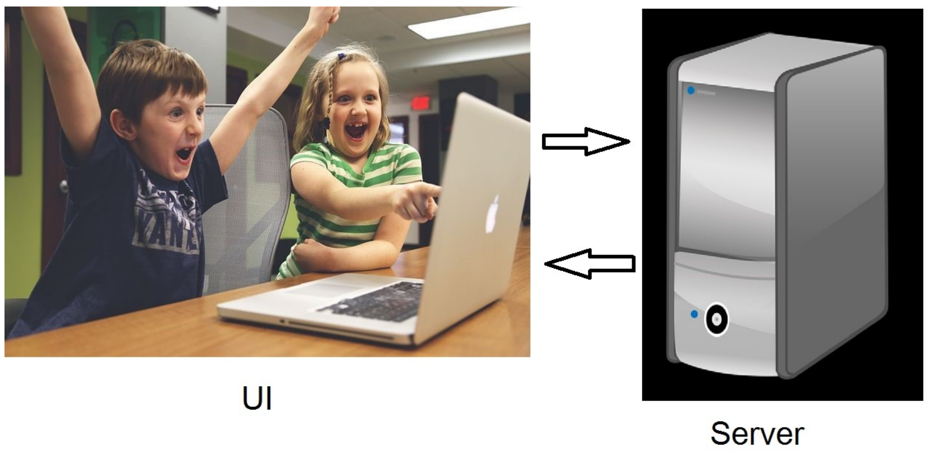
Getting Started - Basic Needs

- R, R studio
- `shiny` package
- Recommended other packages
  - `shinydashboard` (create dashboards)
  - `DT` (Nice Tables)

Elements of an App

- Each app has two things
  - User Interface (UI)
  - Server

App Duties



Elements of an App

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- UI determines **layout** of app
  - Sets up widgets (items users can interact with)

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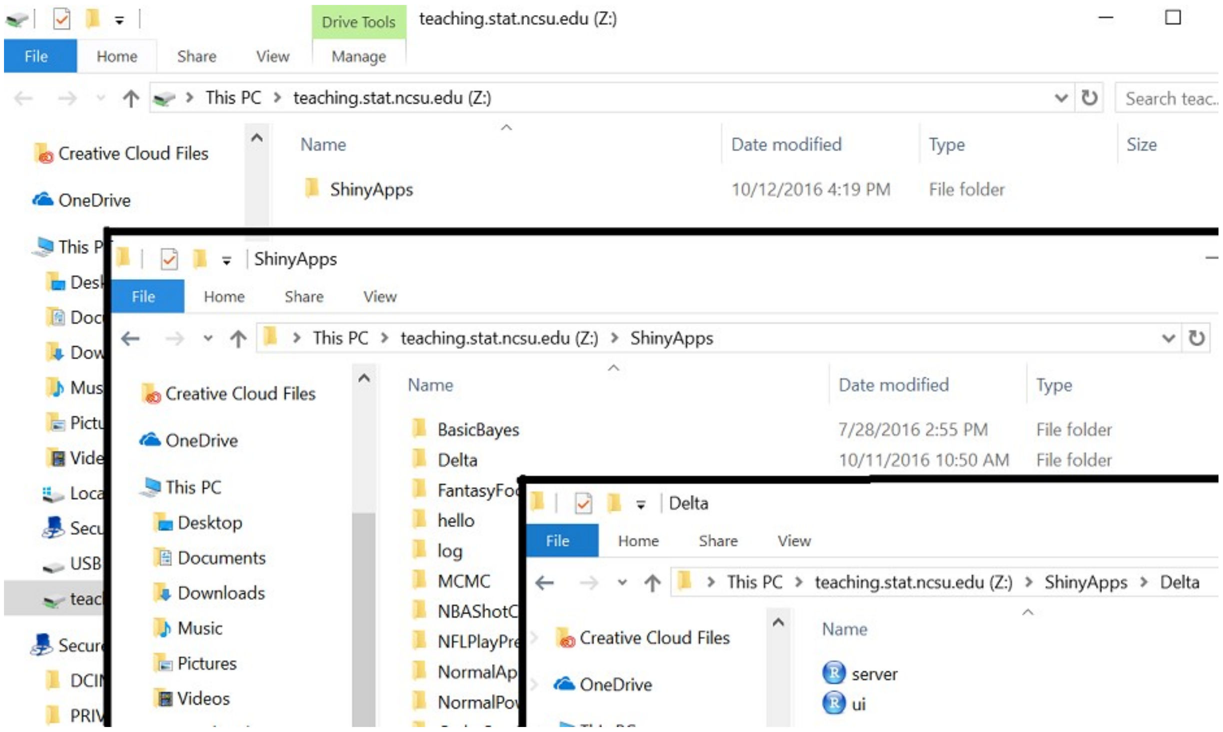
  - Can include plots, model fitting, any R code really…

Elements of an App

- Each app has two things
  - User Interface (UI)
  - Server
- UI determines **layout** of app
  - Sets up widgets (items users can interact with)
- Server contains R code to **run for the app**
  - Can include plots, model fitting, etc.
- Can do with single file (`app.R`) but we'll use a separate file (`ui.R` and `server.R`)

Two File Approach (Recommended)

- Create folder for each App
- Each App's folder should have `ui.R` and `server.R` files
- If single file, `app.R`


Drive Tools
teaching.stat.ncsu.edu (Z:)
File Home Share View Manage
This PC > teaching.stat.ncsu.edu (Z:)
Search teac...
Creative Cloud Files
OneDrive
Name Date modified Type Size
ShinyApps 10/12/2016 4:19 PM File folder
ShinyApps
This PC > teaching.stat.ncsu.edu (Z:) > ShinyApps
This PC
Desktop
Documents
Downloads
Music
Pictures
Videos
Name Date modified Type
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Delta 10/11/2016 10:50 AM File folder
hello
log
MCMC
Delta
This PC > teaching.stat.ncsu.edu (Z:) > ShinyApps > Delta
Name
server
ui

`ui.R` Basic Layout

```
library(shiny)

ui <- fluidPage(
    titlePanel(),

  sidebarLayout(
    sidebarPanel(#usually widgets
      ),
    mainPanel(#usually output
      )
  )
)
```

UI Common Layout

title panel

```
sidebar panel
|
|
|
|
|
|
V
Usually User Inputs
```

```
main panel content-------------------->
|
|
|
| Usually Output
| that Reacts to User Input
|
V
```

`server.R` Basic File

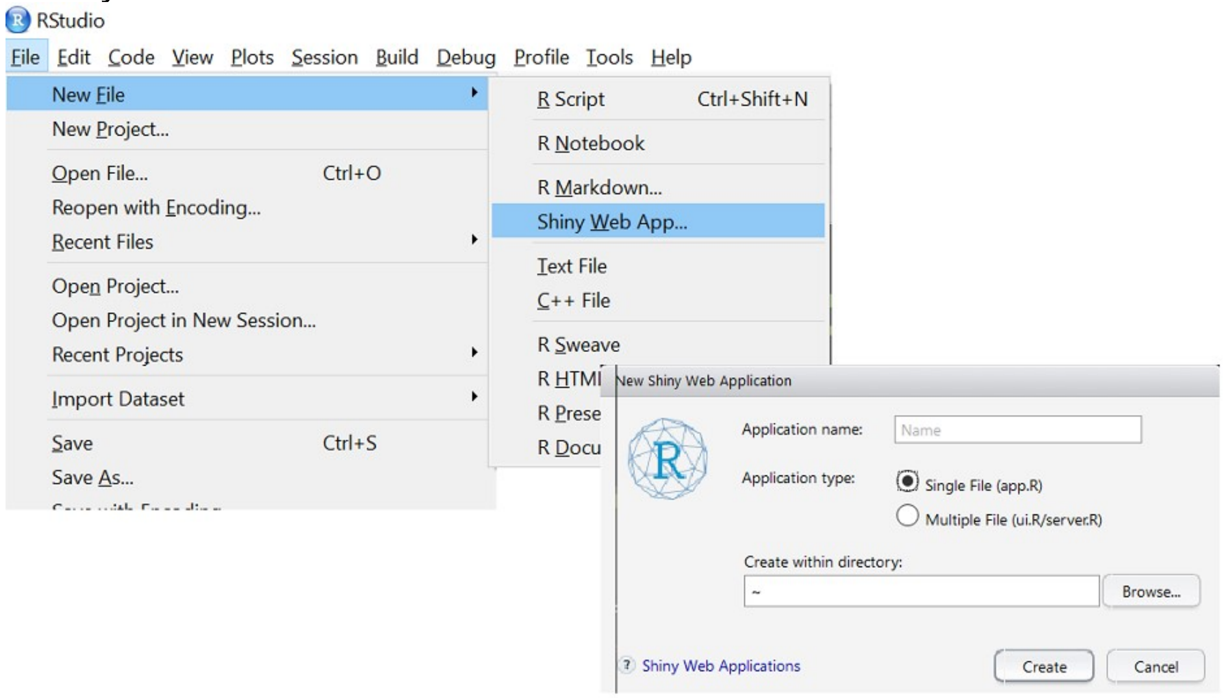
```
library(shiny)

shinyServer(function(input, output, session) {

})
```

Shiny Templates

Readily available in R studio



New Shiny Web Application

Application name: Name

Application type: [✓ Single File (app.R)] Multiple File (ui.R/server.R)

Create within directory: ~

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Two File Template

```r
library(shiny)
ui <- fluidPage(
   # Application title
   titlePanel("Old Faithful Geyser Data"),
   # Sidebar with a slider input for number of bins
   sidebarLayout(
      sidebarPanel(
         sliderInput("bins",
                     "Number of bins:",
                     min = 1,
                     max = 50,
                     value = 30)
      ),
      # Show a plot of the generated distribution
      mainPanel(
         plotOutput("distPlot")
      )
   )
)
```

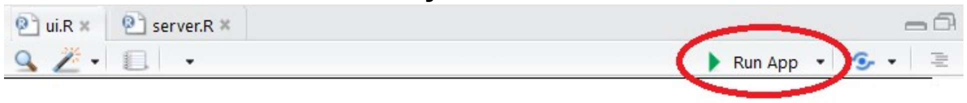
Two File Template

```
# Define server logic required to draw a histogram
server <- function(input, output) {
   output$distPlot <- renderPlot({
      # generate bins based on input$bins from ui.R
      x    <- faithful[, 2]
      bins <- seq(min(x), max(x), length.out = input$bins + 1)

      # draw the histogram with the specified number of bins
      hist(x, breaks = bins, col = 'darkgray', border = 'white')
   })
}
```

Running an App

- While `ui.R` or `server.R` is your active window, click the **Run App** button



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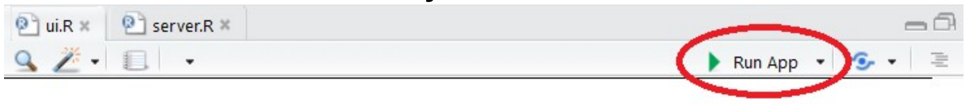
Running an App

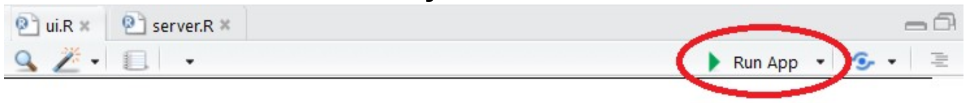
- While `ui.R` or `server.R` is your active window, click the **Run App** button



- Set working directory to ShinyApps folder
- Load `shiny` package
- Use `runApp()` function
    - ex: `runApp("normalPower")`

Running an App

- While `ui.R` or `server.R` is your active window, click the **Run App** button

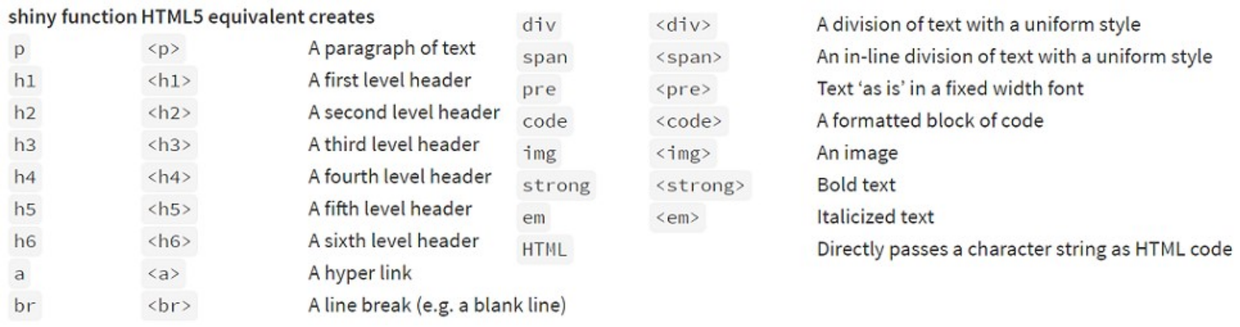


- Set working directory to ShinyApps folder
- Load `shiny` package
- Use `runApp()` function
  - ex: `runApp("normalPower")`
- Running App will tie up R console!
- End by hitting Esc or closing shiny app
- Take a minute and run the template app

Adding to the UI

Using a comma to separate items, you can add

- Any plain strings
- Widgets
- Formatted text (using HTML type functions)



shiny function	HTML5 equivalent	creates
`p`	`<p>`	A paragraph of text
`h1`	`<h1>`	A first level header
`h2`	`<h2>`	A second level header
`h3`	`<h3>`	A third level header
`h4`	`<h4>`	A fourth level header
`h5`	`<h5>`	A fifth level header
`h6`	`<h6>`	A sixth level header
`a`	`<a>`	A hyper link
`br`	`<br>`	A line break (e.g. a blank line)
`div`	`<div>`	A division of text with a uniform style
`span`	`<span>`	An in-line division of text with a uniform style
`pre`	`<pre>`	Text 'as is' in a fixed width font
`code`	`<code>`	A formatted block of code
`img`	`<img>`	An image
`strong`	`<strong>`	Bold text
`em`	`<em>`	Italicized text
`HTML`		Directly passes a character string as HTML code

- Output from things created in the `server.R` file

Adding to the UI - Widgets

- Widgets can be added using their `*Input` functions
- Separate widgets (and other items) by commas in ui.R file

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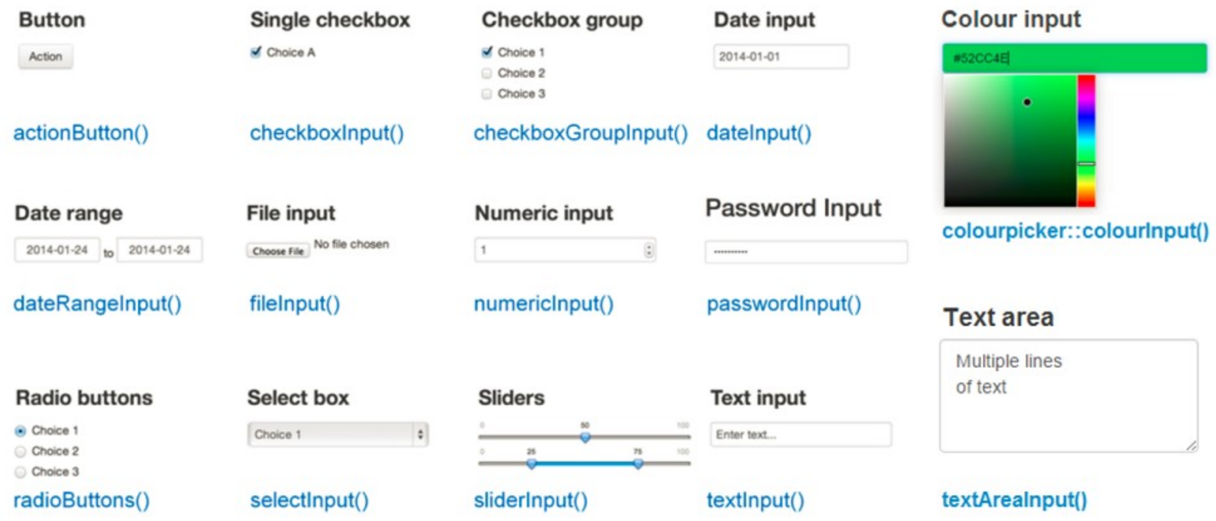


Shiny Widgets for the UI

Widget

Button

Click Here!

Help Information for Widget

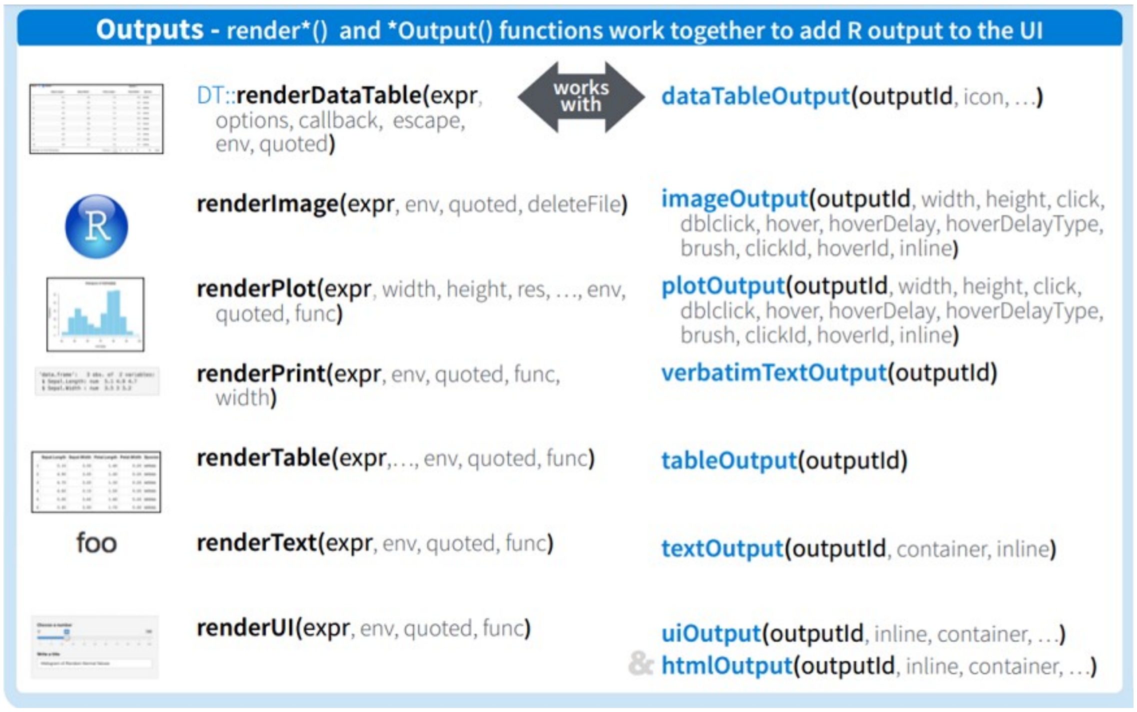
Code Used for Widget Above

What does Shiny return for use?

Sharing Between Server and UI

- Widgets are used to take input from the user
- Use their values in `server.R` (has your analysis or vis code!)
- Functions in `server.R` will create output to go in the `ui.R`

Sharing Between Server and UI

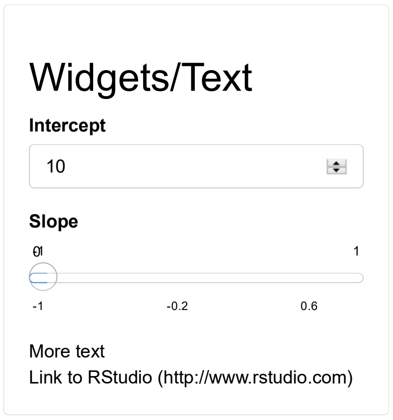


Outputs - render*() and *Output() functions work together to add R output to the UI

DT::**renderDataTable**(**expr**, options, callback, escape, env, quoted)	**dataTableOutput**(**outputId**, icon, ...)
renderImage(**expr**, env, quoted, deleteFile)	**imageOutput**(**outputId**, width, height, click, dblclick, hover, hoverDelay, hoverDelayType, brush, clickId, hoverId, inline)
renderPlot(**expr**, width, height, res, ..., env, quoted, func)	**plotOutput**(**outputId**, width, height, click, dblclick, hover, hoverDelay, hoverDelayType, brush, clickId, hoverId, inline)
renderPrint(**expr**, env, quoted, func, width)	**verbatimTextOutput**(**outputId**)
renderTable(**expr**,..., env, quoted, func)	**tableOutput**(**outputId**)
renderText(**expr**, env, quoted, func)	**textOutput**(**outputId**, container, inline)
renderUI(**expr**, env, quoted, func)	**uiOutput**(**outputId**, inline, container, ...) & **htmlOutput**(**outputId**, inline, container, ...)

Adding to the UI - Example Syntax

```
library(shiny)
ui <- fluidPage(
  sidebarLayout(
    sidebarPanel(
      h2("Widgets/Text"),
      numericInput("NI",label="Intercept",value=10),
      sliderInput("SI",label="Slope",min=-1,max=1,value=0,step=0.1),
      "More text",
      br(),
      a(href="http://www.rstudio.com",target="_blank","Link to RStudio")
    ),
    mainPanel(plotOutput("dataPlot"), #dataPlot is name of "plot" object in server
              textOutput("dataInfo"), #dataInfo is name of "text" object in server
              dataTableOutput("dataTable") #dataTable is name of "data" object in server
    )
  )
)
```


Widgets/Text

Intercept

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Slope

More text
Link to RStudio (http://www.rstudio.com)

Summary So Far

`ui.r`

- Controls layout of app
- Basic layout uses a sidebar panel and a main panel
- Use strings, formatted (html style) text, widgets (`input*` functions), and output from `server.r` (`*Output` functions)
- Separate items with commas

Activity

- **UI Set-up Activity** instructions (http://www4.stat.ncsu.edu/~post/IntermediateR/UISetUpActivity.html) available on web
- Work in small groups
- Ask questions! TAs and I will float about the room
- Feel free to ask questions about anything you didn't understand as well!

Server file

`server.r` also called the 'back-end' because it works behind-the-scenes; its actions are not directly visible

```
## set up server
shinyServer(function(input, output, session) {
  # add stuff
})
```

Server file

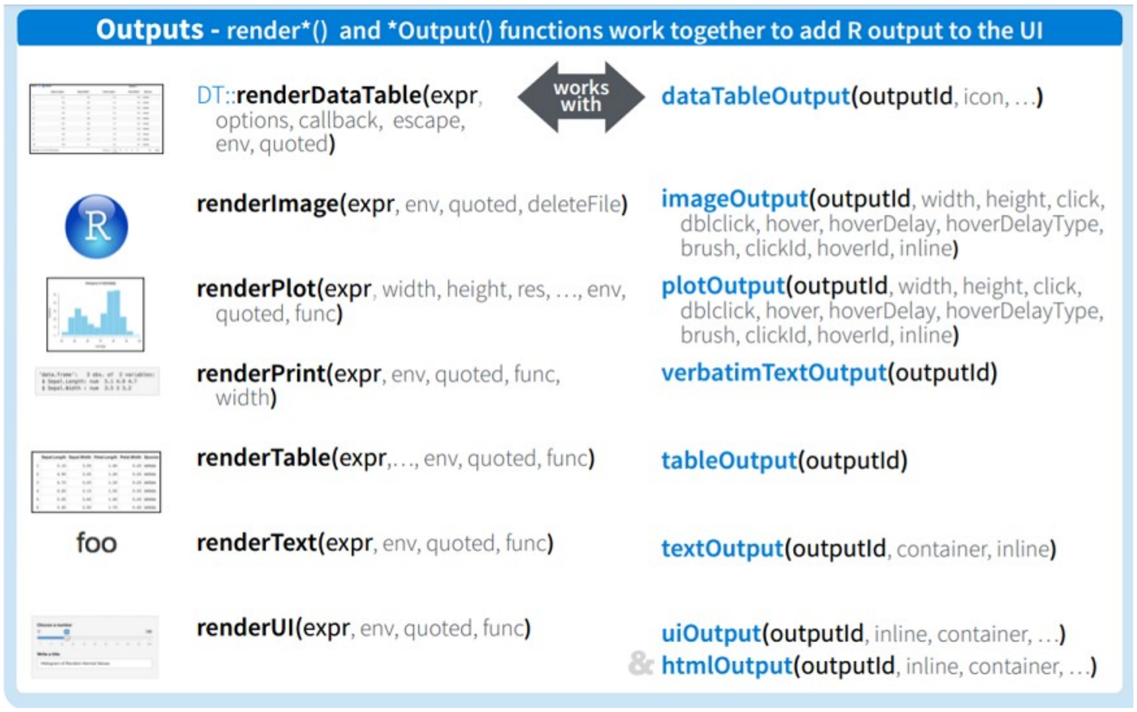
`server.r` also called the 'back-end' because it works behind-the-scenes

```
## set up server
shinyServer(function(input, output, session) {
  # add stuff
})
```

The arguments for the server are `input`, `output`, and `session`. Allow us to

1. Take in inputs from the UI
2. Run functions on them
3. Create outputs to send back

Creating Output to Send to UI



Outputs - render*() and *Output() functions work together to add R output to the UI

	works with	
DT::**renderDataTable(expr**, options, callback, escape, env, quoted**)**		**dataTableOutput(outputId**, icon, …**)**
renderImage(expr, env, quoted, deleteFile**)**		**imageOutput(outputId**, width, height, click, dblclick, hover, hoverDelay, hoverDelayType, brush, clickId, hoverId, inline**)**
renderPlot(expr, width, height, res, …, env, quoted, func**)**		**plotOutput(outputId**, width, height, click, dblclick, hover, hoverDelay, hoverDelayType, brush, clickId, hoverId, inline**)**
renderPrint(expr, env, quoted, func, width**)**		**verbatimTextOutput(outputId)**
renderTable(expr,…, env, quoted, func**)**		**tableOutput(outputId)**
renderText(expr, env, quoted, func**)**		**textOutput(outputId**, container, inline**)**
renderUI(expr, env, quoted, func**)**		**uiOutput(outputId**, inline, container, …**)** & **htmlOutput(outputId**, inline, container, …**)**

Creating Output to Send to UI

Example syntax

```
shinyServer(function(input,output){
  output$nameOfOutputObject<-renderPlot(
    #code that will return a plot
  )

  output$otherOutput<-renderText(
    #code that will return something that R can coerce to a string
  )
})

#in ui.r file, reference would look like
plotOutput("nameOfOutputObject")
textOutput("otherOutput")
```

Accessing Input Values in server.R

- Every input object has an `inputID`

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- In `server.r`, reference input value by

```
input$inputID
```

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```
input$inputID
```

- Example

```
#input widget code from ui.r file
sliderInput(inputID = "slide",label = "Select the Range Here",min = 0,max = 1,
            value = c(0,1))
#reference in server.r might look like
output$userPlot<-renderPlot({
  range<-input$slide
  #create plot that changes based on user input
  plot(data,xlim=range)
})
```

Input and Output

- `input` and `output` objects are kind of like **lists**
- Shiny passes the information back and forth through them

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- Notice how we name our output objects

```
output$nameOfOutputObject<-renderPlot(...))
```

Input and Output

- `input` and `output` objects are kind of like **lists**
- Shiny passes the information back and forth through them
- Notice how we name our output objects

```
output$nameOfOutputObject<-renderPlot(...))
```

- Notice how we access our inputs

```
output$nameOfOutputObject<-renderPlot(
   range<-input$slide
))
```

Quick Try

- Using the template app
- Add text output object in the `server.R` file (use `renderText`) that returns the current value of the input slider
- To do this, just reference the input (like an R function, it will return the last thing you do)
- Don't forget to add a `textOutput` in the `ui.R` file!

Reactivity

- Output objects do not have to depend on an input
- Those that don't will be static
- Any 'chunk' of code in `server.r` that references a user input must be **reactive**
- When a user changes the reference, the code **re-evaluates**

Example Reactivity

```
##code chunk "reacts" to and re-evaluates if
##input$sampleSize or input$otherInput changes

output$dataPlot<-renderPlot({

  n<-input$sampleSize
  input$otherInput #not used anywhere else, but entire
                   #renderPlot chunk still re-evaluates
                   #if changed

  hist(rbinom(n=1,size=n,prob=0.4))

})
```

- type `runApp("01_hello")` (load `shiny` library 1st: `library(shiny)`)

Reactivity

- Reactive variables (user inputs) can only be used in reactive contexts
- All `render*` functions are reactive contexts
- `server.r` can run any R code, but can't access inputs unless put into a reactive context

Error Using Reactive Variables

Following returns the error:

```
shinyApp(ui<-fluidPage(
                numericInput("NI","Give me a number",value = 10),
                textOutput("string")
                ),

         shinyServer(function(input,output){
                print(input$NI+10)
                output$string<-renderText(paste("value plus 10 is",input$NI+10))
         }
))
```

Warning: 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.)

Other Reactive Contexts

- `reactive({})` function allows for reactivity and creation of a new variable
- `observe({})` function allows for reactivity

```
shinyServer(function(input,output){

  #Creates a new reactive variable
  newVar<-reactive({
    value<-c(input$NI+10,input$NI*3)
  })

    #would now print to console
  observe({print(input$NI+10)})

  output$textString<-renderText({
    value<-newVar()  #access like a function!
    paste0("Input plus 10 is ",value[1]," and Input times 3 is ",value[2])
  })
}
```

More on `reactive({})`

- 'Wraps' a normal expression to create a reactive expression (code user can cause to change)
- Can read reactive values and call other reactive expressions
- Only re-evaluates *if necessary*
- Access object as though calling it as a function

More on `reactive({})`

- Access object as though calling it as a function

```
shinyServer(function(input,output){
  #Creates a new reactive variable
  newVar<-reactive({
    value<-c(input$NI+10,input$NI*3)
  })

  output$textString<-renderText({
    value<-newVar()  #access like a function!
    paste0("Input plus 10 is ",value[1]," and Input times 3 is ",value[2])
  })
}
```

More on `observe({})`

- Can read reactive values and call reactive expressions
- *Automatically* re-execute when dependencies change
- Doesn't yield a result
- Mostly used to update UI elements (more later)

```
shinyServer(function(input,output){
  #would now print to console
  observe({print(input$NI+10)})

    #update UI
    observe({
        input$noPitch
        updateCheckboxGroupInput(session, "pitchTypeChoice", selected = c(""))
    })
}
```

Summary So Far

`ui.r`

- Controls layout of app
- Basic layout uses a sidebar panel and a main panel
- Use strings, formatted (html style) text, widgets (`input*` functions), and output from `server.r` (`*Output` functions)
- Separate items with commas

`server.r`

- Back-end for app
- Create outputs that react to inputs (`render*` functions)
- To respond to input, must be in a reactive context

Devloping an App

- **Highly Recommended:**

Draw out what you want the app to look like

- Write R code to complete your app in a static manner!
- Translate to appropriate Shiny output functions

Activity

- **First Full App Activity** instructions (http://www4.stat.ncsu.edu/~post/IntermediateR/FirstAppActivity.html) available on web
- Work in small groups
- Ask questions! TAs and I will float about the room
- Feel free to ask questions about anything you didn't understand as well!

What do we want to be able to do?

- Communicate findings effectively
- Document findings
- Make process reproducible
- Share process

Dynamic UI

- Often want to update UI based on user input!
- Recall: UI and Server basically pass lists back and forth
- Methods for updating UI
  - `update*` functions
  - `renderUI()`/`uiOutput()`
  - `conditionalPanel()`

Using update* Functions

- Every input widget has a corresponding update function
  - `updateActionButton()`
  - `updateCheckboxInput()`
  - `updateNumericInput()`
  - …

Using update* Functions

- Every input widget has a corresponding update function
  - `updateActionButton()`
  - `updateCheckboxInput()`
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  - …
- Require session argument on server() function

```
shinyServer(function(input, output,session) {
  ## do stuff
})
```

Using update* Functions

- Every input widget has a corresponding update function
  - `updateActionButton()`
  - `updateCheckboxInput()`
  - `updateNumericInput()`
  - …
- Require session argument on server() function

```
shinyServer(function(input, output,session) {
  ## do stuff
})
```

- After all observers (reactive things) evaluate, updater sends message back to client

Using update* Functions

- Syntax of `update*` functions similar to the functions that created the inputs

Example syntax:

```
numericInput(inputId, label, value, min = NA, max = NA, step = NA,
  width = NULL)

updateNumericInput(session, inputId, label = NULL, value = NULL,
  min = NULL, max = NULL, step = NULL)
```

Using update* Functions

- Syntax of `update*` functions similar to the functions that created the inputs

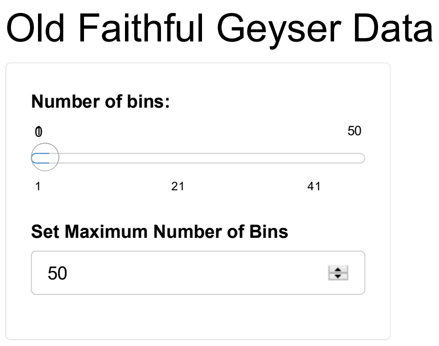
Example syntax:

```
numericInput(inputId, label, value, min = NA, max = NA, step = NA,
  width = NULL)

updateNumericInput(session, inputId, label = NULL, value = NULL,
  min = NULL, max = NULL, step = NULL)
```

- Any arguments with `NULL` values ignored (i.e. will not result in any changes to the input object)
- For `radioButtons()`, `checkboxGroupInput()`, and `selectInput()`, the set of choices can be cleared by using `choices = character(0)` (similary for the set of selected)

Using `update*` Functions



Old Faithful Geyser Data

Number of bins:

Set Maximum Number of Bins

50

`updateSliderInput()` (First Attempt)

```
  ui <- fluidPage(
        ...
        sidebarPanel(
           sliderInput("bins","Number of bins:",min = 1,
                       max = 50,value = 30),
           numericInput("maxBins",label="Set Maximum Number of Bins",
                        value=50,min=1,max=100)
        ),
        ...
  ),
  server <- function(input, output,session) {
      ...
      updateSliderInput(session,"bins",max=input$maxBins)
  }
)
```

What is our issue?

`updateSliderInput()` (Fixed)

```
ui <- fluidPage(
      ...
      sidebarPanel(
         sliderInput("bins","Number of bins:",
                     min = 1,max = 50,value = 30),
         numericInput("maxBins",label="Set Maximum Number of Bins",
                      value=50,min=1,max=100)
      ),
      ...
)
server <- function(input, output,session) {
    ...
    observe({updateSliderInput(session,"bins",max=input$maxBins)})
}
```

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`update*` UI Functions

- Use the template app
- Try to add a numeric input for the user to specify the largest value of the slider
- Use the `updateSliderInput` function to update the max of the slider
- Don't forget `observe`!

`renderUI()` and `uiOutput()`

- Alternatively, `renderUI()` and `uiOutput()` can be used

`renderUI()` and `uiOutput()`

- Alternatively, `renderUI()` and `uiOutput()` can be used
- Note: Shiny essentially writes HTML/JavaScript for us!

```
print(fluidPage(titlePanel(title="Hi"),
                sidebarLayout(sidebarPanel(),mainPanel())))
```

```
## <div class="container-fluid">
##   <h2>Hi</h2>
##   <div class="row">
##     <div class="col-sm-4">
##       <form class="well"></form>
##     </div>
##     <div class="col-sm-8"></div>
##   </div>
## </div>
```

`renderUI()` and `uiOutput()`

- Alternatively, `renderUI` and `uiOutput` can be used
- Note: Shiny essentially writes HTML/JavaScript for us!

```
print(numericInput("id","Label User Sees",value=10))
```

```
## <div class="form-group shiny-input-container">
##   <label for="id">Label User Sees</label>
##   <input id="id" type="number" class="form-control" value="10"/>
## </div>
```

`renderUI()` and `uiOutput()`

`renderUI()`

- Makes a **reactive version** of a function that generates HTML (like any widget)
- Have `renderUI()` return a shiny 'tag object,', HTML, or a list of these

- Use with `uiOutput()` in UI file
- Interprets the HTML and outputs appropriately (a `div` element)

`renderUI()` and `uiOutput()` (using widgets)

```
ui <- fluidPage(
      ...
      sidebarPanel(
          uiOutput("slider"),
          numericInput("maxBins",label="Set Maximum Number of Bins",
                       value=50,min=1,max=100)
      ),
      ...
),
server <- function(input, output,session) {
    ...
    output$slider<-renderUI({
        sliderInput("bins","Number of bins:",min = 1,
                    max = input$maxBins,value = 30)
        })
}
```

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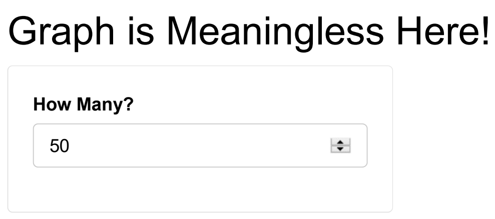
`renderUI()` and `uiOutput()` (using HTML)

```
ui <- fluidPage(
      ...
      sidebarPanel(
           uiOutput("info"),
           numericInput("purchase",label="How Many?",
                        value=50,min=0,max=100)
      ),
      ...
),
server <- function(input, output,session) {
    ...
      output$info<-renderUI({
        text<-paste0("You have selected to buy ",input$purchase)
        h3(text)
      })
}
```

`renderUI()` and `uiOutput()` (using HTML)



Graph is Meaningless Here!

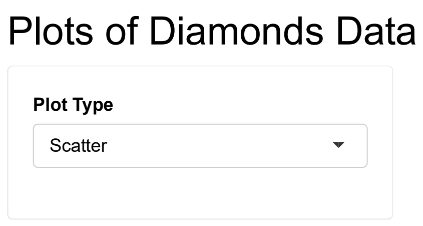
`renderUI()` and `uiOutput()` (using HTML)

- Use the template app
- Try to add some dynamic updating text to the UI

`conditionalPanel()`

- Create a 'panel' that is only visible if a condition is met
- Condition can depend on input or output value
- Accessed differently! (Use a '.' not a '$')

`conditionalPanel()`


Plots of Diamonds Data

Plot Type

Scatter

conditionalPanel()

```
...
sidebarPanel(
  selectInput("plotType", "Plot Type",
            c(Scatter = "scatter",Histogram = "hist")),

  # Only show this panel if the plot type is a histogram
  conditionalPanel(condition = "input.plotType == 'hist'",
          selectInput("breaks", "Breaks",
               c("Sturges","Scott","Freedman-Diaconis","[Custom]" = "custom")),

      # Secondary conditonalPanel, Only show this panel if Custom is selected
      conditionalPanel(
          condition = "input.breaks == 'custom'",
          sliderInput("breakCount", "Break Count", min=1, max=200, value=40)
      )
  )
)
```

`conditionalPanel()`

- Use the template app
- Try to add a new UI element if a condition of the slider is met

Dynamic UI Recap

- Often want to update UI based on user input!
- Recall: UI and server basically pass lists back and forth
- Methods for updating UI
  - `update*` functions
  - `renderUI()`/`uiOutput()`
  - `conditionalPanel()`

More Advanced UI Layout

- Contents of UI wrapped in `fluidPage()`
- Content can be wrapped in `fluidRow()`'s
- Columns can be created
- Should sum to 12 in total width!

Customized Layout

fluidRow with columns

2nd column

column widths in a given row should add to 12

2nd fluidRow below above row

Columns can contain their own fluidRow as well, allowing for a lot of customization of layouts!

subcol subcol

```
shinyUI(fluidPage(
  fluidRow(
    column(2,"fluidRow with columns--------...---------"),
    column(6,"2nd column------------...--------"),
    column(4,"column widths in a given row must add to 12------...---------")),
  fluidRow(tags$hr()),
  fluidRow(
    column(6,"2nd fluidRow below above row----...-----"),
    column(6,
           fluidRow("Columns can contain their own fluidRow as well, allowing for a lot o
           fluidRow(
             column(3,"subcol ----...-----"),
             column(9,"subcol ----...-----")
           ))
  )
))
```

Recap

`ui.r`

- Controls layout of app (can use standard layouts or customize)
- Use strings, formatted (html style) text, widgets (`input*` functions), and output from `server.r` (`*Output` functions)
- Separate items with commas
- Update inputs, render HTML reactively, conditionally show input

`server.r`

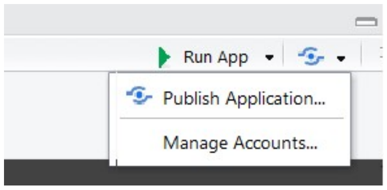
- Back-end for app
- Create outputs that react to inputs (`render*` functions)
- To respond to input, must be in a reactive context
- Code can be included prior to `shinyServer()`

Activity

- **Dynamic UI App Activity** instructions (http://www4.stat.ncsu.edu/~post/IntermediateR/DynamicUIActivity.html) available on web
- Work in small groups
- Ask questions! TAs and I will float about the room
- Feel free to ask questions about anything you didn't understand as well!

Sharing App

- Running App locally ties up your system
- Others can't access it!
- Can host apps on shinyapps.io (powered by RStudio)
  - Free, but number of connects and hours limited
  - Gives stats about usage
  - Integrated into R Studio



Sharing App

Another option:

- Host App on Shiny Server
- Costs money!
  - Free for academic use (I believe)
- Might need IT help to utilize

What do we want to be able to do?

- Communicate findings effectively
- Document findings
- Make process reproducible
- Share process

Where do we start?

- Review of Key Concepts
- R Markdown Basics
  - Code Chunks
  - Images/Equations/Misc.
- R Markdown Options
  - Documents: PDF, HTML
  - Presentations: Slides
  - Interactive Components
- R Shiny Applications/Presentations

Time Permitting: Miscellaneous Useful Things

Code can be placed prior to shinyServer

```
##Code here that you only need to evaluate once.
##This can include reading in data, creation of
##     functions common to all sessions, and
##     reading of other common r scripts.

shinyServer(function(input, output) {

##Code here that can be reactive.  Differs for
##     every instance of your app that runs.

})
```

Other Useful Things

Including Other Files

```
## top of server.R, output from here is common to all users

#data set only read in once
dat <- read_csv("dataset.csv")

#function created and not modified
helper <- function(item1, item2) {item1 + item2}

shinyServer(function(input, output) {
  ##reactive things, instance of app dependent
})
```

Other Useful Things

Including Other Files

If you have a lot of code, you can read in a separate script

Other Useful Things

Including Other Files

If you have a lot of code, you can read in a separate script

- If external script is `helpers.R` in same folder as app:

```
## top of server.R
source("helpers.R")

shinyServer(function(input, output) {
  ## do stuff
})
```

Other Useful Things

- Return `NULL` to remove errors when loading things
- Can use `isolate()` to improve code efficiency

```
observe({
  input$saveButton  # Do take a dependency on input$saveButton

  # isolate a whole block
  data <- isolate({
    a <- input$valueA   # No dependency on input$valueA or input$valueB
    b <- input$valueB
    c(a=a, b=b)
  })
  writeToDatabase(data)
})
```

Other Useful Things

- Improved data tables with `DT` package!
- DT example (http://shiny.stat.ncsu.edu/jbpost2/NBAShotChart/)

- Improved plots with `plotly` package!
- plotly example (http://shiny.stat.ncsu.edu/jbpost2/RegVis/)

Other Useful Things

- Can add in Latex easily!
- Include `withMathJax()` as a UI argument
- Calls in javascript that will replace Latex source code
- Must open in browser to render!

```
fluidRow(
    #add in latex functionality if needed
    withMathJax(),
          ...
```

Other Useful Things

- Can add tabs to your apps!
- Create "dashboards" with `shinydashboard` package
- Tab and Dashboard example (http://shiny.stat.ncsu.edu/jbpost2/OrderStatsDist/)

- Use mouse over and click inputs!
- Click Input Example (http://shiny.stat.ncsu.edu/jbpost2/BasketballCharting)

- Include Shiny in your Markdown slides!
- Use ioslides and add `runtime: shiny`

Other Useful Things

- shinythemes (https://rstudio.github.io/shinythemes/) are available
- shinyjs package (https://github.com/daattali/shinyjs) adds more functionality
- Can grab apps from GitHub (https://github.com/rstudio/shiny_example)
- List of all functions (https://shiny.rstudio.com/reference/shiny/latest/) for the UI and server
- Lots of good tutorials!
  - Shiny tutorials (https://shiny.rstudio.com/tutorial/)
  - Dean Attali (http://deanattali.com/blog/building-shiny-apps-tutorial/)
  - Shiny Articles (http://shiny.rstudio.com/articles/)
- R Shiny Cheat Sheet (http://shiny.rstudio.com/images/shiny-cheatsheet.pdf)

Debugging

- Much harder in shiny!
- Recommendation: Get static working code, then transfer to shiny

Debugging

- Can use `observe({print(...)})`

```
shinyServer(function(input,output){

  #would now print to console
  observe({print(input$NI+10)})

}
```

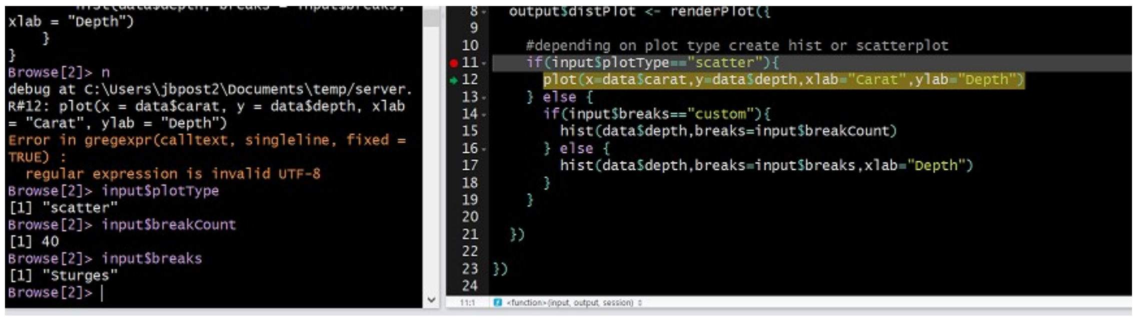
Debugging

R studio gives (http://shiny.rstudio.com/articles/debugging.html) three major approaches:

1. Breakpoints - Pausing execution of your program
2. Tracing - Collecting information as your program runs
3. Error handling - Finding the source of errors (both on the client and server side) and ascertaining their cause.

Breakpoints

- Can be used in `server.r`
- Click to the left of the line number



```
xlab = "Depth")
    }
}
Browse[2]> n
debug at C:\Users\jbpost2\Documents\temp/server.
R#12: plot(x = data$carat, y = data$depth, xlab
= "Carat", ylab = "Depth")
Error in gregexpr(calltext, singleline, fixed =
TRUE) :
  regular expression is invalid UTF-8
Browse[2]> input$plotType
[1] "scatter"
Browse[2]> input$breakCount
[1] 40
Browse[2]> input$breaks
[1] "Sturges"
Browse[2]> |
```

```
 8   output$distPlot <- renderPlot({
 9
10     #depending on plot type create hist or scatterplot
11     if(input$plotType=="scatter"){
12       plot(x=data$carat,y=data$depth,xlab="Carat",ylab="Depth")
13     } else {
14       if(input$breaks=="custom"){
15         hist(data$depth,breaks=input$breakCount)
16       } else {
17         hist(data$depth,breaks=input$breaks,xlab="Depth")
18       }
19     }
20
21   })
22
23 })
24
```

- Now can access values and step through program
- Can also use browser()

Tracing

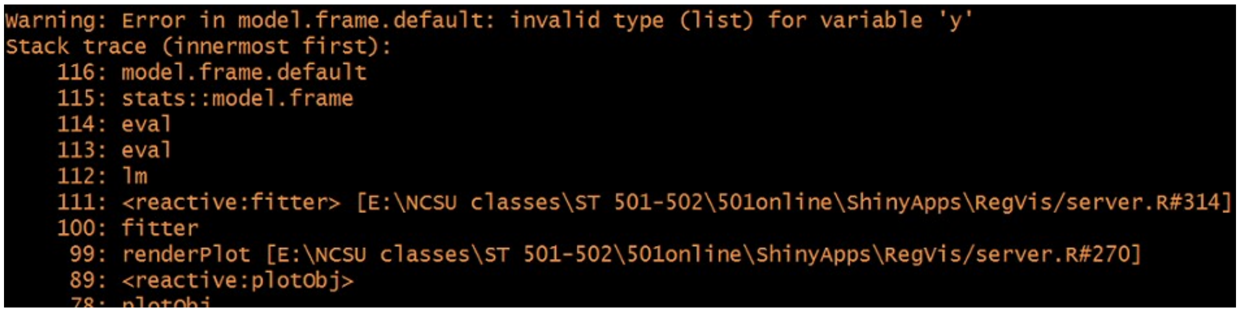
- Can run apps in 'showcase mode' (http://shiny.rstudio.com/gallery/kmeans-example.html)
- Invoke your app with the code below

```
shiny::runApp(display.mode="showcase")
```

- Also a reactive log that can be viewed

Error Handling

- Check stack trace shiny returns



```
Warning: Error in model.frame.default: invalid type (list) for variable 'y'
Stack trace (innermost first):
    116: model.frame.default
    115: stats::model.frame
    114: eval
    113: eval
    112: lm
    111: <reactive:fitter> [E:\NCSU classes\ST 501-502\501online\ShinyApps\RegVis/server.R#314]
    100: fitter
     99: renderPlot [E:\NCSU classes\ST 501-502\501online\ShinyApps\RegVis/server.R#270]
     89: <reactive:plotObj>
     78: plotObj
```

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Enter Debug Mode on Error

- Can make Shiny enter the debugger when an error occurs by using the following statement:

```
options(shiny.error = browser)
```

- Overall, experience helps!