An Introduction to Shiny Apps in R with Applications to Statistics Education

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2 Demonstration

In Fundamentals of writing Shiny Apps in R

- The Template
- Inputs and Outputs
- Example: Slope-intercept app
- Appearance of the app



Song: "Shiny (H)appy People", by R.E.M.

Link to YouTube Video

http://facweb.gvsu.edu/adriand1/index.html

- PDF of these slides
- Link to ePoster for Teaching and Learning with Technology Symposium
- Math in Action
 - slides
 - sample apps and their R code

<u>Note:</u> All web addresses in this presentation are hyperlinks on the PDF.

• Shiny apps are similar to Java Applets but without the following problems:

Problems with Java Applets

Require updates or downloads

Java(TM) was blocked because it is out of date and needs to be updated.



You must have Administrator Rights to this computer to complete any installations.

- Blocked due to security concerns
- Browsers no longer supporting Java Applets
 - Google Chrome (after version 45)
 - Microsoft Edge
- Not customizable unless you know Java.

- Free!
- Three Downloads:
 - The Base System: https://cran.rstudio.com/ (may need to update if your version is a few years old)
 - Oser Interface:
 - https://www.rstudio.com/products/rstudio/#Desktop
 - $\textbf{Shiny Package (In R, Tools} \rightarrow \textbf{Install Packages...)}$
- Students do not need to know R to use Shiny Apps.
- Note: Version of R on GVSU computers does not have Shiny.

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Demonstrations

ePoster

- ePoster is a Shiny App
- Contains 12 tabs organized in menus
- Each tab is a learning activity

Math in Action

- "Single tab" apps at http://facweb.gvsu.edu/adriand1/mia.html
- Click on "shinyapps.io" or "GVSU server" next to the following apps:
 - Slope-intercept Form of a Line
 - The Unit Circle: sine and cosine functions (try the animation)
 - Equation of a circle
 - Equation of a parabola (vertex form)
 - Normal distribution
- R code for each app given.

- Shiny Apps provide for student learning that is
 - dynamic
 - interactive
 - exploration-based
 - more fun
- Illustrate dynamic visual concepts very well

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Excellent Online Tutorial about Shiny Apps

- Website: http://shiny.rstudio.com/tutorial/
- I borrow from it in this presentation.

User Interface (UI)

What is shown on the webpage

A computer (server) running R

Performs calculations to update the webpage

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Fundamentals of writing Shiny Apps in R The Template

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

- Every time you make a new app, you should start with this template.
- Available on my Math in Action webpage

The template

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

- library(shiny): Loads the package "shiny" into the current R session.
- ui <- fluidPage(): What goes between () determines what is shown on the user interface (UI), i.e. webpage.
- server <- function(input, output): Tells the server what to do to update the webpage.
 - Takes input from the webpage (like slope and intercept)
 - Produces output to the webpage (like updated graph)
- shinyApp(ui = ui, server = server): R does its "magic" to create the app from your code.

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*Input() and *Output() functions

In general

- Go in the ui <- fluidPage() part.
- *Input(): input from user of webpage \rightarrow server
- *Output(): output from server \rightarrow user of webpage

My apps use lots of...

- sliderInput()
- plotOutput()

Family of *Input() functions

Buttons	Single checkbox	Checkbox group	Date input
Action	S Choice A	Choice 1	2014-01-01
Submit		Choice 3	
<pre>actionButton() submitButton()</pre>	<pre>checkboxInput()</pre>	<pre>checkboxGroupInput()</pre>	<pre>dateInput()</pre>
Date range	File input	Numeric input	Password Input
2014-01-24 to 2014-01-24	Choose File No file chosen	1	[
<pre>dateRangeInput()</pre>	<pre>fileInput()</pre>	<pre>numericInput()</pre>	<pre>passwordInput()</pre>
Radio buttons	Select box	Sliders	Text input
Choice 1 Choice 2 Choice 3	Choice 1 \$	0 50 100 0 25 75 100	Enter text
<pre>radioButtons()</pre>	<pre>selectInput()</pre>	<pre>sliderInput()</pre>	<pre>textInput()</pre>

Link to Shiny "widget" gallery

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

For documentation (help): ?functionname

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Example: Slope-intercept app

Code

```
ui <- fluidPage(
    sliderInput(inputId="m", label='Slope (m)',
            value=1.3, min=-3, max=3, step=.1),
    sliderInput(inputId="b", label='Y-Intercept (b)',
            value=1.7, min=-2, max=2, step=.1),
    plotOutput('myplot')
)</pre>
```

Webpage



Building the output (plot) in the server function

3 steps:

- Save to output\$
- Use render*() functions to produce output in this case, renderPlot().
- Incorporate inputs with input\$

1. Save to output\$

Code

- Save to output\$
- The name following output\$ needs to match the name in plotOutput.
- Here: output\$myplot matches plotOutput('myplot')

2. Use render*()

Code

• render*() functions make the app "reactive".

- Other render*() functions:
 - renderTable()
 - renderText()

3. Use input\$ to incorporate inputs

```
ui <- fluidPage(
  sliderInput(inputId="m", label='Slope (m)',
               value=1.3, min=-3, max=3, step=.1),
  sliderInput(inputId="b", label='Y-Intercept (b)',
               value=1.7, min=-2, max=2, step=.1),
 plotOutput('myplot')
server <- function(input, output) {</pre>
  output$myplot <- renderPlot({</pre>
    x \leftarrow seq(from=-3, to=3, by=1)
    y <- input$m * x + input$b</pre>
    plot(x, y, type='1')
 3)
3
```

Note:

Code

- input\$m matches sliderInput(inputId='m', ...)
- input\$<u>b</u> matches sliderInput(inputId='<u>b</u>', ...)

Add to the plot



- ylim=c(-3,3) fixes the y-axis limits (so we can see the effect of the slope)
- abline(h=0) and abline(v=0) add the x- and y-axes.

Resulting app (code on MIA website - example.R)



Resulting app (code on MIA website - example.R)



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Layout: fluidRow() and column()

Code

- o column() goes inside fluidRow()
- Arguments of column():
 - width (must be integer, whole window: 12)
 - Objects in that column

Code

Separates and outlines rows and columns.

- HTML code consists of tags.
- For example, the HTML tag to make the text the largest headline is "h1".

HTML code

<h1> Slope intercept form </h1>

• The corresponding R code is:

R code

tags\$h1('Slope intercept form')

Completed example

Code

```
ui <- fluidPage(
  fluidRow(wellPanel(
    tags$h1('Slope-intercept app'),
    tags h3('y = mx + b')
 )).
  fluidRow(column(4, wellPanel(
           sliderInput(inputId="m", label='Slope (m)',
                       value=1.3, min=-3, max=3, step=.1),
           sliderInput(inputId="b", label='Y-Intercept (b)',
                       value=1.7, min=-2, max=2, step=.1)
           )),
           column(8, wellPanel(
             plotOutput('myplot')
             ))
```

Completed app



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4 Server options for Shiny Apps

Use R as a local server

- Save code as the file app.R.
- Click on "Run App"

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1	#slope_intercept	^
2	library(shiny)	100
3	library(graphics)	
4	ui <- fluidPage(
5	wellPanel(
6	<pre>tags\$h1(strong('slope-intercept form of a line')),</pre>	
7	tagsh3('y = mx + b')	
8).	
9	fluidRow(
10	column(3, wellPanel(
11	tags\$h2(strong('Manipulation')).	
12	<pre>tagssp('Use the following sliders to change the', tagsstrong('slope (</pre>	m)').
13	'and'. strong('v-intercept (b)'). 'of the line.').	
14	<pre>sliderInput(inputId="m", label='Slope (m)', value=1.3, min=-3, max=3.</pre>	~
15	<pre></pre>	
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- Great for developing apps.
- Disadvantage: For other users to run apps, need R (with package Shiny) installed.

- Allows user without R to use apps through a web browser.
- Free Plan Limitations:
 - Only 5 Apps
 - Only 25 active hours per month
- Other plans available with more apps and hours but for \$\$\$.
- Info:

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

- Use Linux to create your own server.
- Advantage: no limits on number of apps or hours
- Info: www.rstudio.com/products/shiny/shiny-server/
- Not recommended unless you are an advanced Linux user.
- **Thanks Dave!** Dave has set up a Shiny Server for our department.

Using Dave's Shiny Server

- Ask Dave for an account.
- Ownload WinSCP or another file transfer program.
- Make "ShinyApps" directory. For example, for me: /home/adriand/ShinyApps
- Put a folder containing app.R (and other files) in the ShinyApps folder.
- Solution Name of this folder: name of app.
- Example: /home/adriand/ShinyApps/ePoster/app.R
- Website for app: http://dbserve.stat.gvsu.edu:3838/adriand/ePoster/

WinSCP Screenshot

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- Let's "publish" the app we made and call it "seminar_app".
- <u>Caution</u>: To use apps on the server, users either need to be on the GVSU network or logged in through VPN.

- California Polytechnic State University
- <u>Reference</u>: Doi, J., Potter, G., Wong, J., Alcaraz, I., & Chi, P. (2016). Web Application Teaching Tools for Statistics Using R and Shiny. Technology Innovations in Statistics Education, 9(1).
- Website: http://www.statistics.calpoly.edu/shiny

Thank you.