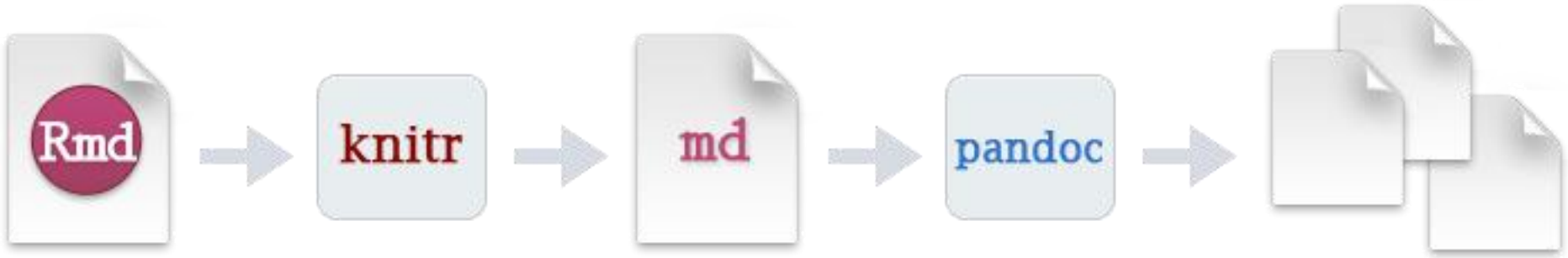
Notebooks and shiny apps

Using Markdown

How it works



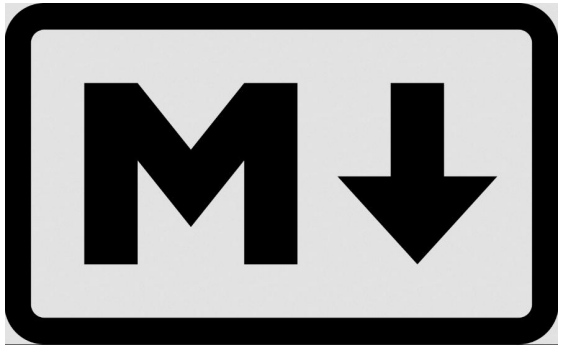
When you run `render`, R Markdown feeds the .Rmd file to knitr, which executes all of the code chunks and creates a new markdown (.md) document which includes the code and it's output.

The markdown file generated by knitr is then processed by pandoc which is responsible for creating the finished format.

This may sound complicated, but R Markdown makes it extremely simple by encapsulating all of the above processing into a single `render` function.

Commentary sections use ‘Markdown’

- Simple markup language
- Designed to be nicely readable as plain text
- Compiles to properly formatted text
- Simple syntax



Markdown basics

- Headings

```
# Heading1
## Heading 2
### Heading 3 etc.

Heading 1
=========

Heading 2
---------
```

- Lists (need a blank line first)

```
* Bullet 1
 [Tab] * Sub-bullet 1
* Bullet 2

1. Numbered 1
2. Numbered 2
```

Headings also give you navigation for your document, so they're worth using!

Markdown basics

- Emphasis

```
*italics*
_italics_

**bold**
__bold__

***bold italics***
___bold italics___

vol=width\*depth\*height
```

NOT bold (escaped)

- Other formatting

```
```fixed width code etc```

> quoted text

super^script^

sub~script~

********* or -------- page break
```

Needs blank line above and below
```

Markdown basics

- Tables

```
| Name      | Quest                          | Success          |
| :-------- | :----------------------------: | ---------------: |
| Simon     | To teach R                     | Sometimes        |
| Emma      | To teach the world to sing     | Always           |
| Libby     | To pass her GCSEs              | Unknown          |
```

`:---` Left Justified
`:--:` Centred
`---:` Right Justified

Markdown basics

$e = mc^2$ `$e=mc^2$`

$\sum_{i=1}^{n} X_i$ `$\sum_{i=1}^n X_i$`

$F_{i,j}$ `$F_{i,j}$`

$\sqrt{x^2 - 5y}$ `$\sqrt{x^2 - 5y}$`

$\sum_{i=1}^{n}\left(\frac{X_i}{Y_i} \right)$ `$\sum_{i=1}^{n}\left( \frac{X_i}{Y_i} \right)$`

- Markdown supports Latex equations.
  - **$**`equation`**$** is inline with text
  - **$$**`equation`**$$** is as a separate block

R code block details

Working directories

- Working directories
  - Working directory is automatically set to directory with Rmd file
  - That’s why we immediately save
  - Designed so that data and code all go together
  - Can run `setwd` but get a warning, and only lasts for 1 block

Good code block practices

- Break code into short chunks
- All chunks are part of the same session

- Stop the block as soon as any output is generated

```{r}
tibble(x=1:5) -> some.data
some.data
```

x
<int>
1
2
3
4
5

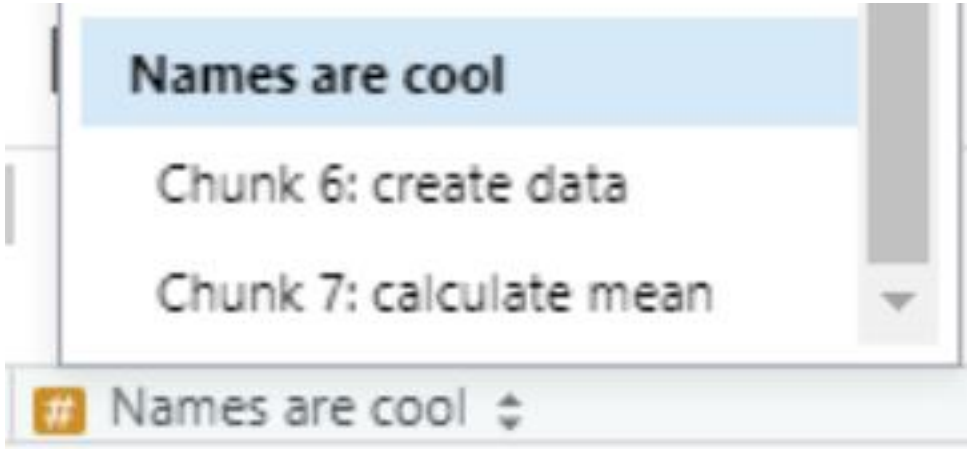
5 rows

```{r}
some.data %>% pull(x) %>% mean()
```

```
[1] 3
```

Good code block practices

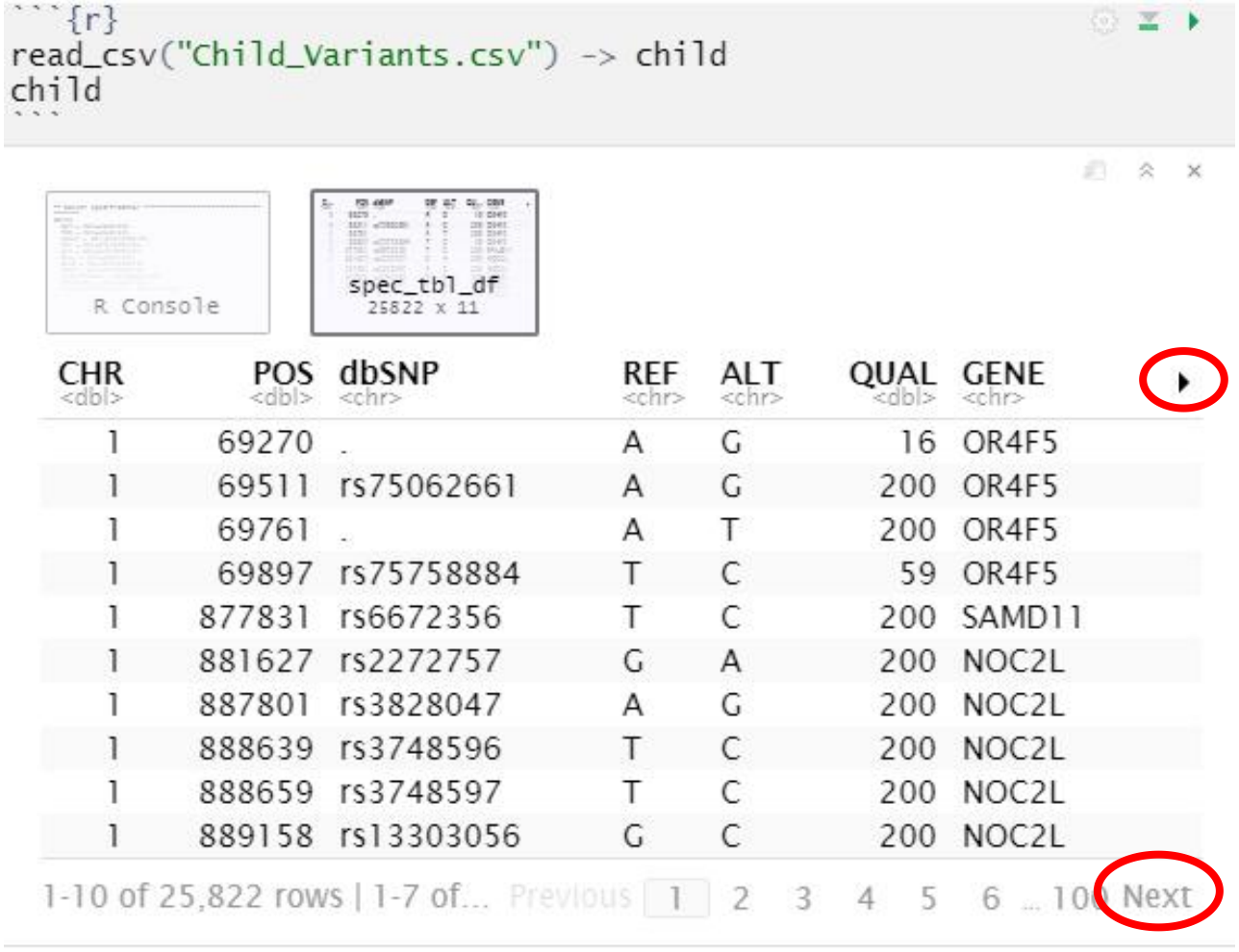
- Name your chunks
- Name appears in the navigation along with headings you've created




````
Names are cool
--------------

```{r "create data"}
tibble(x=1:5) -> some.data
some.data
```

```{r "calculate mean"}
some.data %>% pull(x) %>% mean()
```
````

Displaying tibbles

- By default you don't see the text form of tibbles/dataframes
- You get a nice interactive table
  - Not in all output formats
- Buttons to see more columns/rows



Displaying tibbles

- Although you only see 10 rows, all of the data goes into your document
- When rendered to HTML / PDF this can make your document BIG
- Use the `head()` function to only show a few example rows

````
```{r}
read_csv("Child_Variants.csv") -> child
head(child, n=20)
```
````

CHR <dbl>	POS <dbl>	dbSNP <chr>	REF <chr>	ALT <chr>	QUAL <dbl>	GENE <chr>
1	69270	.	A	G	16	OR4F5
1	69511	rs75062661	A	G	200	OR4F5
1	69761	.	A	T	200	OR4F5
1	69897	rs75758884	T	C	59	OR4F5
1	877831	rs6672356	T	C	200	SAMD11
1	881627	rs2272757	G	A	200	NOC2L
1	887801	rs3828047	A	G	200	NOC2L
1	888639	rs3748596	T	C	200	NOC2L
1	888659	rs3748597	T	C	200	NOC2L
1	889158	rs13303056	G	C	200	NOC2L

1-10 of 20 rows | 1-7 of 11 columns Previous 1 2 Next

Controlling warnings / errors / messages

```{r}
library(tidyverse)
```

```
Registered S3 methods overwritten by 'dbplyr':
  method         from
  print.tbl_lazy
  print.tbl_sql
-- Attaching packages --------------------------------------------------- tidyverse 1.3.0 --
v ggplot2 3.3.2     v purrr   0.3.4
v tibble  3.0.4     v dplyr   1.0.2
v tidyr   1.1.2     v stringr 1.4.0
v readr   1.4.0     v forcats 0.5.0
-- Conflicts ------------------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
```

```{r}
read_tsv("small_file.txt") -> small
```

```
-- Column specification --------------------------------------------------------
cols(
  Sample = col_character(),
  Length = col_double(),
  Category = col_character()
)
```

Controlling warnings / errors / messages

- Can select which output you want to see using the block header

```
```{r "Block name", warnings=FALSE}
```

- Can remove
  - Warnings `{r warnings=FALSE}`
  - Errors `{r error=TRUE}` means that script doesn't stop on error
  - Messages `{r message=FALSE}`
  - Code `{r echo=FALSE}`
  - Code + output `{r include=FALSE}`
```

Changing graphics options

- You can change the way that figures / graphs are displayed by changing R code block options

- Change the file format (default is PNG)

```
```{r dev="svg"}
```

- Change the size

```
```{r fig.height=5, fig.width=8}
```

- Change the alignment (only affected compiled document)

```
```{r fig.align="center"}
```

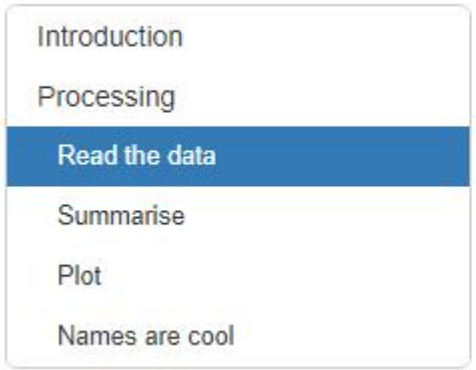
- Add a legend

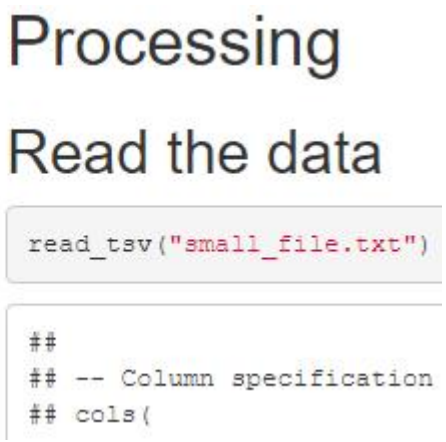
```
```{r fig.cap="This is a great picture"}
```

Changing document appearance

Table of Contents

- If you have used headings in your document then you can auto-create a table of contents
- This can be a fixed set of links at the top of your document, or a floating table on the left
- This is set in the header section






```
---
title: "Example Notebook"
output:
  html_document:
    df_print: paged
    toc: yes
    toc_float: yes
---
```

Document themes

- HTML documents are based on the bootswatch theme collection (https://bootswatch.com)

- You can change the theme by adding to the header

```
---
title: "Themes"
output:
  html_document:
    df_print: paged
    toc: true
    toc_float: true
    theme: yeti
    highlight: kate
---
```

Document themes

Themes

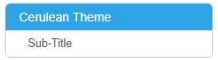
Default Theme

This is a small document to show the effect of changing the themes.

Sub-Title

- Themes can change
- The overall appearance

of your document in a quick and easy fashion.



Themes

Cerulean Theme

This is a small document to show the effect of changing the themes.

Sub-Title

- Themes can change
- The overall appearance

of your document in a quick and easy fashion.

Themes

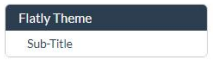
Journal Theme

This is a small document to show the effect of changing the themes.

Sub-Title

- Themes can change
- The overall appearance

of your document in a quick and easy fashion.



Themes

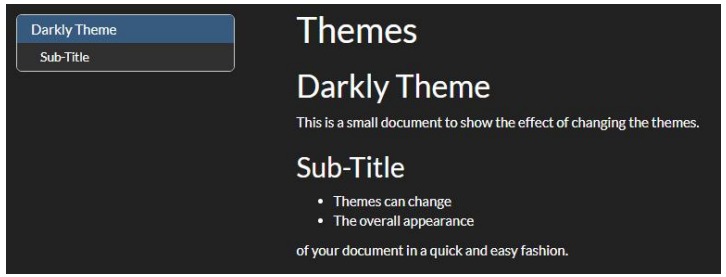
Flatly Theme

This is a small document to show the effect of changing the themes.

Sub-Title

- Themes can change
- The overall appearance

of your document in a quick and easy fashion.



Themes

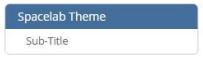
Readable Theme

This is a small document to show the effect of changing the themes.

Sub-Title

- Themes can change
- The overall appearance

of your document in a quick and easy fashion.



Themes

Spacelab Theme

This is a small document to show the effect of changing the themes.

Sub-Title

- Themes can change
- The overall appearance

of your document in a quick and easy fashion.

Themes

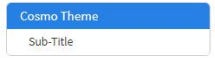
United Theme

This is a small document to show the effect of changing the themes.

Sub-Title

- Themes can change
- The overall appearance

of your document in a quick and easy fashion.



Themes

Cosmo Theme

This is a small document to show the effect of changing the themes.

Sub-Title

- Themes can change
- The overall appearance

of your document in a quick and easy fashion.

(there are more than this)

Highlighting themes

- Similarly to the document themes you can also change the colouring / style used to highlight R code in your document

```
---
title: "Themes"
output:
  html_document:
    df_print: paged
    toc: true
    toc_float: true
    theme: yeti
    highlight: kate
---
```

Highlighting themes

```
# Haddock

library(tidyverse)

starwars %>%
  filter(height>150) %>%
  arrange(desc(birth_year)) %>%
  filter(gender=="male")
```

```
# Zenburn

library(tidyverse)

starwars %>%
  filter(height>150) %>%
  arrange(desc(birth_year)) %>%
  filter(gender=="male")
```

```
# Espresso

library(tidyverse)

starwars %>%
  filter(height>150) %>%
  arrange(desc(birth_year)) %>%
  filter(gender=="male")
```

```
# Monochrome

library(tidyverse)

starwars %>%
  filter(height>150) %>%
  arrange(desc(birth_year)) %>%
  filter(gender=="male")
```

```
# Kate

library(tidyverse)

starwars %>%
  filter(height>150) %>%
  arrange(desc(birth_year)) %>%
  filter(gender=="male")
```

```
# Textmate


library(tidyverse)


starwars %>%

  filter(height>150) %>%

  arrange(desc(birth_year)) %>%

  filter(gender=="male")
```

```
# Tango

library(tidyverse)

starwars %>%
  filter(height>150) %>%
  arrange(desc(birth_year)) %>%
  filter(gender=="male")
```

```
# Pygments

library(tidyverse)

starwars %>%
  filter(height>150) %>%
  arrange(desc(birth_year)) %>%
  filter(gender=="male")
```

Tibble / DataFrame display options

- Rather than text output you see an interactive HTML version of tibbles
  - This will vary by output document type

- A few options exist for how they are displayed these are set in the header, and are specific to the HTML output type:

```
html_document:
    df_print: paged
```

Tibble / DataFrame display options

	Option value	Text or HTML	Fits to space	Restricts rows	Paging controls
Only works on data frames	`default`	text	no	no	no
	`kable`	HTML	no	no	no
	`tibble`	text	yes	yes	no
This is the default	`paged`	HTML	yes	yes	yes

Tibble / DataFrame display options

Tibble

```
## # A tibble: 20 x 5
##    Plant Type   Treatment   conc uptake
##    <chr> <chr>  <chr>      <dbl>  <dbl>
##  1 Qn1   Quebec nonchilled    95   16
##  2 Qn1   Quebec nonchilled   175   30.4
##  3 Qn1   Quebec nonchilled   250   34.8
##  4 Qn1   Quebec nonchilled   350   37.2
##  5 Qn1   Quebec nonchilled   500   35.3
##  6 Qn1   Quebec nonchilled   675   39.2
##  7 Qn1   Quebec nonchilled  1000   39.7
##  8 Qn2   Quebec nonchilled    95   13.6
##  9 Qn2   Quebec nonchilled   175   27.3
## 10 Qn2   Quebec nonchilled   250   37.1
## 11 Qn2   Quebec nonchilled   350   41.8
## 12 Qn2   Quebec nonchilled   500   40.6
## 13 Qn2   Quebec nonchilled   675   41.4
## 14 Qn2   Quebec nonchilled  1000   44.3
## 15 Qn3   Quebec nonchilled    95   16.2
## 16 Qn3   Quebec nonchilled   175   32.4
## 17 Qn3   Quebec nonchilled   250   40.3
## 18 Qn3   Quebec nonchilled   350   42.1
## 19 Qn3   Quebec nonchilled   500   42.9
## 20 Qn3   Quebec nonchilled   675   43.9
```

Kable

Plant	Type	Treatment	conc	uptake
Qn1	Quebec	nonchilled	95	16.0
Qn1	Quebec	nonchilled	175	30.4
Qn1	Quebec	nonchilled	250	34.8
Qn1	Quebec	nonchilled	350	37.2
Qn1	Quebec	nonchilled	500	35.3
Qn1	Quebec	nonchilled	675	39.2
Qn1	Quebec	nonchilled	1000	39.7
Qn2	Quebec	nonchilled	95	13.6
Qn2	Quebec	nonchilled	175	27.3
Qn2	Quebec	nonchilled	250	37.1
Qn2	Quebec	nonchilled	350	41.8
Qn2	Quebec	nonchilled	500	40.6
Qn2	Quebec	nonchilled	675	41.4
Qn2	Quebec	nonchilled	1000	44.3
Qn3	Quebec	nonchilled	95	16.2
Qn3	Quebec	nonchilled	175	32.4
Qn3	Quebec	nonchilled	250	40.3
Qn3	Quebec	nonchilled	350	42.1
Qn3	Quebec	nonchilled	500	42.9
Qn3	Quebec	nonchilled	675	43.9

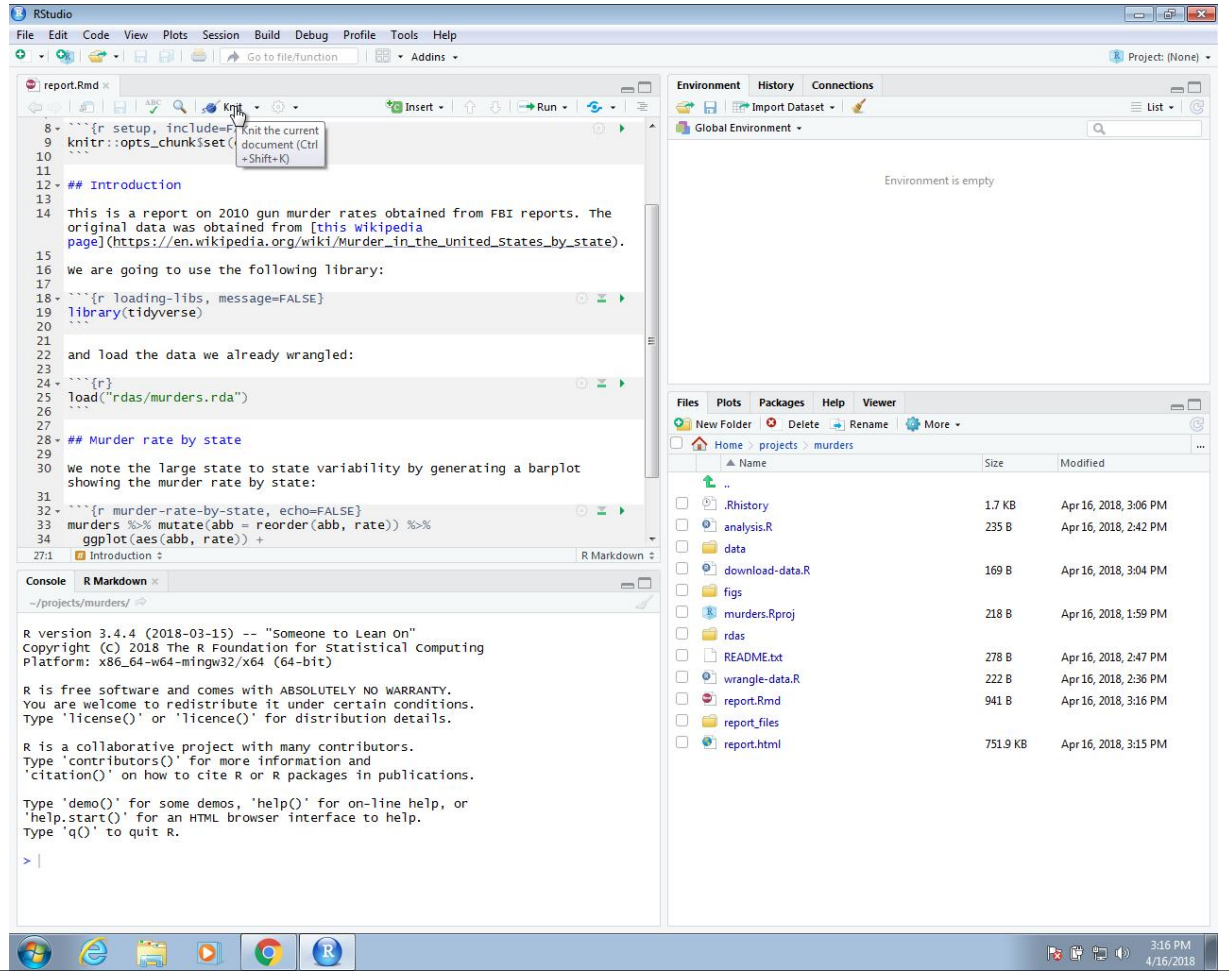
Paged

Plant <chr>	Type <chr>	Treatment <chr>	conc <dbl>	uptake <dbl>
Qn1	Quebec	nonchilled	95	16.0
Qn1	Quebec	nonchilled	175	30.4
Qn1	Quebec	nonchilled	250	34.8
Qn1	Quebec	nonchilled	350	37.2
Qn1	Quebec	nonchilled	500	35.3
Qn1	Quebec	nonchilled	675	39.2
Qn1	Quebec	nonchilled	1000	39.7
Qn2	Quebec	nonchilled	95	13.6
Qn2	Quebec	nonchilled	175	27.3
Qn2	Quebec	nonchilled	250	37.1

1-10 of 20 rows Previous 1 2 Next

knitR

We use the **knitR** package to compile R markdown documents. The specific function used to compile is the **knit** function, which takes a filename as input. RStudio provides a button that makes it easier to compile the document.



Example

```
--- title: "Report on Gun Murders"
author: "Rafael Irizarry"
date: "`r format(Sys.Date())`"
output: github_document
---
```

```{r setup, include=FALSE}
knitr::opts_chunk$set(echo = TRUE)
```

Introduction

This is a report on 2010 gun murder rates obtained from FBI reports. The original data was obtained from [this Wikipedia page](https://en.wikipedia.org/wiki/Murder_in_the_United_States_by_state). We are going to use the following library:

```{r loading-libs, message=FALSE}
library(tidyverse)
```

and load the data we already wrangled:

```{r} load("rdas/murders.rda")
```

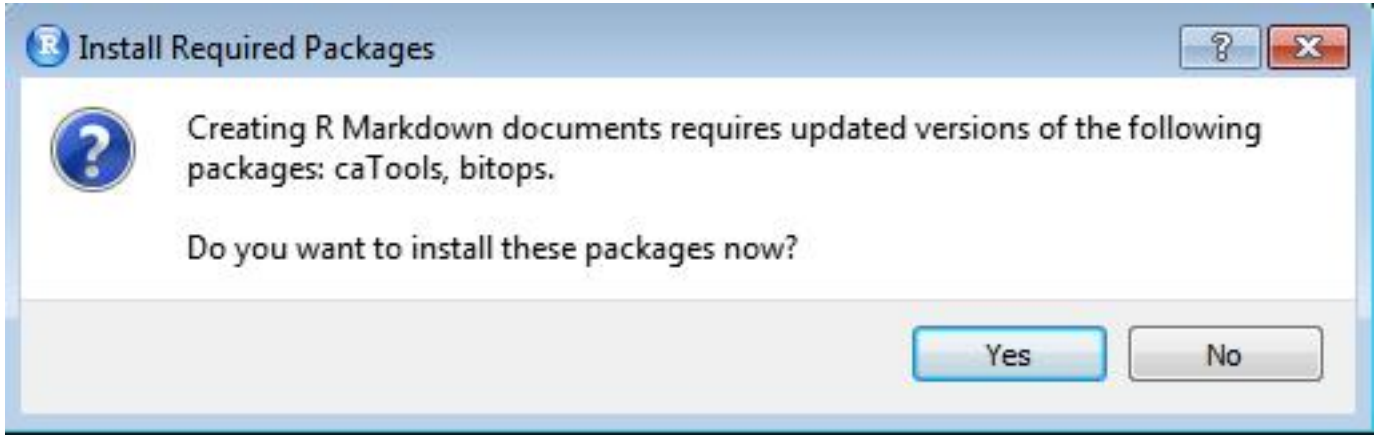
Murder rate by state

We note the large state to state variability by generating a barplot showing the murder rate by state:

```{r murder-rate-by-state, echo=FALSE}
murders %>% mutate(abb = reorder(abb, rate)) %>%
ggplot(aes(abb, rate)) + geom_bar(width = 0.5, stat = "identity", color = "black") + coord_flip()
```

Knit button

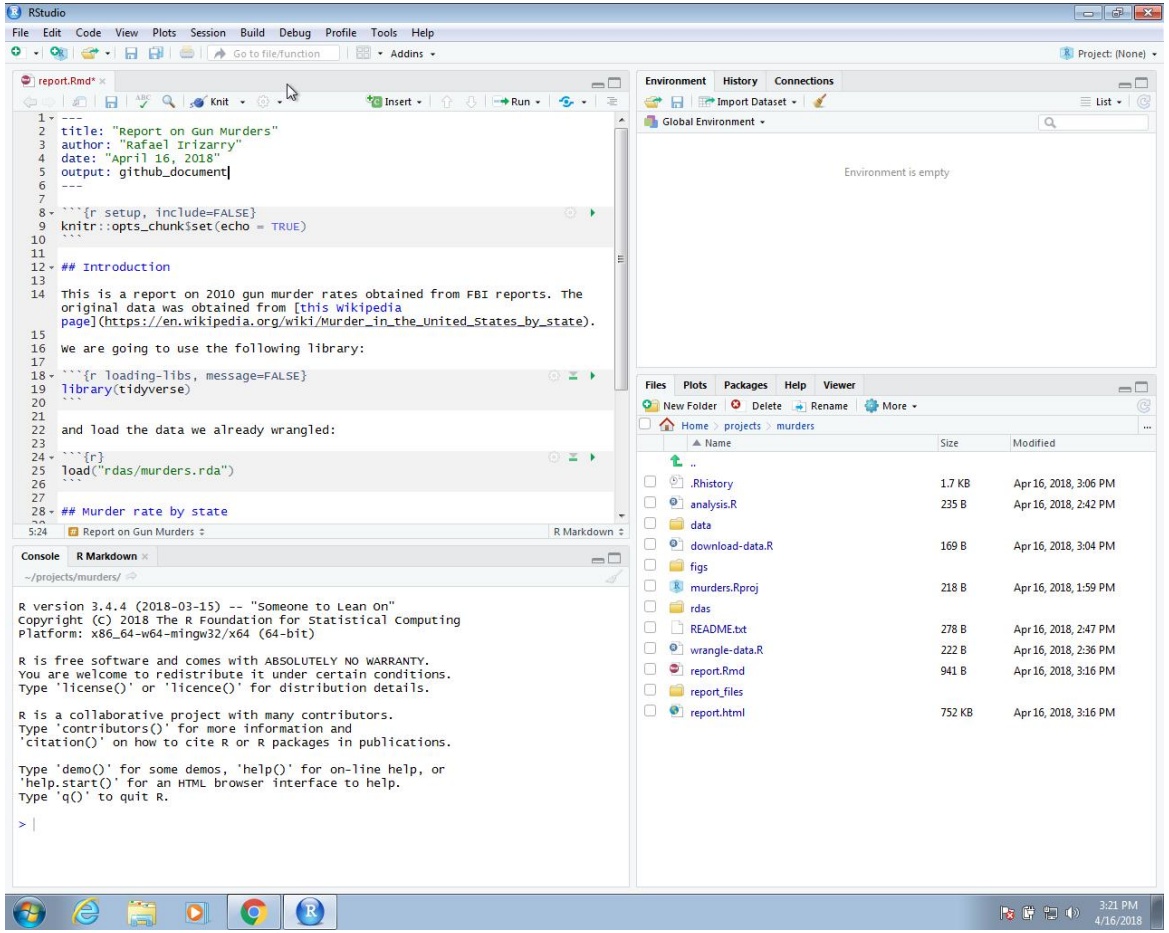
The first time you click on the *Knit* button, a dialog box may appear asking you to install packages you need:



Once you have installed the packages, clicking the *Knit* will compile your R markdown file and the resulting document will pop-up:
This produces an html document which you can see in your working directory. To view it, open a terminal and list the files. You can open the file in a browser and use this to present your analysis. You can also produce a PDF or Microsoft document by changing: output: html_document to output: pdf_document or output: word_document.

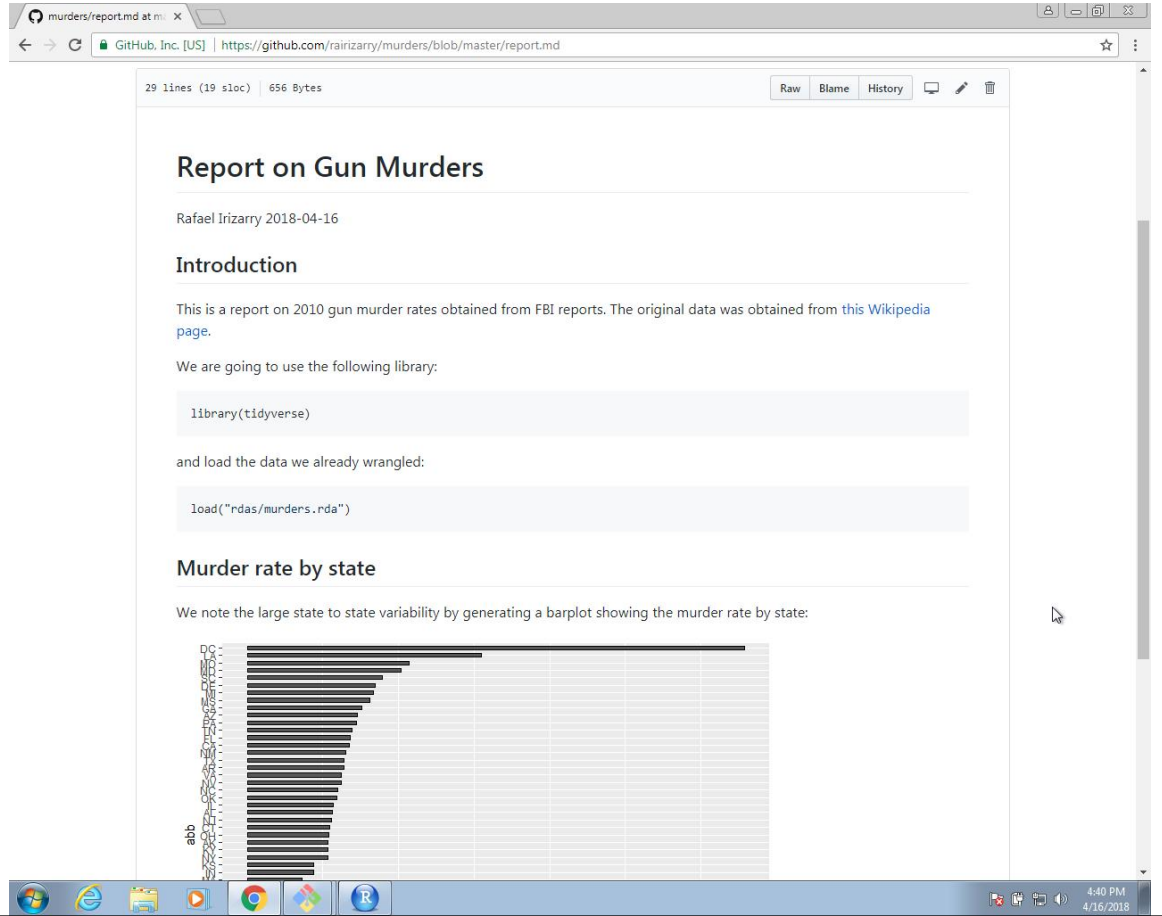
github_document

We can also produce documents that render on GitHub using output: github_document like this:



Web report

This will produce a markdown file, with suffix **md**, that renders in GitHub. Because we have uploaded these files to GitHub, you can click on the **md** file and you will see the report as a webpage:



Slide presentation

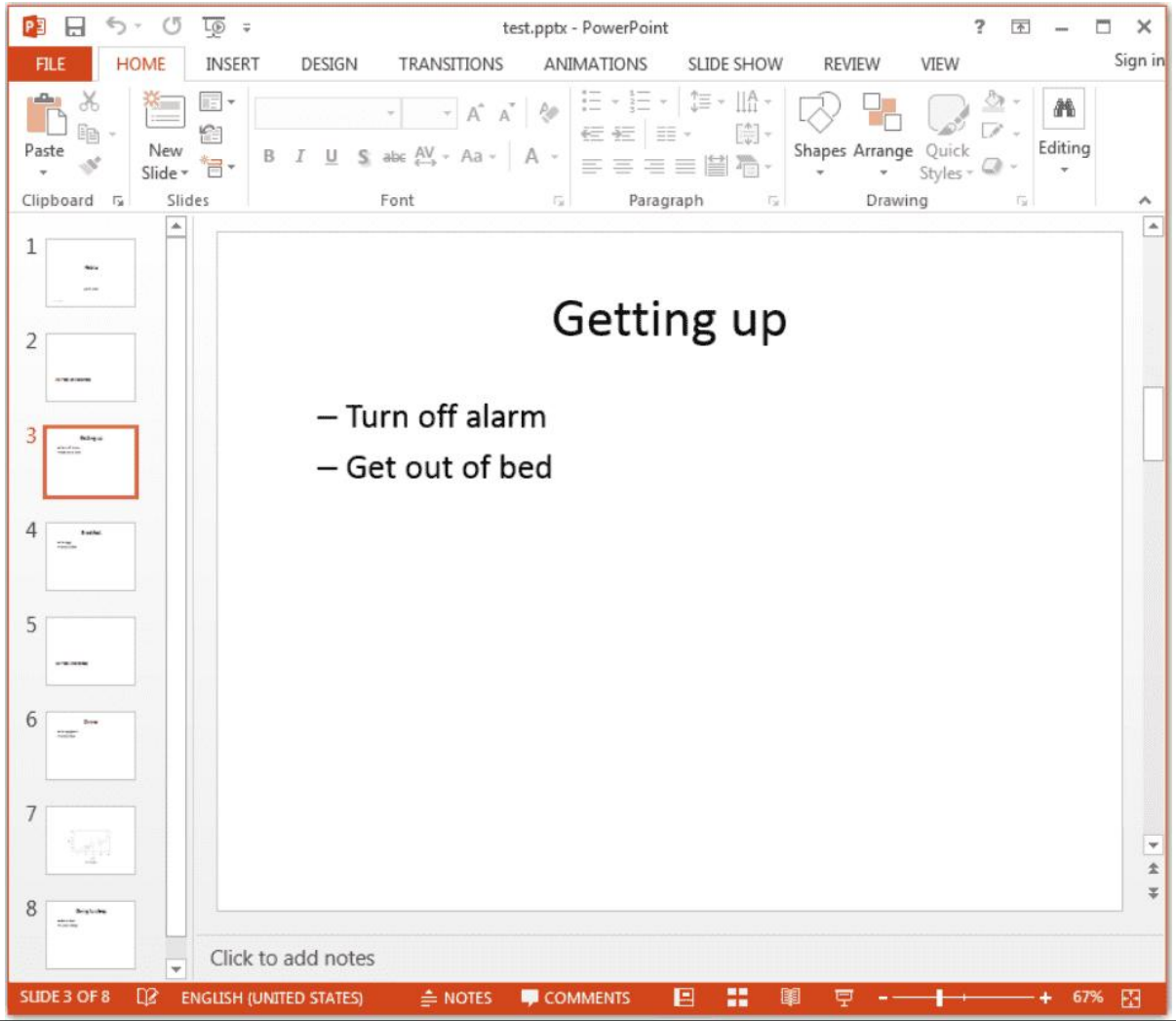
R Markdown renders to four presentation formats:

- beamer_presentation - PDF presentations with beamer
- ioslides_presentation - HTML presentations with ioslides
- slidy_presentation - HTML presentations with slidy
- powerpoint_presentation - PowerPoint presentation
- revealjs::revealjs_presentation - HTML presentations with reveal.js

Each format will intuitively divide your content into slides, with a new slide beginning at each first or second level header.

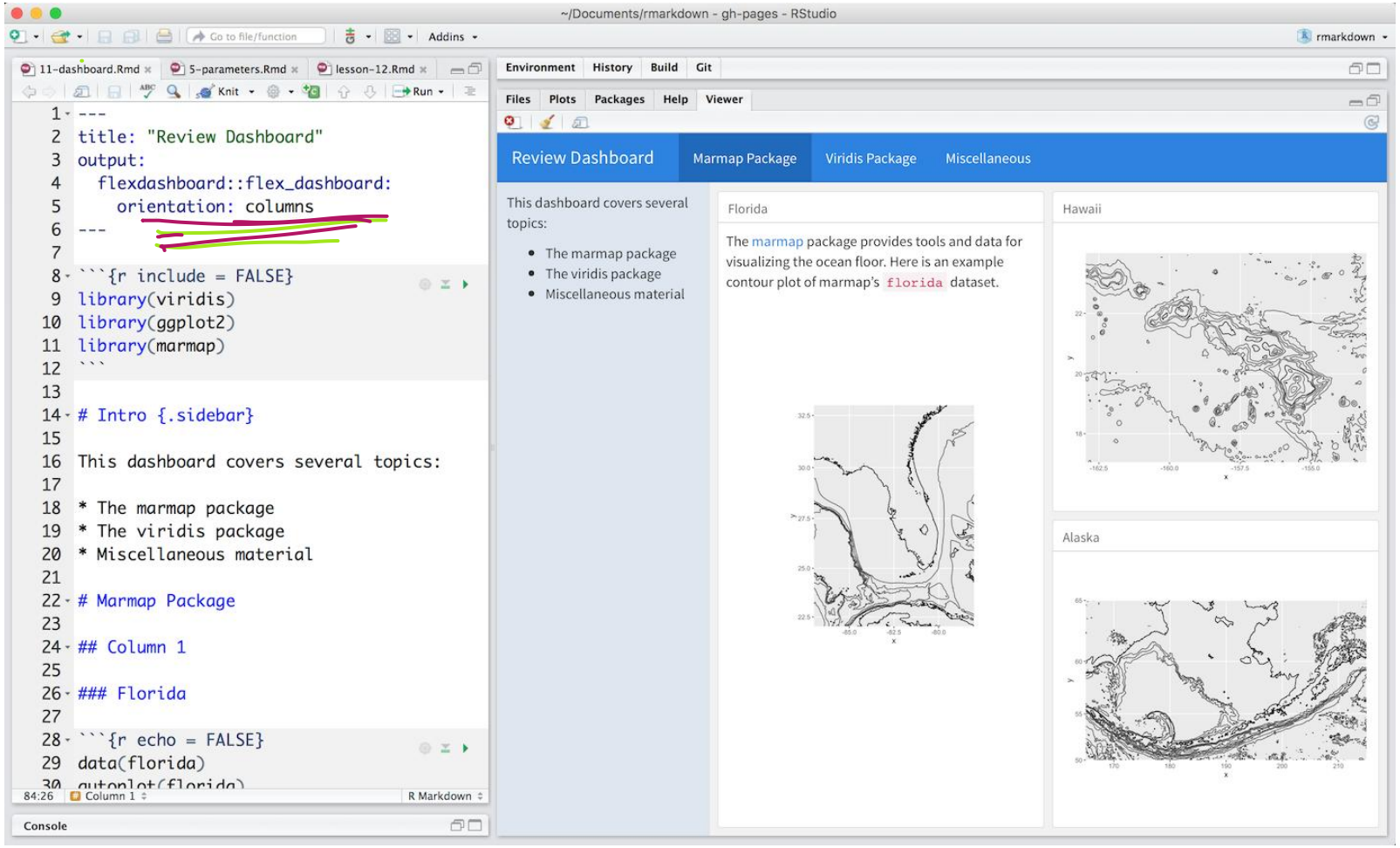
Power Point

```
--- title: "Habits"
author: John Doe
date: March 22, 2005
output: powerpoint_presentation
---
# In the morning
## Getting up
-    Turn off alarm
-    Get out of bed
## Breakfast
-    Eat eggs
-    Drink coffee
# In the evening
## Dinner
-    Eat spaghetti
-    Drink wine
---
```{r, cars, fig.cap="A scatterplot.", echo=FALSE}
plot(cars)
```
Going to sleep
-    Get in bed
-    Count sheep
```



Dashboard

Dashboards are a useful way to communicate large amounts of information visually and quickly. Create one with the flexdashboard::flex_dashboard output format



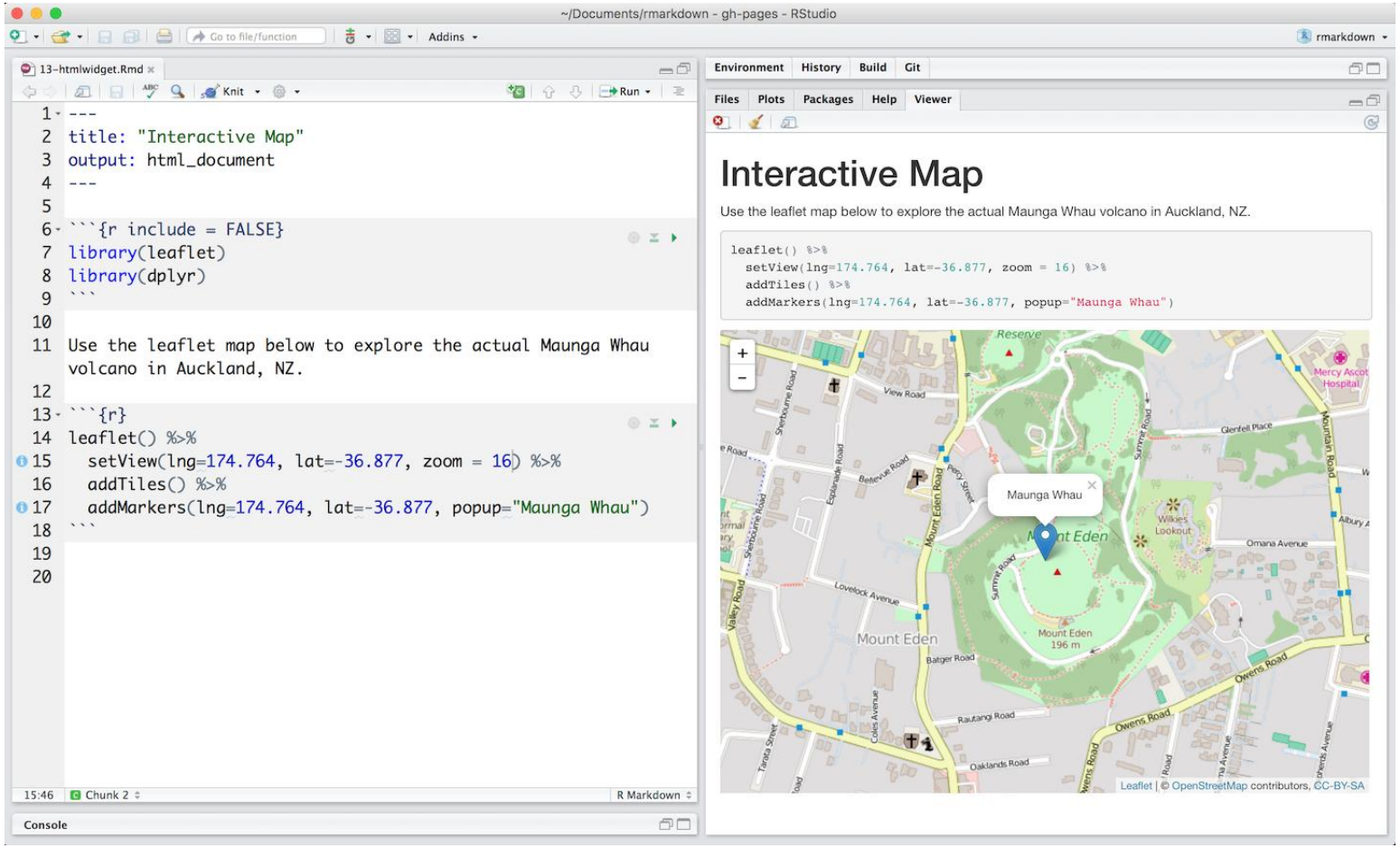
Flexdashboard makes it easy to organize your content into a visual layout:

- Each Level 1 Header (#) begins a new page in the dashboard.
- Each Level 2 Header (##) begins a new column.
- Each Level 3 Header (###) begins a new box.

Interactive documents

Markdown documents are a perfect platform for interactive content. To make your documents interactive, add:

1. Interactive JavaScript visualizations based on [htmlwidgets](#) or
2. Reactive components made with [Shiny](#)



Shiny apps

Shiny

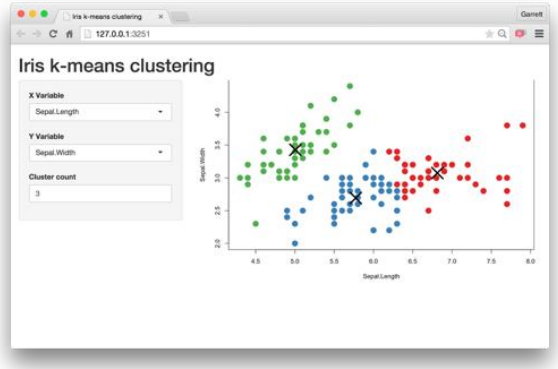
Shiny is an R package that makes it easy to build interactive web apps straight from R. You can host standalone apps on a webpage or embed them in R Markdown documents or build dashboards.
You can also extend your Shiny apps with CSS themes, htmlwidgets, and JavaScript actions.

web apps was for R users:

In the past	With shiny
•You need a deep knowledge of web technologies like HTML, CSS and JavaScript.	•Providing a carefully curated set of user interface (UI for short) functions that generate the HTML, CSS, and JavaScript that you need for common tasks.
•Making complex interactive apps requires careful analysis of interaction flows to make sure that when an input changes, only the related outputs are updated.	•Introducing a new style of programming called **reactive programming** which automatically tracks the dependencies of a code

Every Shiny app is maintained by a computer running R

We have to Connect both 2 to communicate b/w them.



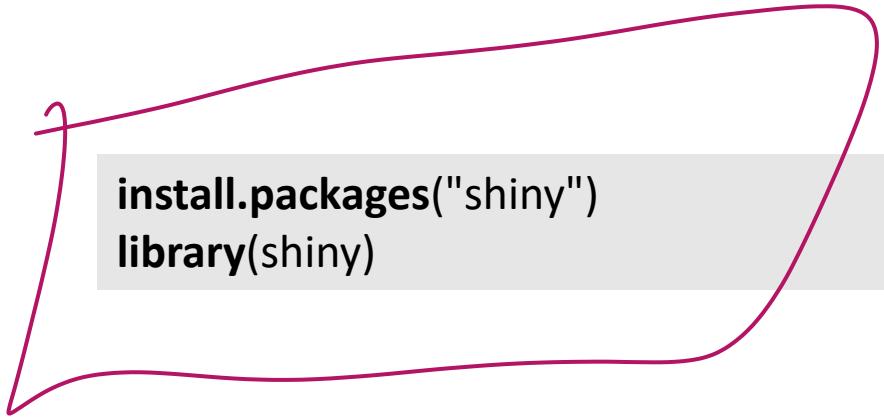
Server Instructions

User Interface (UI)

Introduction

Two key components of every Shiny app:

- the **UI** (short for user interface) which defines how your app *looks*,
- the **server function** which defines how your app *works*. Shiny uses reactive programming to automatically update outputs when inputs change so we'll finish by learning the third important component of Shiny apps: reactive expressions.



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

Build your app

Add elements to your app as arguments to fluidPage()

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

Inputs

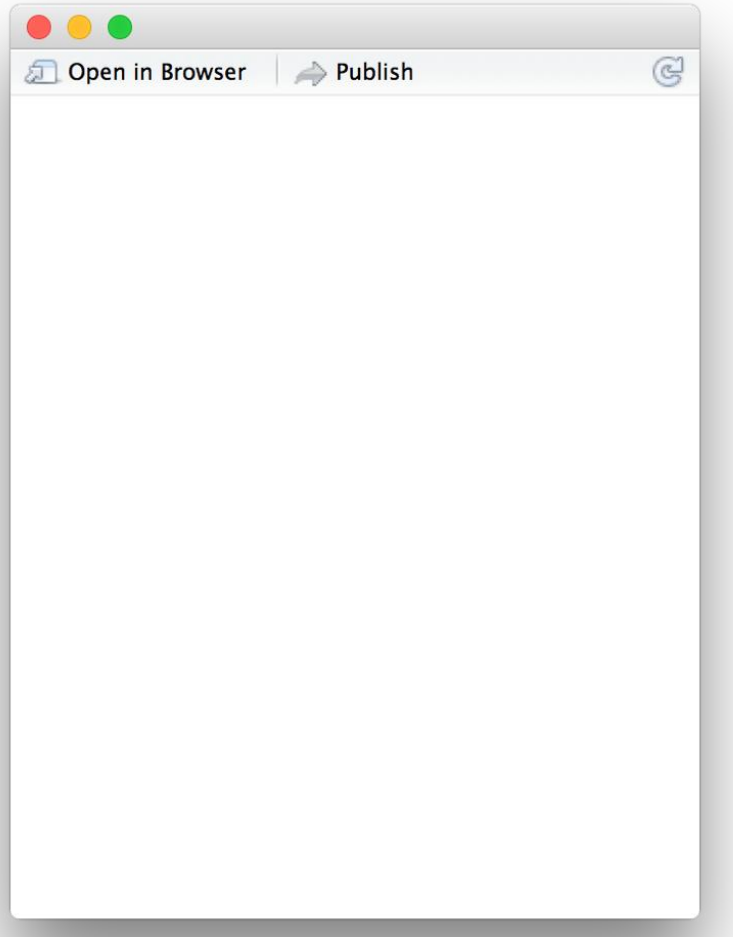
```
library(shiny)
ui <- fluidPage(



)

server <- function(input, output) {}

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

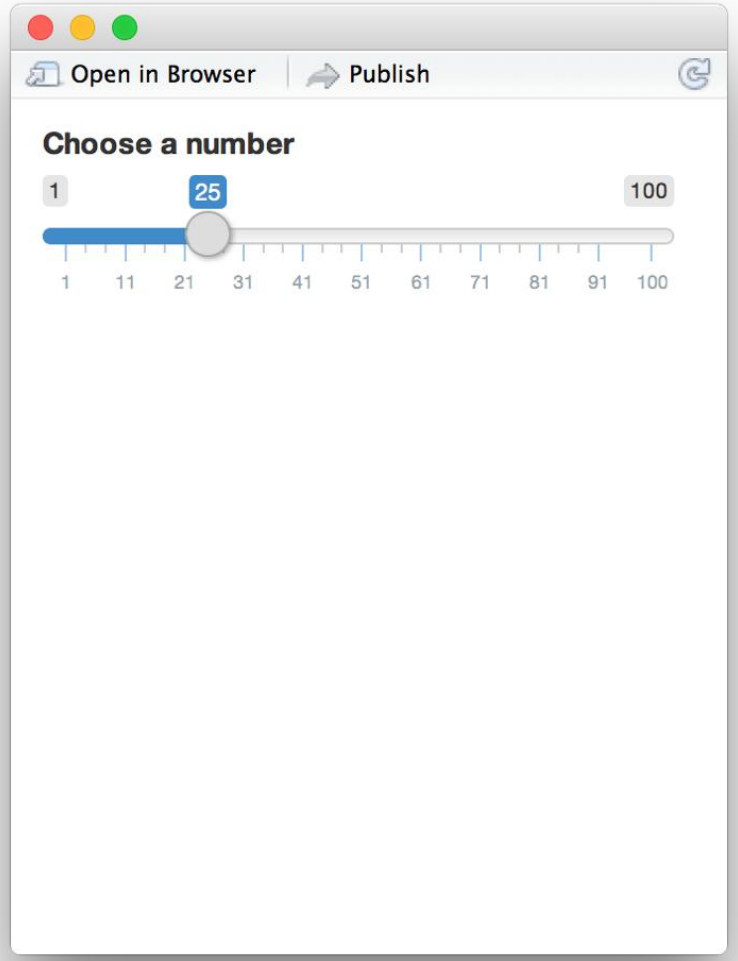


Inputs

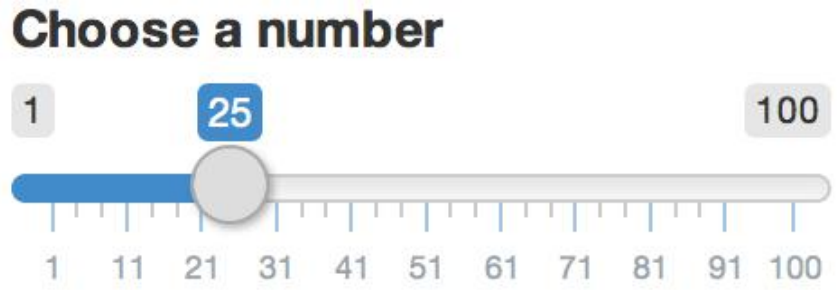
```
library(shiny)
ui <- fluidPage(
  sliderInput(inputId = "num",
    label = "Choose a number",
    value = 25, min = 1, max = 100)
)

server <- function(input, output) {}

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



Syntax




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

input name
(for internal use)

Notice:
Id not ID

label to display

input specific arguments

?sliderInput

Other inputs

Buttons

actionButton()
submitButton()

Single checkbox

checkboxInput()

Checkbox group

checkboxGroupInput()

Date input

dateInput()

Date range

dateRangeInput()

File input

fileInput()

Numeric input

numericInput()

Password Input

passwordInput()

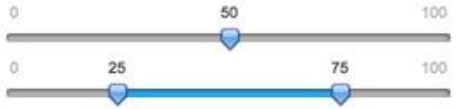
Radio buttons

radioButtons()

Select box

selectInput()

Sliders



sliderInput()

Text input

textInput()

Outputs

To display output, add it to fluidPage() with an *Output() function

```
plotOutput("hist")
```

the type of output to display

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

Outputs

```
library(shiny)

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

server <- function(input, output) {}

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

Comma between arguments

how to assemble inputs into outputs ?

Server function

1 Save objects to display to output$

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

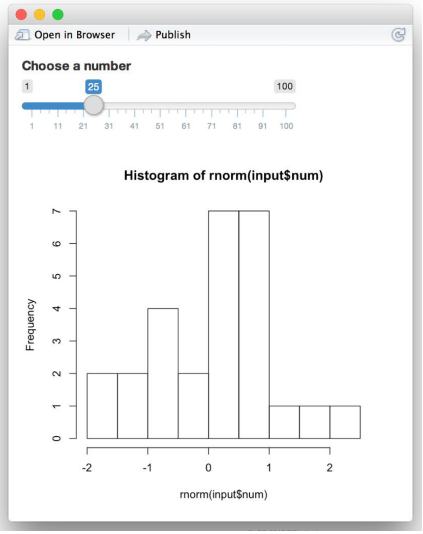

}
```

2 Build objects to display with **render*()**

```
server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(100))
  })
}
```

3 Access **input** values with input$

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



Render

textOutput() ⟷ renderText()

Output function in UI code pairs with a render function in the server code.

render*()

Builds reactive output to display in UI

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

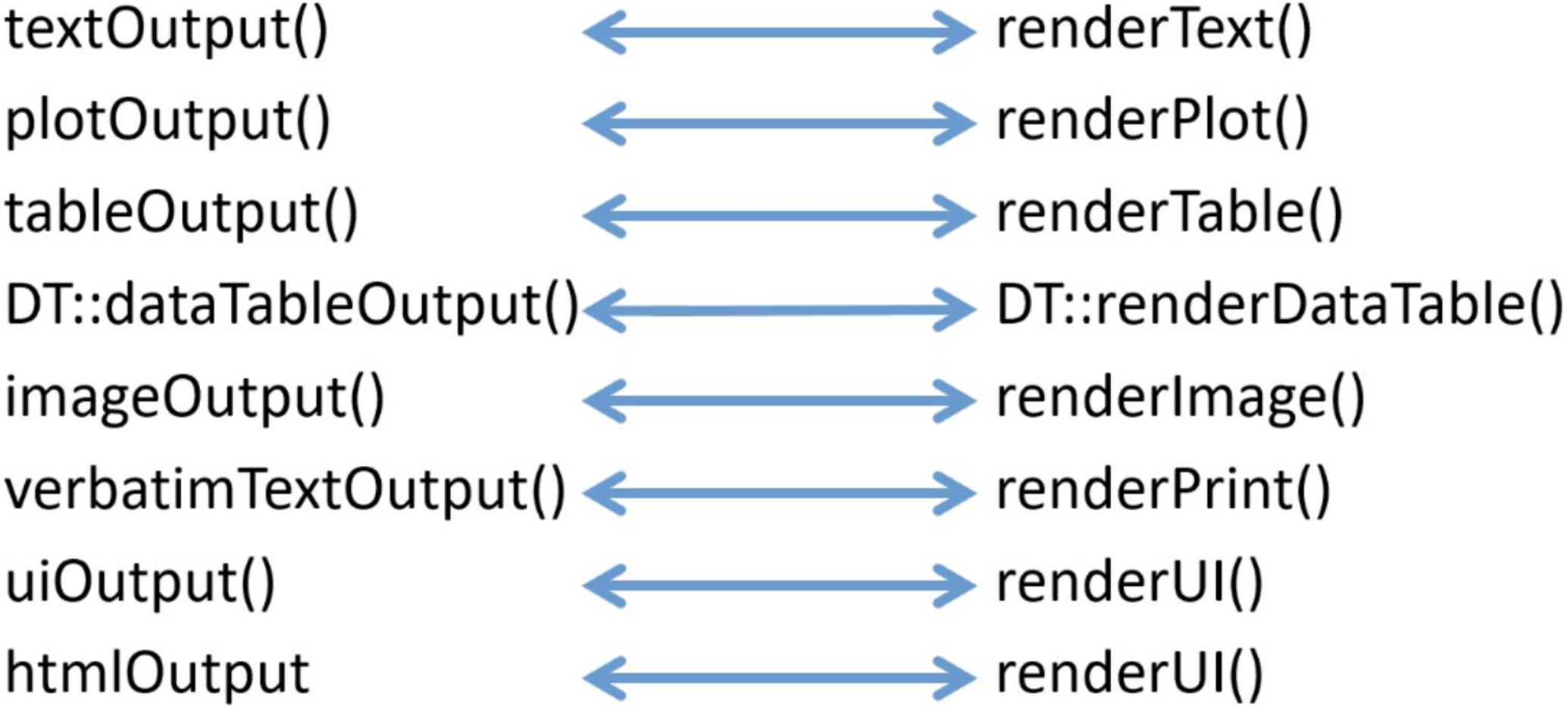
type of object to build

code block that builds the object

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

Outputs and render functions



Simple app code

```
library(shiny)

ui <- fluidPage(

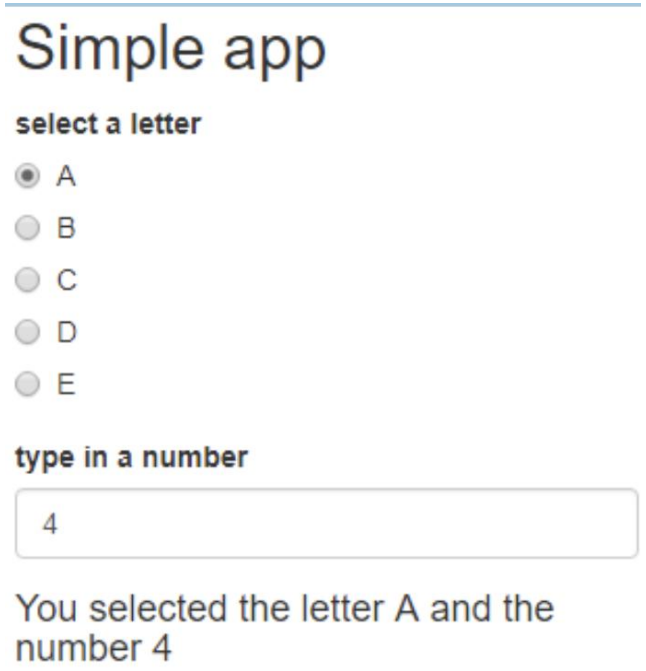
  titlePanel("Simple app"),

  radioButtons(inputId = "letter_choice",
               label   = "select a letter",
               choices  = LETTERS[1:5]),
  numericInput(inputId = "number_choice",
               label   = "type in a number",
               value   = 4),
  textOutput(outputId = "message")
)

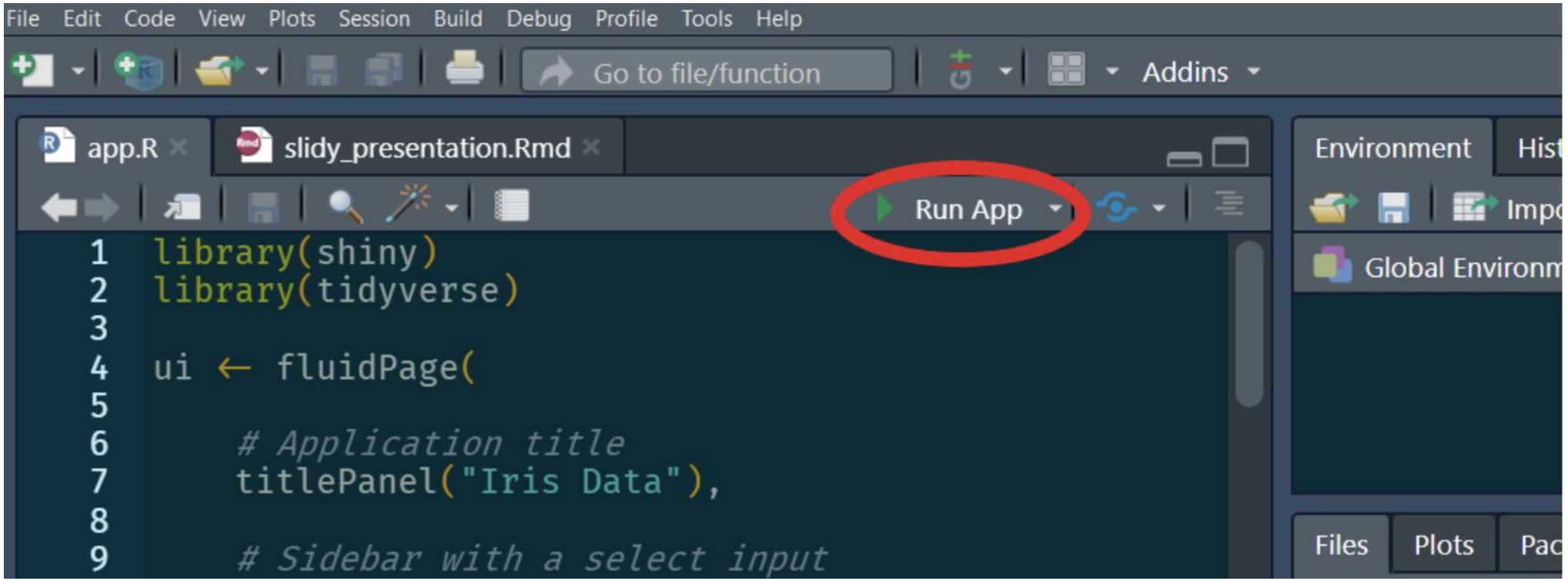
server <- function(input, output) {

  output$message <- renderText({
    paste0("You selected the letter ", input$letter_choice,
           " and the number ", input$number_choice)
  })
}

shinyApp(ui, server)
```



How to run a shiny app?



Exercise 1

Create a Shiny application from scratch that looks (and functions) like the one below.

- There should be 2 textInput fields for entering user names, and one numericInput for entering height
- The message at the bottom should display the first and last names entered by the user, along with their height
- Add some radio buttons to allow users to select age brackets
- Change the height selector to a slider
- Feel free to add extra info fields

Two inputs

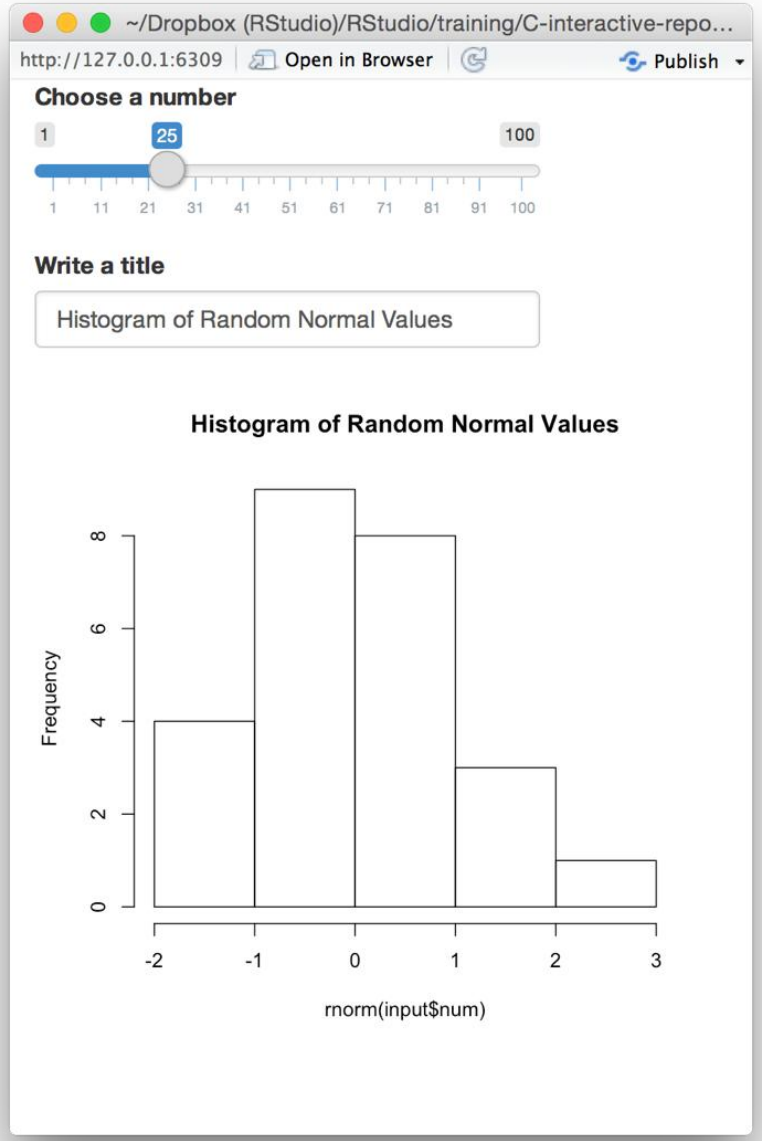
```
# 01-two-inputs

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)
```



Two outputs

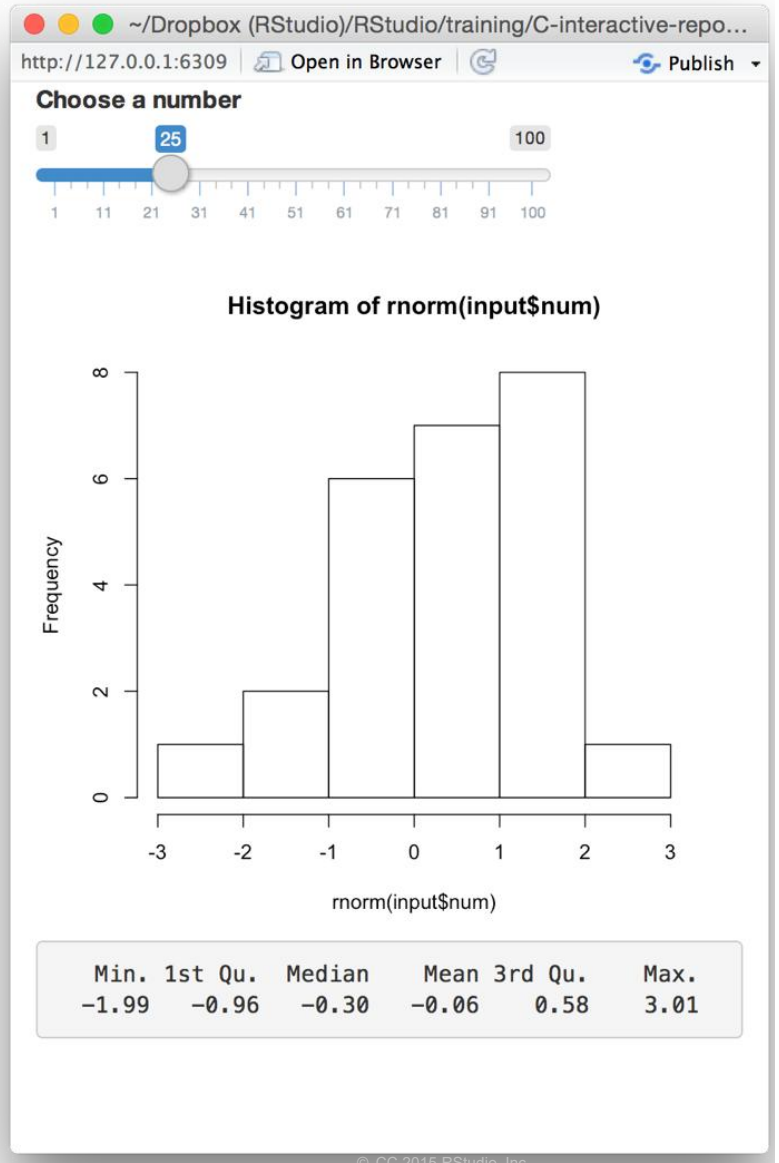
```
# 02-two-outputs

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)
```



Side bar layouts - syntax

```
sidebarLayout(
  sidebarPanel,
  mainPanel,
  position = c("left", "right"),
  fluid = TRUE
)

sidebarPanel(..., width = 4)
mainPanel(..., width = 8)
```

Side bar layouts - example

```
ui <- fluidPage(

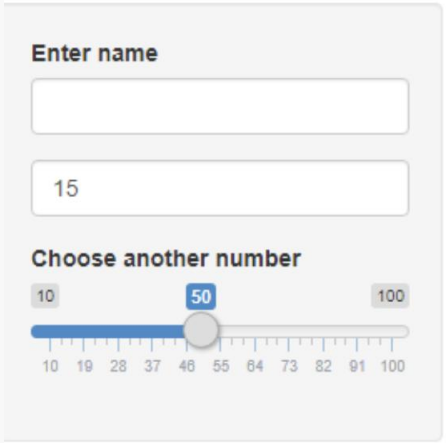
  titlePanel("Exercise 1.1"),

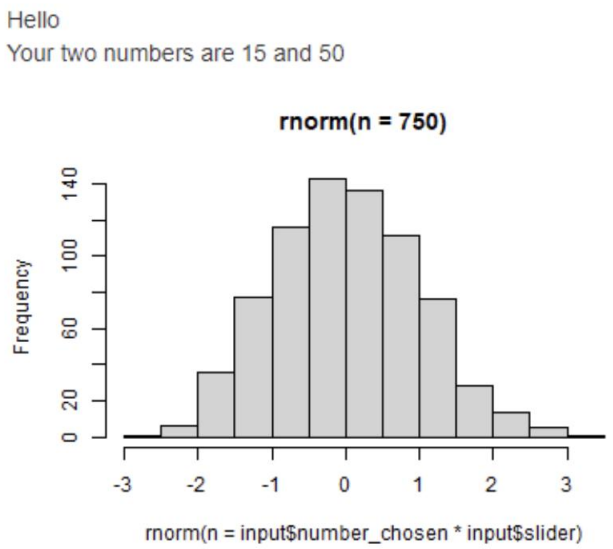
  sidebarLayout(

    sidebarPanel(

      textInput(inputId = "user_name",
                label   = "Enter name"),
      numericInput(inputId = "number_chosen",
                   label   = NULL, value   = 15),
      sliderInput(inputId = "slider",
                  label   = "Choose another number",
                  min     = 10, max = 100, value = 50),
    ),
    mainPanel(

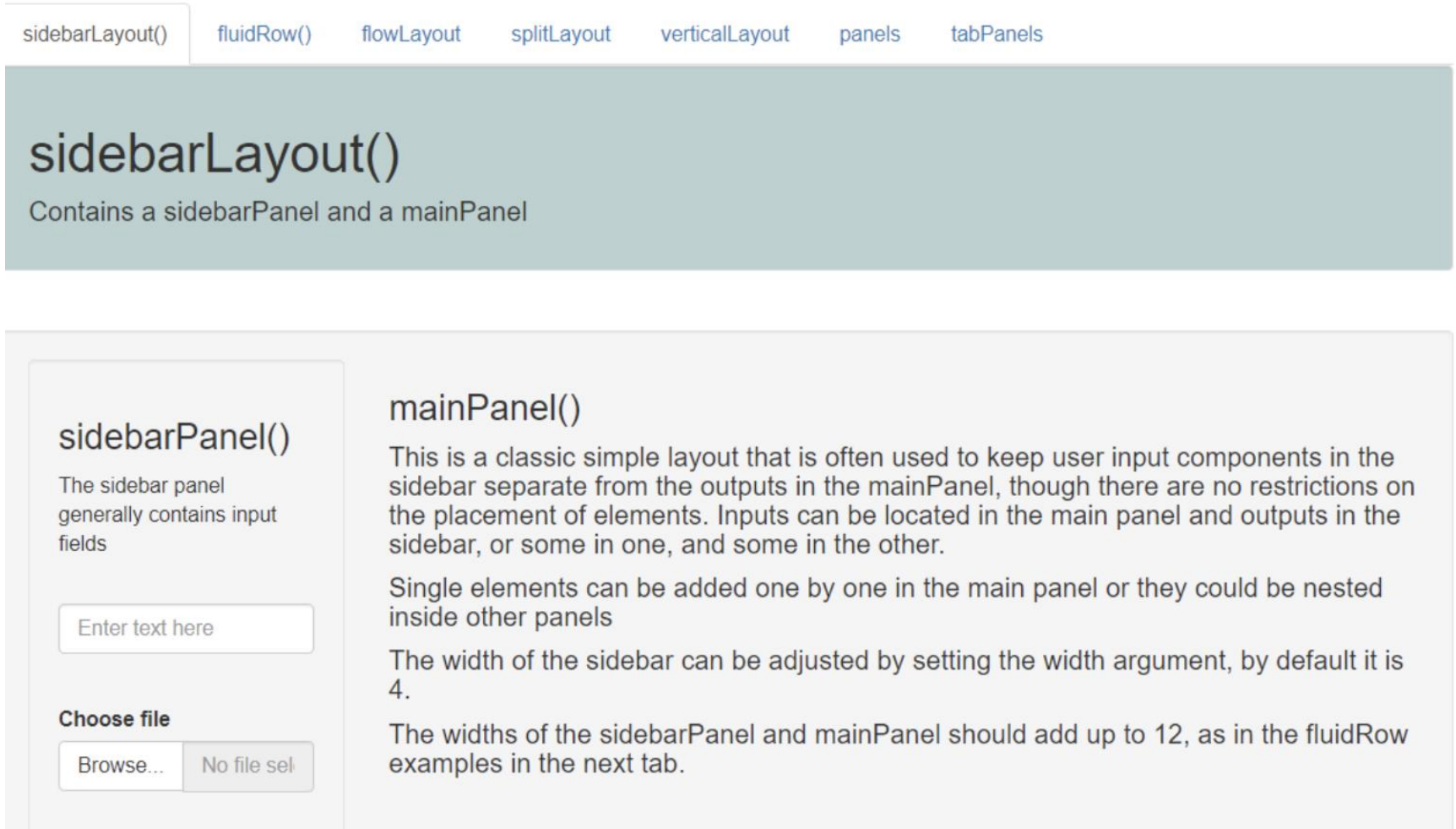
      textOutput(outputId = "supplied_name"),
      textOutput(outputId = "info"),
      plotOutput(outputId = "density_plot", height = "300px", width = "400px")
    )
  ))
```





Layout examples

The 'objects' referred to within the layouts could be single elements such as a plot, table, image or piece of text, or a panel containing multiple elements. Panels can be nested within panels.



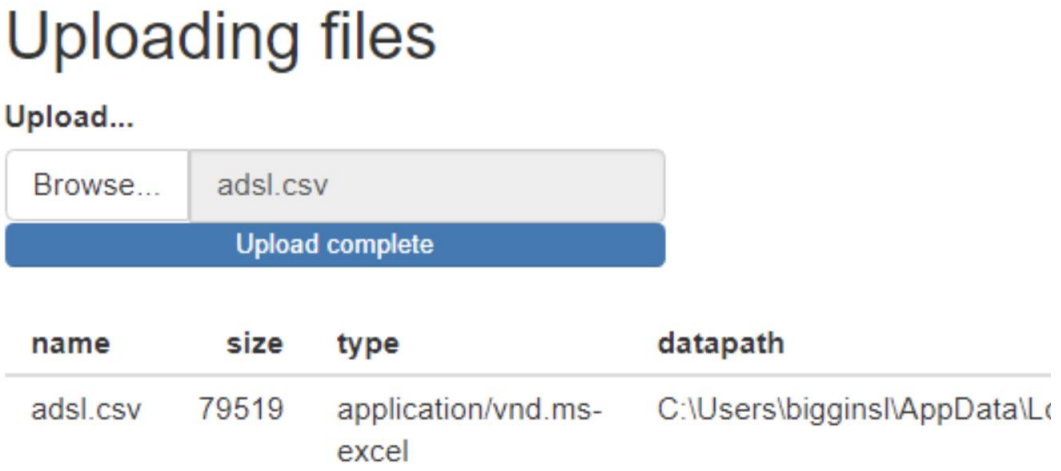
Importing files – fileInput()

Unlike other inputs, fileInput() returns a data frame with 4 columns

```
ui <- fluidPage(

  titlePanel("Uploading files"),
  fileInput(inputId = "upload",
            label = "Upload...",),
  tableOutput("files")
)
server <- function(input, output) {

  output$files <- renderTable(input$upload)
}
```



default max file size is 5MB

```
# allow file up to 10MB to be uploaded
options(shiny.maxRequestSize = 10 * 1024^2)
```

Importing files – fileInput()

```
library(shiny)
library(readr)

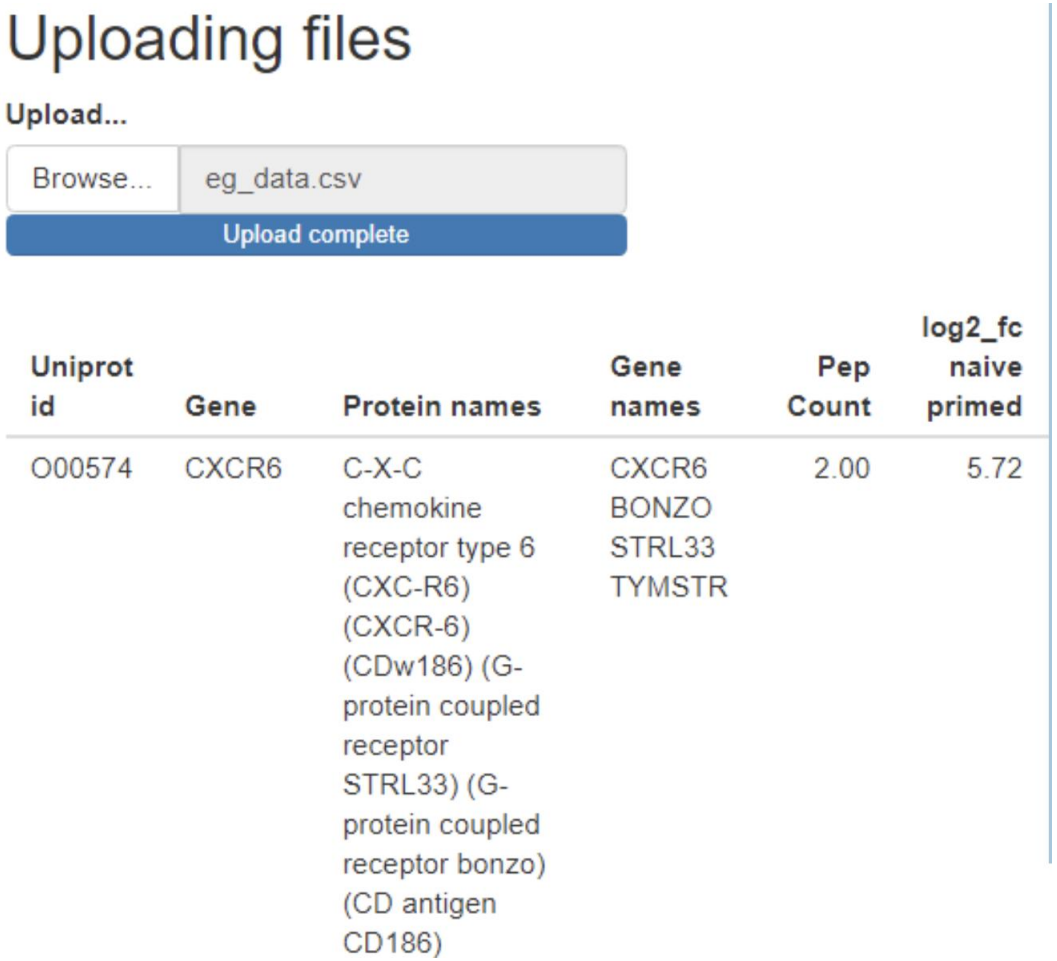
options(shiny.maxRequestSize = 10 * 1024^2)

ui <- fluidPage(
  titlePanel("Uploading files"),
  fileInput(inputId = "upload",
            label = "Upload...",),
  tableOutput("files")
)

server <- function(input, output) {

  output$files <- renderTable({
    req(input$upload)
    dataset <- read_csv(input$upload$datapath)
    head(dataset)
  })
}

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



Uniprot id	Gene	Protein names	Gene names	Pep Count	log2_fc naive primed
O00574	CXCR6	C-X-C chemokine receptor type 6 (CXC-R6) (CXCR-6) (CDw186) (G-protein coupled receptor STRL33) (G-protein coupled receptor bonzo) (CD antigen CD186)	CXCR6 BONZO STRL33 TYMSTR	2.00	5.72

Importing files – fileInput()

fileInput() summary

fileInput() returns a data frame of 4 columns

```
input$id$datapath
```

Access the filepath.

```
options(shiny.maxRequestSize = 10 * 1024^2)
```

Increase max upload size (to 10MB).

```
req(input$id)
```

Check a file has been chosen.

File validity

```
fileInput(inputId, label,
          accept = ".csv")
```

Use the accept parameter in fileInput() to limit files shown in browser.

```
req(input$file)
ext <- tools::file_ext(input$file$name)
validate(need(ext == "csv",
              "Please upload a csv file"))
read_csv(input$file$datapath)
```

The accept argument is only a suggestion to the file browser.
Use further checks to validate file type.

Pre-processing datasets

Data can be imported, manipulated if necessary and saved as R data objects (.Rds or .RData). This can be done in a pre-processing script to allow the data to simply be loaded within the Shiny app.

Saving and loading one file

```
# in pre-processing script
tree_data <- read_csv("tree_measurements.csv")
saveRDS(tree_data, file = "data/tree_data.Rds")
```

```
# in app.R script
tree_data <- readRDS("data/tree_data.Rds")
```

Saving a named list

```
tree_list  <- list(
  "beech" = beech_trees,
  "oak" =  oak_trees)
saveRDS(tree_list, file = "data/tree_list.Rds")
```

```
# in app.R script
tree_data <- readRDS("data/tree_list.Rdata")
tree_data$beech # to access the beech dataset
tree_data$oak   # to access the oak dataset
```

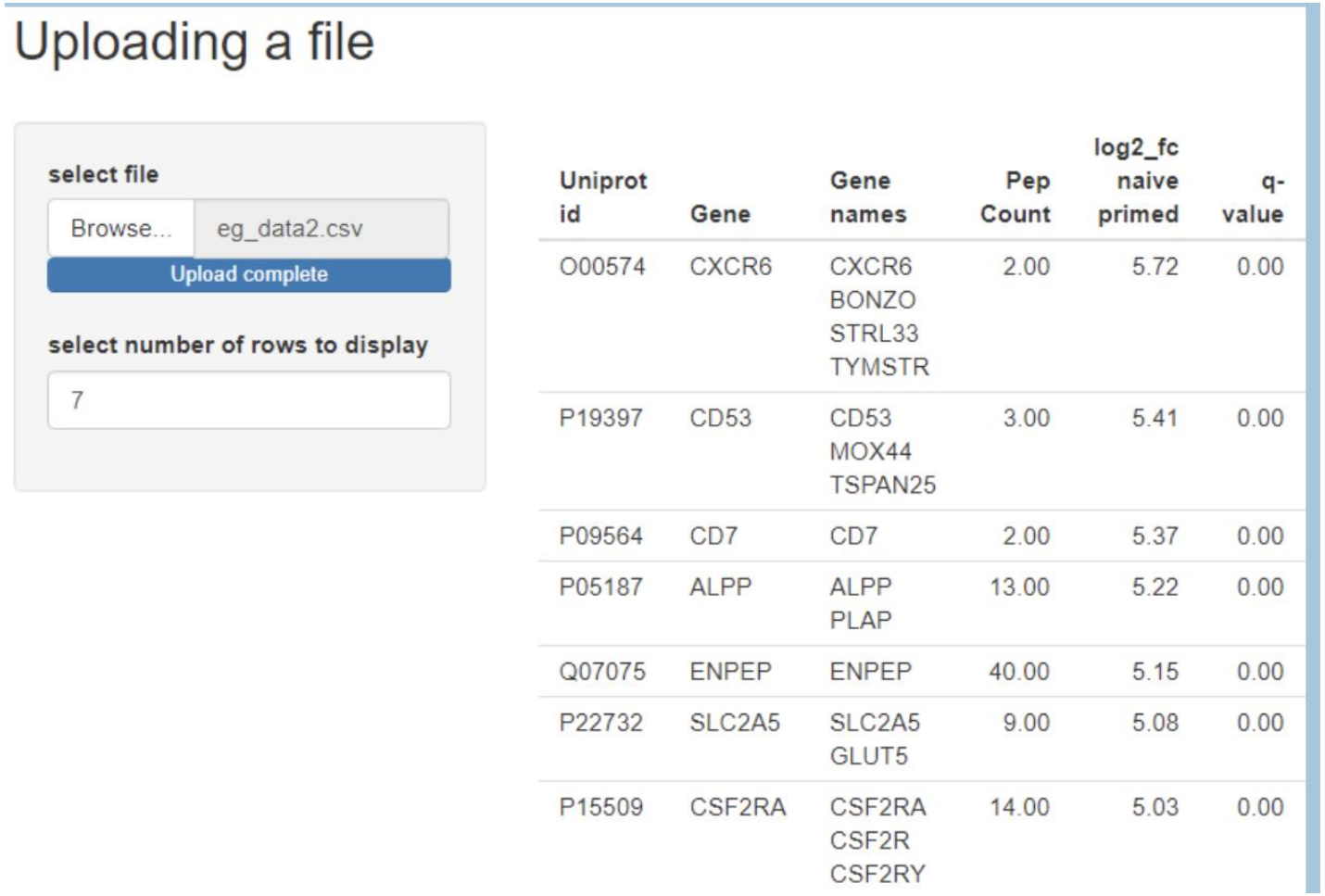
Saving more than one dataset in .Rdata

```
# in pre-processing script
beech_trees <- read_csv("beech_tree_measurements.csv")
oak_trees <- read_csv("oak_tree_measurements.csv")
save(beech_trees, oak_trees, file = "data/tree_data.Rdata")
```

```
# in app.R script
load("data/tree_data.Rdata") # loads the 2 datasets beech_trees and oak_trees
```

Exercise 2

Uploading a file.
Create an app that looks like this one. It should:
- allow a csv file to be chosen and uploaded
- display the first few rows of data in a table
- have an option to change the number of rows displayed



Uniprot id	Gene	Gene names	Pep Count	log2_fc naive primed	q-value
O00574	CXCR6	CXCR6 BONZO STRL33 TYMSTR	2.00	5.72	0.00
P19397	CD53	CD53 MOX44 TSPAN25	3.00	5.41	0.00
P09564	CD7	CD7	2.00	5.37	0.00
P05187	ALPP	ALPP PLAP	13.00	5.22	0.00
Q07075	ENPEP	ENPEP	40.00	5.15	0.00
P22732	SLC2A5	SLC2A5 GLUT5	9.00	5.08	0.00
P15509	CSF2RA	CSF2RA CSF2R CSF2RY	14.00	5.03	0.00

Reactivity

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

Two outputs with reactive()

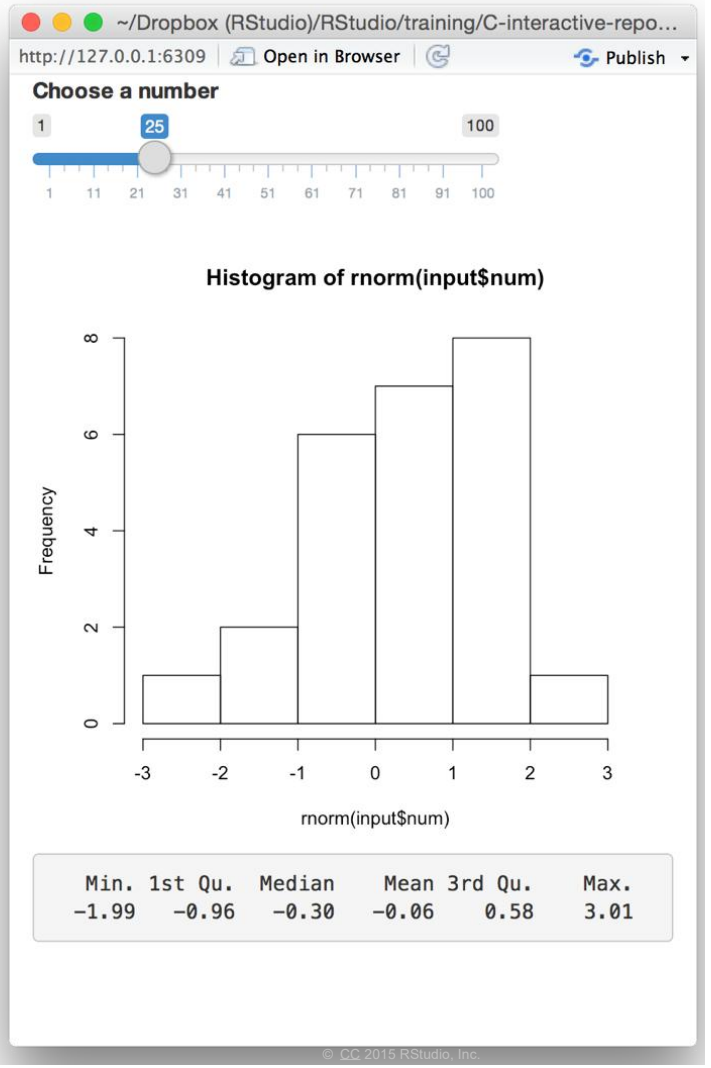
```
# 03-reactive

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 = 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

Can we prevent the title field from updating the plot?

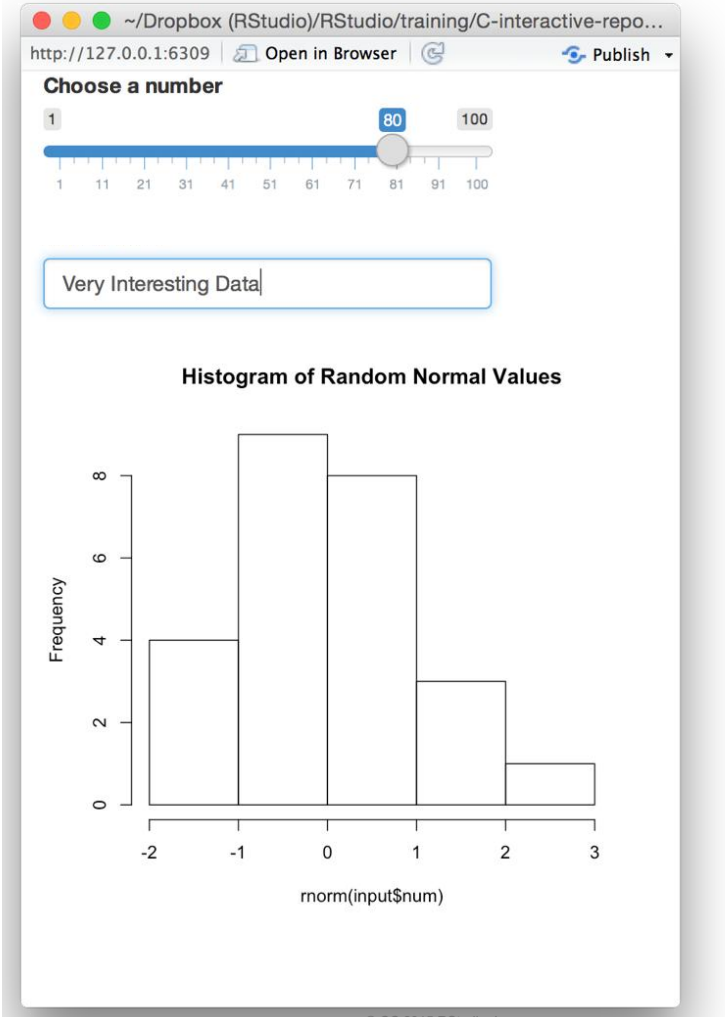
```
# 04-isolate

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")
)

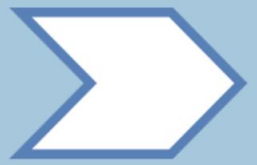
server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$num),
      main = isolate({input$title}))
  })
}

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



Reactive expressions and observers

Both store expressions that can be executed.

Reactive expression	Observer
	
Returns values	Doesn't return values
Callable	Not callable
not side effects	Side effects
Lazy	Eager
Caches values	N/A

Reactive expresssions need an observer as a descendent in order to execute.

reactive() – calculating values without side effects
observe() – performing actions with side effects

Action buttons

input name
(for internal use)

label to
display

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

Notice:
Id not ID

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()

Action buttons

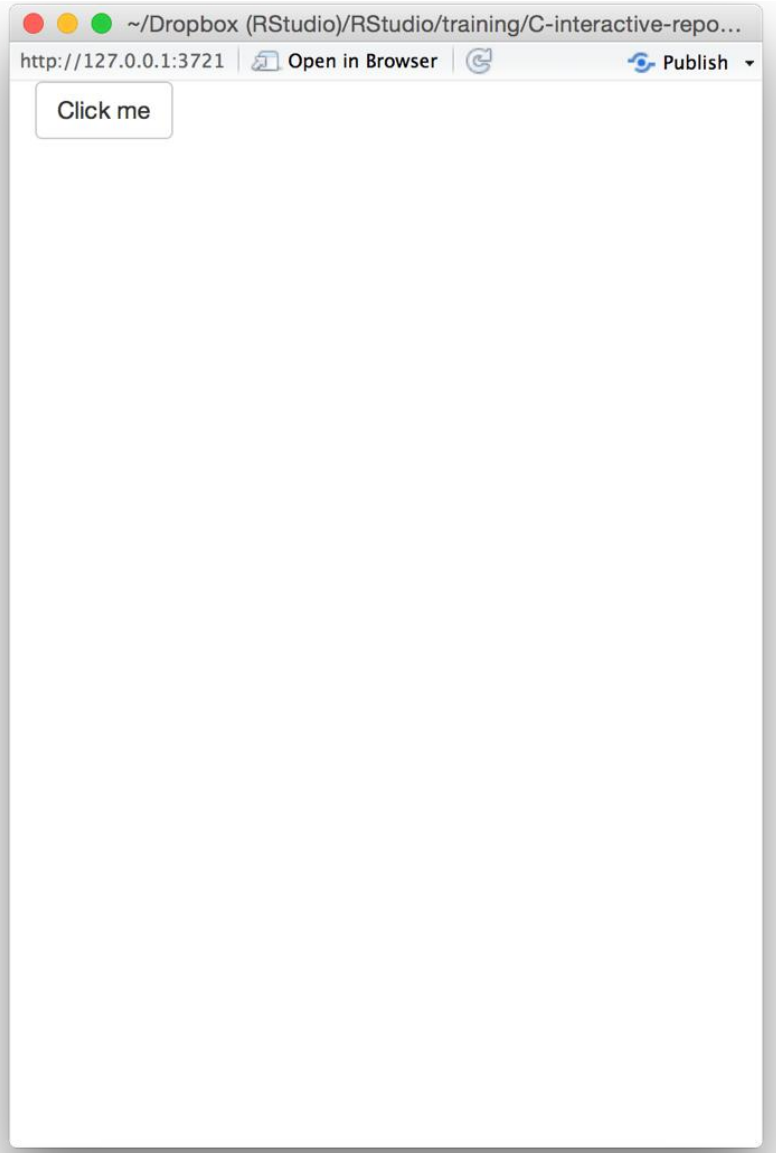
```
# 05-actionButton

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)
```



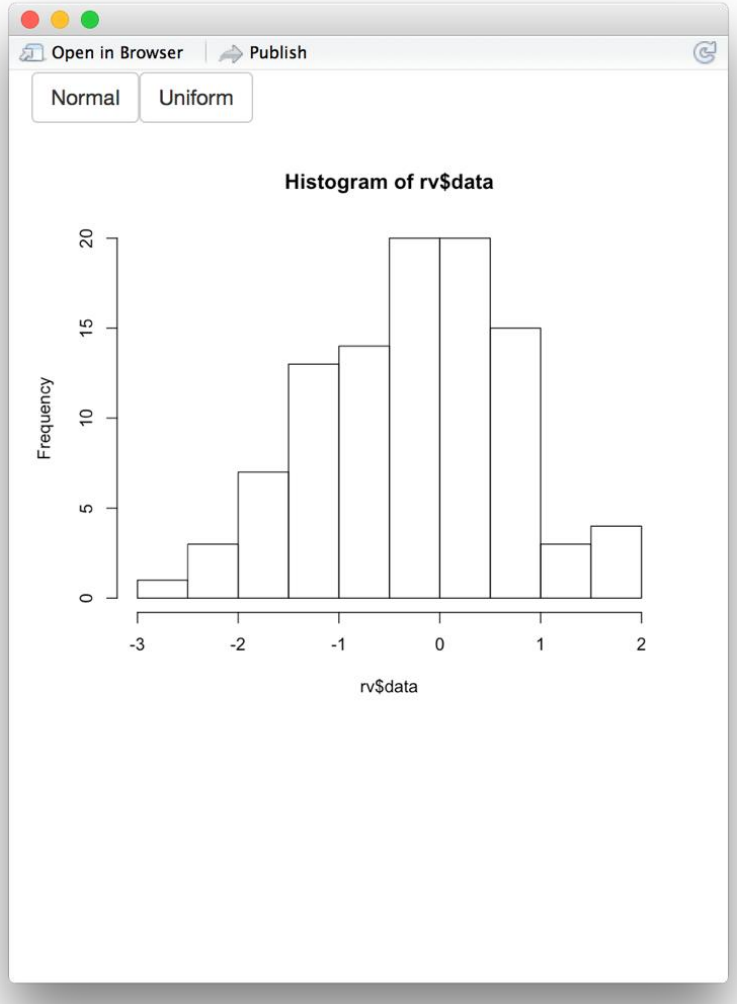
reactiveValues()

Creates a list of reactive values to manipulate programmatically

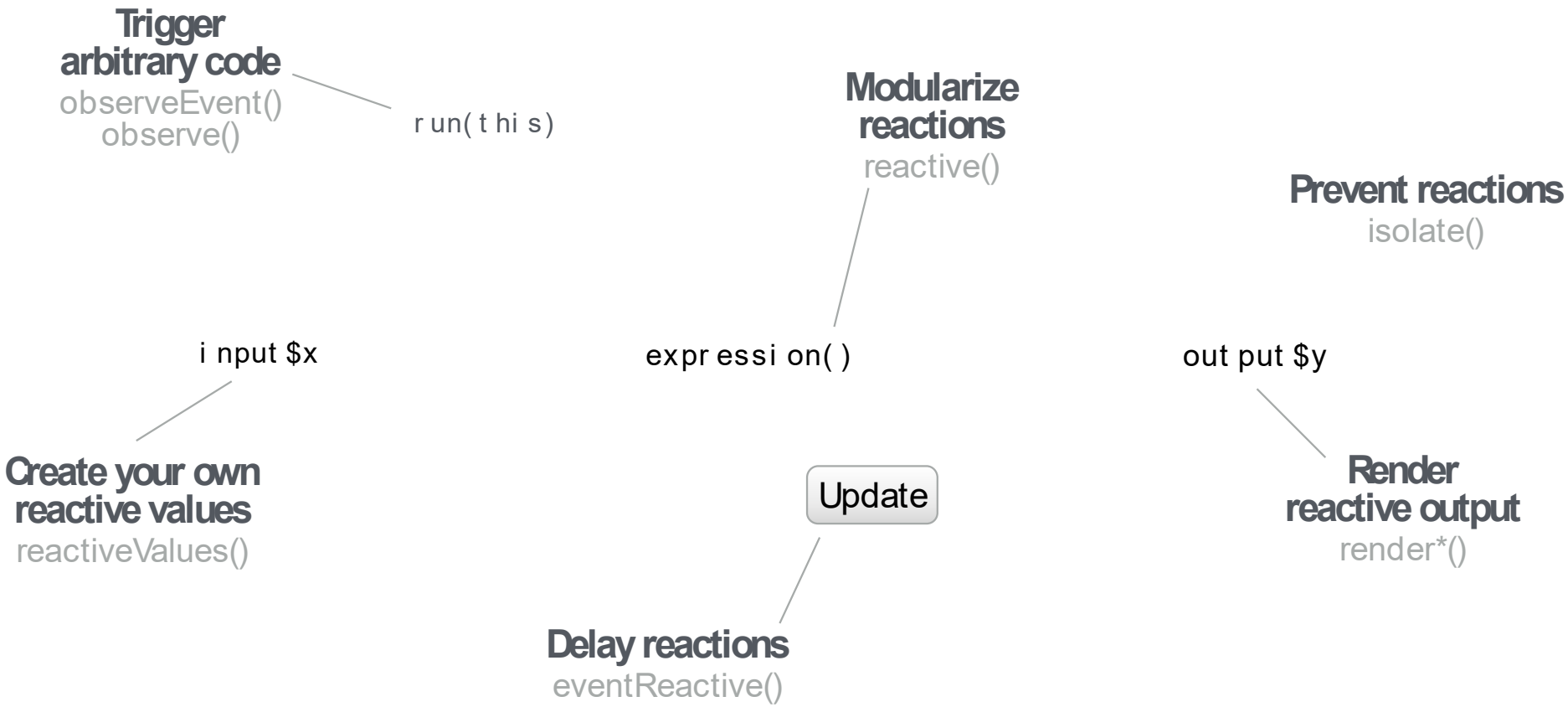
```
rv <- reactiveValues(data = rnorm(100))
```

(optional) elements to add to the list

```r
# 08-reactiveValues

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)
```



Summary


Trigger arbitrary code
observeEvent()
observe()
run(this)
Modularize reactions
reactive()
Prevent reactions
isolate()
input $x
expression()
output $y
Create your own reactive values
reactiveValues()
Update
Render reactive output
render*()
Delay reactions
eventReactive()

Exercise 3

Create an app that looks like this one (minus these instructions), using the sidebarLayout and the iris dataset

1. In the sidebarPanel, create radio buttons to select between sepal length, sepal width, petal length and petal width
2. In the main panel, create a boxplot showing the attribute selected from the radio buttons for the 3 different species.
3. Add a textInput to allow the user to name the plot
4. Show the iris data in table format below the plot
5. In the sidebar, allow the user to select the number of rows to be shown

[Optional]

1. Move the plot and table in to separate tabs
2. Add another tab with a table showing the mean and standard deviation for the selected attribute

The app

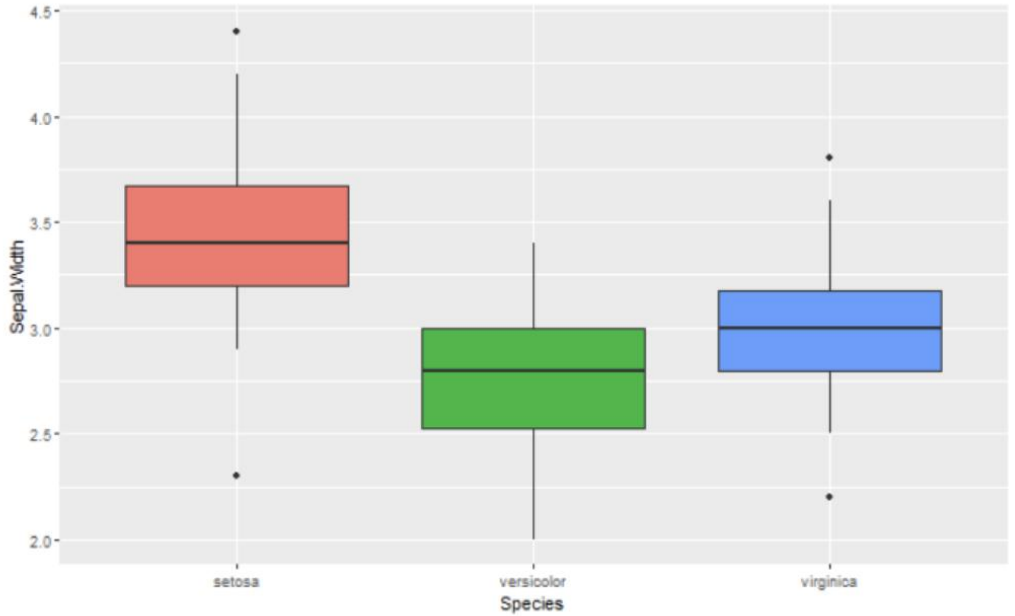
Select attribute to plot

- Sepal.Length
- Sepal.Width
- Petal.Length
- Petal.Width

Enter plot name

Number of rows in table

6



Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.10	3.50	1.40	0.20	setosa
4.90	3.00	1.40	0.20	setosa

Exercise 4

Create an app that looks like this one, it should:

- Import the advs.csv file.
- Provide drop down lists of variables to plot on x and y axes.
- Filter data based on the selected subject and parameter.