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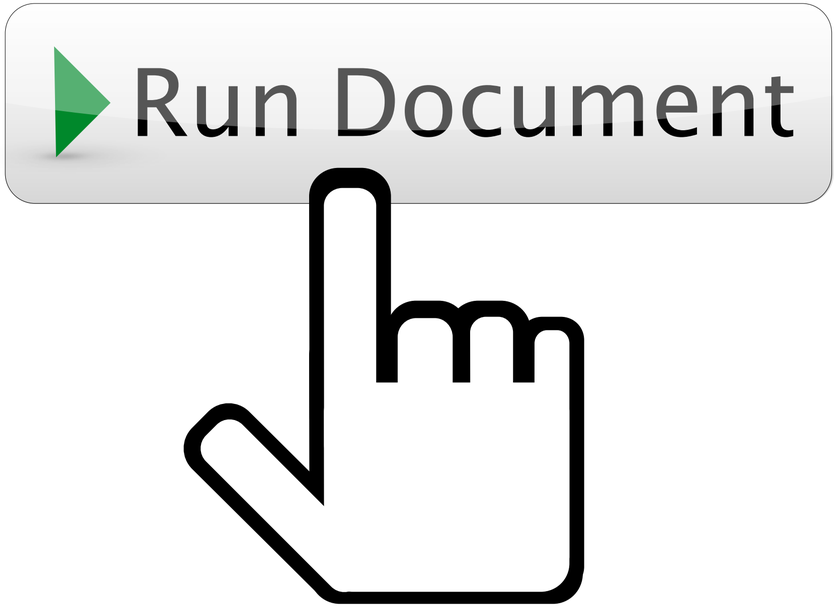
Shiny and R Markdown

Interactive apps and reproducible reports from R



Garrett Grolemund

Data Scientist and Master Instructor
June 2015
Email: garrett@rstudio.com

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R Markdown Resources

File > New File > R Markdown…
http://rmarkdown.rstudio.com/
http://www.rstudio.com/resources/cheatsheets/
http://rmarkdown.rstudio.com/developer_document_templates.html
http://rmarkdown.rstudio.com/developer_parameterized_reports.html

htmlwidgets Resources

htmlwidgets.org
http://www.htmlwidgets.org/showcase_leaflet.html

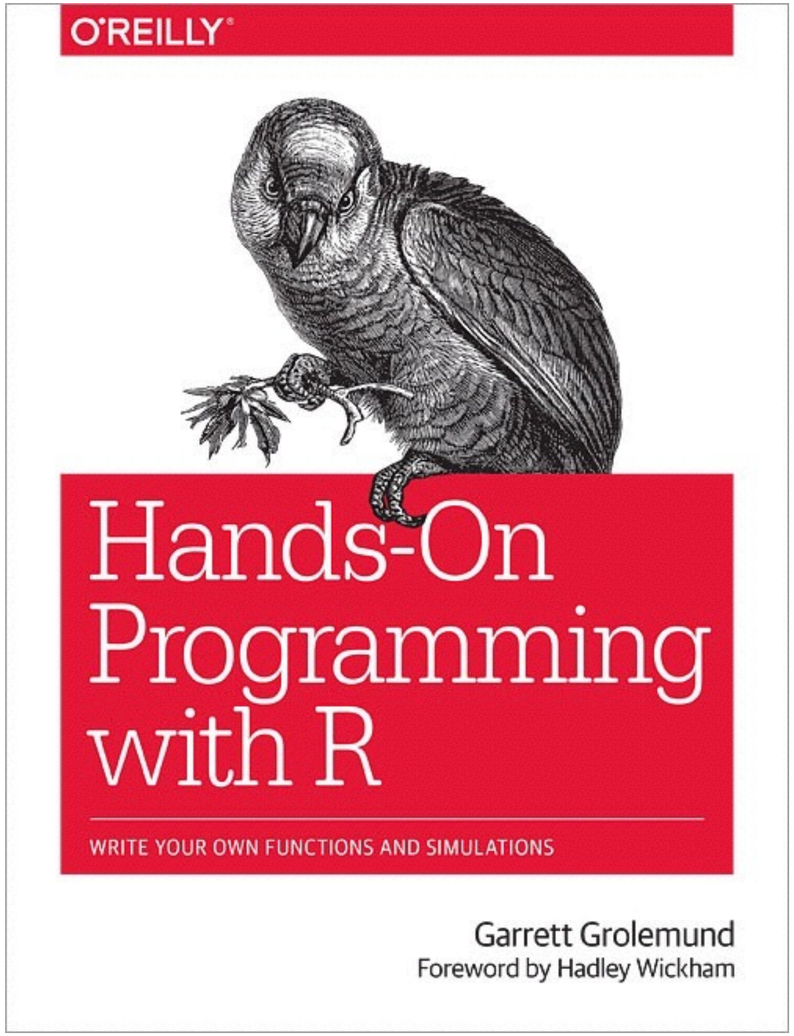
Shiny Resources

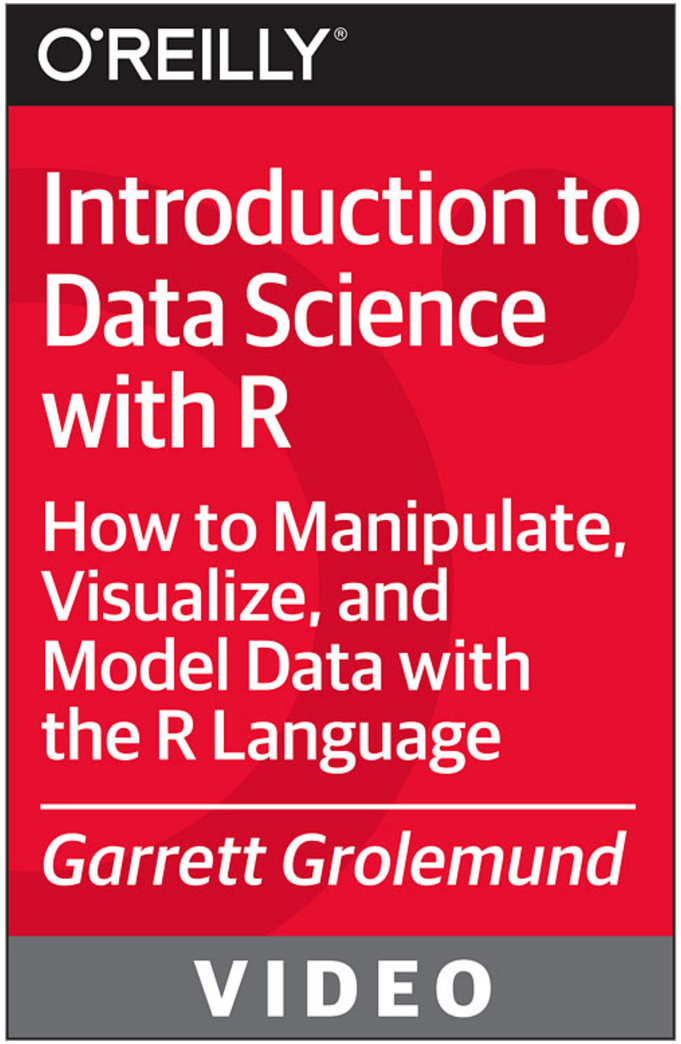
shiny.rstudio.com/articles
shiny.rstudio.com/tutorial
http://www.rstudio.com/resources/cheatsheets/

Shiny Demos

http://www.rstudio.com/products/shiny/shiny-user-showcase/
http://shiny.rstudio.com/gallery/

http://webpopix.org:8080/dashboard/absorption/
http://shiny.rstudio.com/gallery/widget-gallery.html
http://rstudio.github.io/shinydashboard/
https://gallery.shinyapps.io/marketing/
https://gallery.shinyapps.io/LDAelife/
http://shiny.rstudio.com/gallery/superzip-example.html
https://gallery.shinyapps.io/EDsimulation/
http://shiny.rstudio.com/articles/#interactive-plots
http://shiny.rstudio.com/gallery/authentication-and-database.html
https://gallery.shinyapps.io/ga-effect/
http://gallery.shinyapps.io/087-crandash





DataCamp

- Reporting with R Markdown
- Data Visualization in R with ggvis
- Data Manipulation in R with dplyr

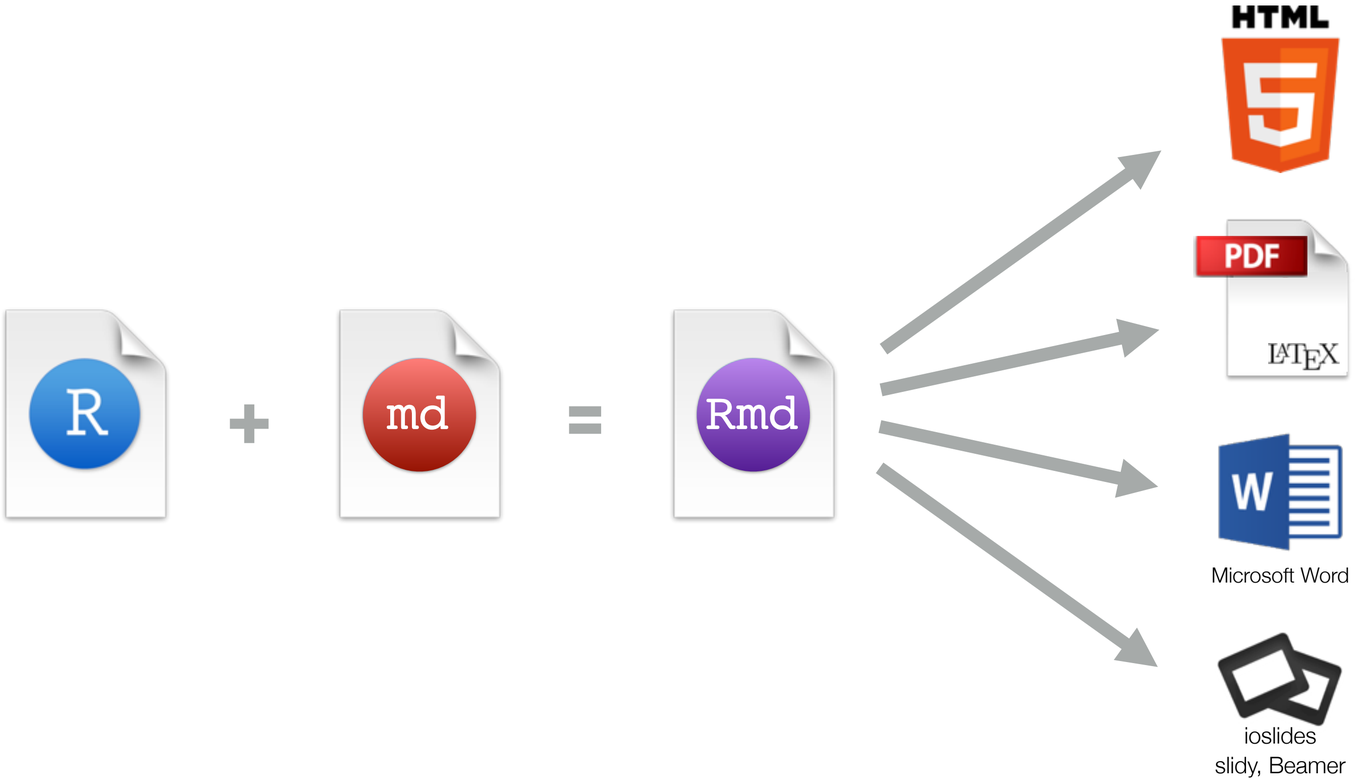
R Markdown

Can we do better?

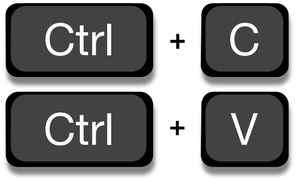
Ctrl + C (Copy)

Ctrl + V (Paste)

R Markdown

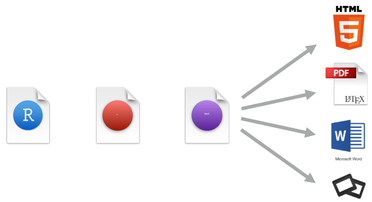


Recap: R Markdown

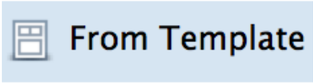


Reproducible

Automatic



Flexible



Reusable

```
params:
```

Parameterizable

Teach yourself R Markdown

The R Markdown Development Center

rmarkdown.rstudio.com

R Markdown — Dynamic D ×

Garrett

rmarkdown.rstudio.com

R Markdown v2 Home Authoring Formats Developer

R Markdown — Dynamic Documents for R

R Markdown is an authoring format that enables easy creation of dynamic documents, presentations, and reports from R. It combines the core syntax of markdown (an easy-to-write plain text format) with embedded R code chunks that are run so their output can be included in the final document. R Markdown documents are fully *reproducible* (they can be automatically regenerated whenever underlying R code or data changes).

This website describes R Markdown v2, a next generation implementation of R Markdown based on knitr and pandoc. This implementation brings many enhancements to R Markdown, including:

- Many available output formats including HTML, PDF, and MS Word.
- Support for creating Beamer, ioslides, and Slidy presentations.
- New markdown syntax including expanded support for tables and bibliographies.
- Hooks for customizing HTML and PDF output (include CSS, headers, and footers).
- Include raw LaTeX within markdown for advanced customization of PDF output.
- Compile HTML, PDF, or MS Word notebooks from R scripts.
- Extensiblity: create custom templates and even entirely new output formats.
- Create interactive R Markdown documents using Shiny.

Note that PDF output (including Beamer slides) requires an installation of TeX.

Quick Tour

Installation

You can install the R Markdown package from CRAN as follows:

```
install.packages("rmarkdown")
```

The R Markdown Reference Guide

www.rstudio.com/resources/cheatsheets/

R Markdown Reference Guide

Learn more about R Markdown at rmarkdown.rstudio.com
Learn more about Interactive Docs at shiny.rstudio.com/articles

Contents:

Syntax	Becomes

Make a code chunk with three back ticks followed by an r in braces. End the chunk with three back ticks:
``{r}
paste("Hello", "World!")
``
	Make a code chunk with three back ticks followed by an r in braces. End the chunk with three back ticks:
	`paste("Hello", "World!")`
	`## [1] "Hello World!"`

Place code inline with a single back ticks. The first back tick must be followed by an R, like this `r paste("Hello", "World!")`.	Place code inline with a single back ticks. The first back tick must be followed by an R, like this Hello World!.

Add chunk options within braces. For example, `echo=FALSE` will prevent source code from being displayed:
``{r eval=TRUE, echo=FALSE}
paste("Hello", "World!")
``
	Add chunk options within braces. For example, `echo=FALSE` will prevent source code from being displayed:
	`## [1] "Hello World!"`

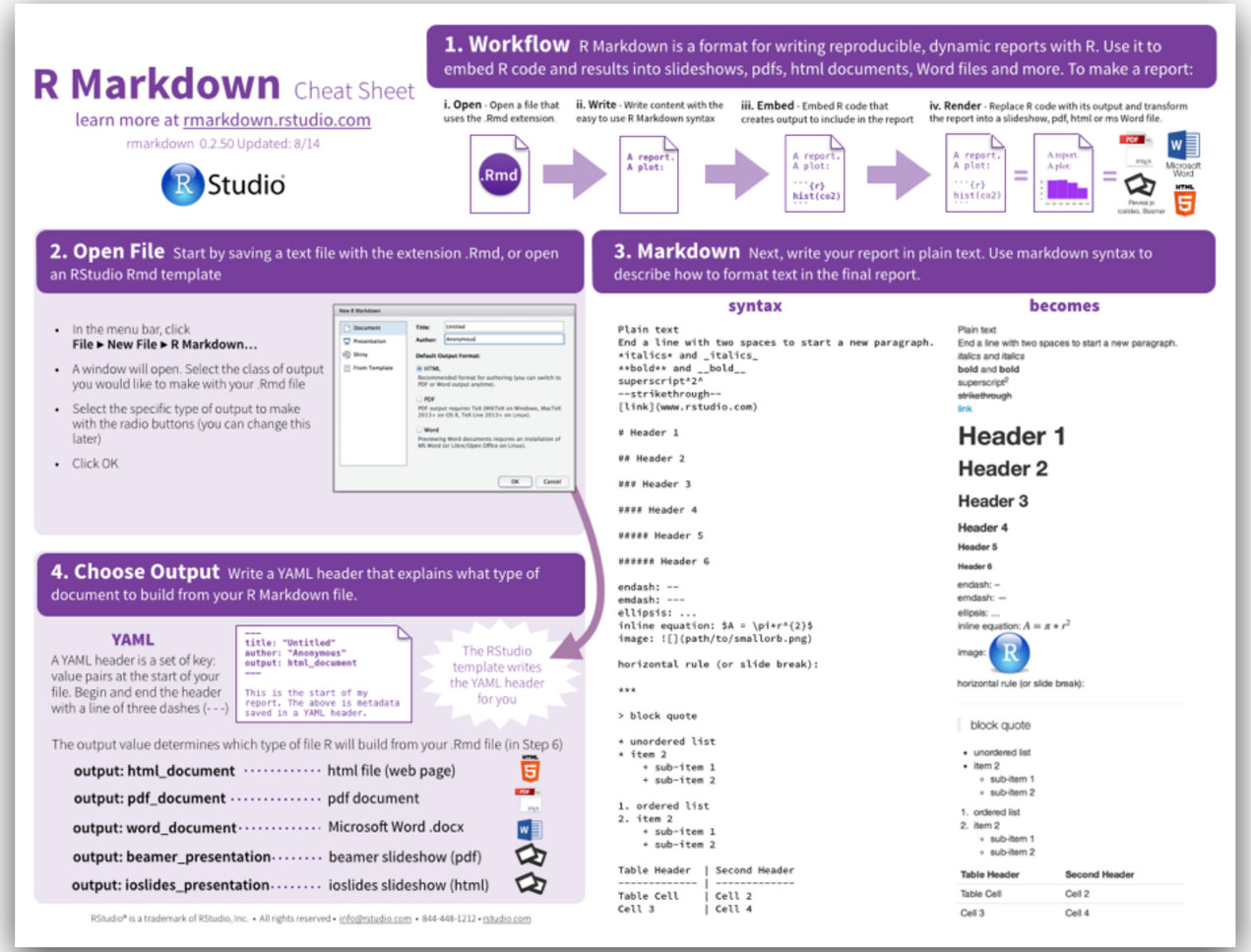
Learn more about chunk options at http://yihui.name/knitr/options

Chunk options

option	default value	description
Code evaluation		
child	NULL	A character vector of filenames. Knitr will knit the files and place them into the main document.
code	NULL	Set to R code. Knitr will replace the code in the chunk with the code in the code option.
engine	'R'	Knitr will evaluate the chunk in the named language, e.g. **engine = 'python'**. Run **names(knitr::knit_engines$get())** to see supported languages.
eval	TRUE	If **FALSE**, knitr will not run the code in the code chunk.
include	TRUE	If **FALSE**, knitr will run the chunk but not include the chunk in the final document.
purl	TRUE	If **FALSE**, knitr will not include the chunk when running **purl()** to extract the source code.
Results		
collapse	FALSE	If **TRUE**, knitr will collapse all the source and output blocks created by the chunk into a single block.
echo	TRUE	If **FALSE**, knitr will not display the code in the code chunk above it's results in the final document.
		If **'hide'**, knitr will not display the code's results in the final document. If **'hold'**, knitr will delay displaying all output

The R Markdown Cheat Sheet

www.rstudio.com/resources/cheatsheets/



R Markdown Cheat Sheet

learn more at rmarkdown.rstudio.com

rmarkdown 0.2.50 Updated: 8/14

RStudio

1. Workflow

R Markdown is a format for writing reproducible, dynamic reports with R. Use it to embed R code and results into slideshows, pdfs, html documents, Word files and more. To make a report:

i. Open - Open a file that uses the .Rmd extension.

ii. Write - Write content with the easy to use R Markdown syntax

iii. Embed - Embed R code that creates output to include in the report

iv. Render - Replace R code with its output and transform the report into a slideshow, pdf, html or ms Word file.

2. Open File

Start by saving a text file with the extension .Rmd, or open an RStudio Rmd template

- In the menu bar, click **File ▸ New File ▸ R Markdown...**
- A window will open. Select the class of output you would like to make with your .Rmd file
- Select the specific type of output to make with the radio buttons (you can change this later)
- Click OK

3. Markdown

Next, write your report in plain text. Use markdown syntax to describe how to format text in the final report.

syntax

```
Plain text
End a line with two spaces to start a new paragraph.
*italics* and _italics_
**bold** and __bold__
superscript^2^
~~strikethrough~~
[link](www.rstudio.com)

# Header 1

## Header 2

### Header 3

#### Header 4

##### Header 5

###### Header 6

endash: --
emdash: ---
ellipsis: ...
inline equation: $A = \pi*r^{2}$
image: ![](path/to/smallorb.png)

horizontal rule (or slide break):

***

> block quote

* unordered list
* item 2
    + sub-item 1
    + sub-item 2

1. ordered list
2. item 2
    + sub-item 1
    + sub-item 2

Table Header  | Second Header
------------- | -------------
Table Cell    | Cell 2
Cell 3        | Cell 4
```

becomes

Plain text
End a line with two spaces to start a new paragraph.
italics and *italics*
bold and **bold**
superscript^2
~~strikethrough~~
link

Header 1
Header 2
Header 3
Header 4
Header 5
Header 6

endash: –
emdash: —
ellipsis: ...
inline equation: $A = \pi * r^2$
image:
horizontal rule (or slide break):

> block quote

- unordered list
- item 2
  - sub-item 1
  - sub-item 2

1. ordered list
2. item 2
   - sub-item 1
   - sub-item 2

Table Header	Second Header
Table Cell	Cell 2
Cell 3	Cell 4

4. Choose Output

Write a YAML header that explains what type of document to build from your R Markdown file.

YAML

A YAML header is a set of key: value pairs at the start of your file. Begin and end the header with a line of three dashes (- - -)

```
---
title: "Untitled"
author: "Anonymous"
output: html_document
---

This is the start of my
report. The above is metadata
saved in a YAML header.
```

The RStudio template writes the YAML header for you

The output value determines which type of file R will build from your .Rmd file (in Step 6)

- **output: html_document** ····· html file (web page)
- **output: pdf_document** ····· pdf document
- **output: word_document** ····· Microsoft Word .docx
- **output: beamer_presentation** ····· beamer slideshow (pdf)
- **output: ioslides_presentation** ····· ioslides slideshow (html)

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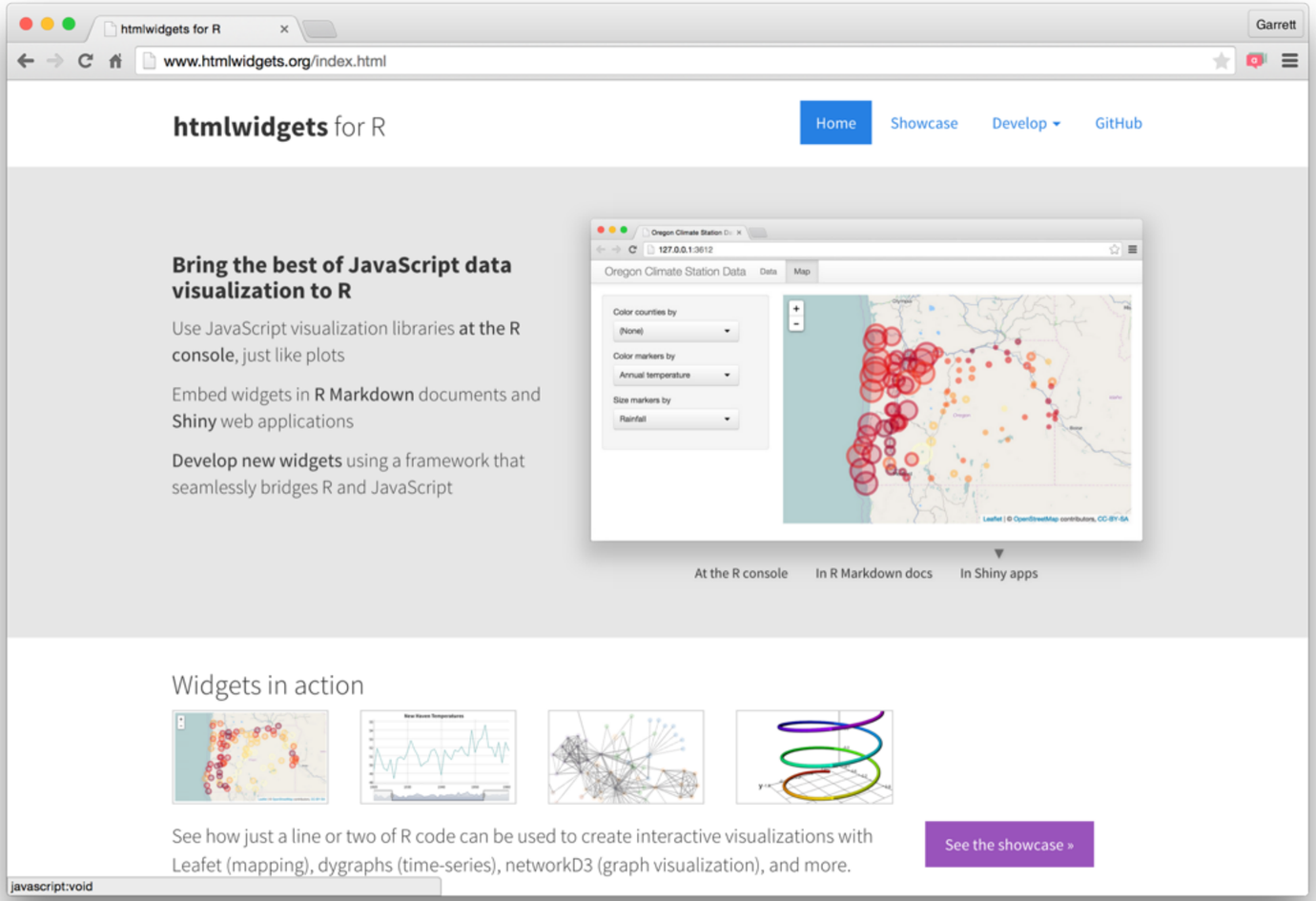
htmlwidgets

htmlwidgets

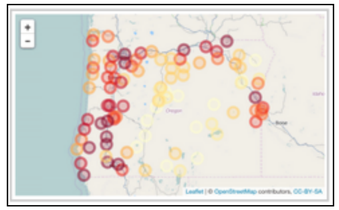
Use htmlwidgets in:

- RStudio viewer pane
- R Markdown files
- Shiny Apps

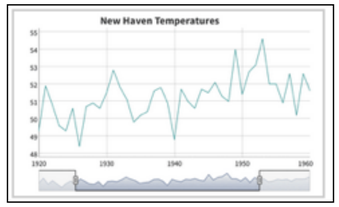
www.htmlwidgets.org



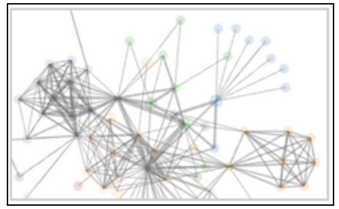
Packages with ready-to-use htmlwidgets:



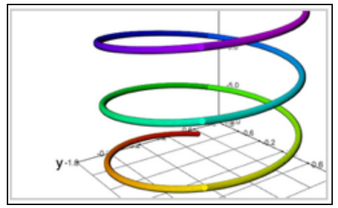
Leaflet - Interactive maps
rstudio.github.io/leaflet/



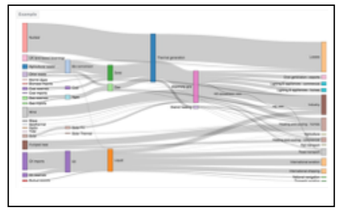
dygraphs - Time series
rstudio.github.io/dygraphs



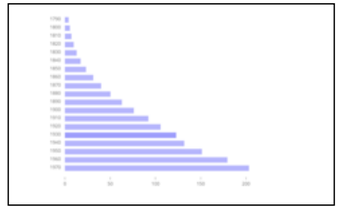
networkD3 - network graphs
christophergandrud.github.io/networkD3/



threejs - 3D charts
github.com/bwlewis/rthreejs

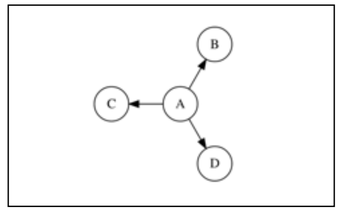


rCharts - Various charts
rCharts.io



MetricsGraphics - d3 charts
hrbrmstr.github.io/metricsgraphics/

DT - Data tables
rstudio.github.io/DT/

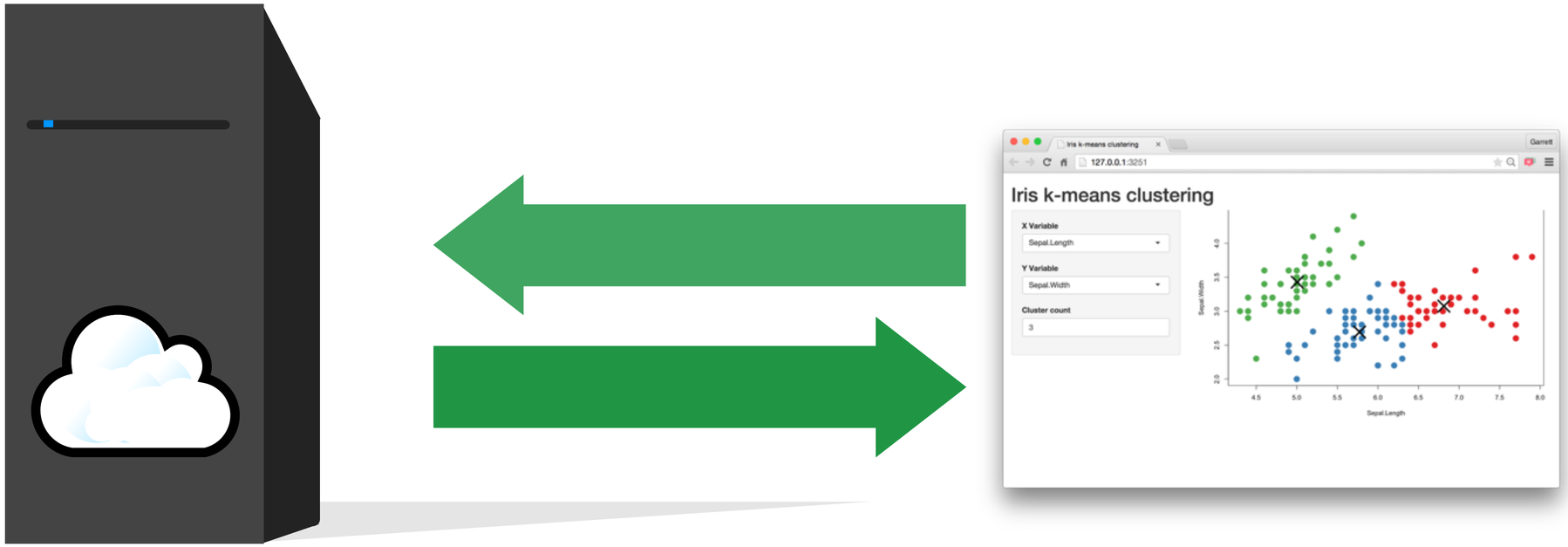


Diagrammer - Diagrams
rich-iannone.github.io/DiagrammeR/

Shiny

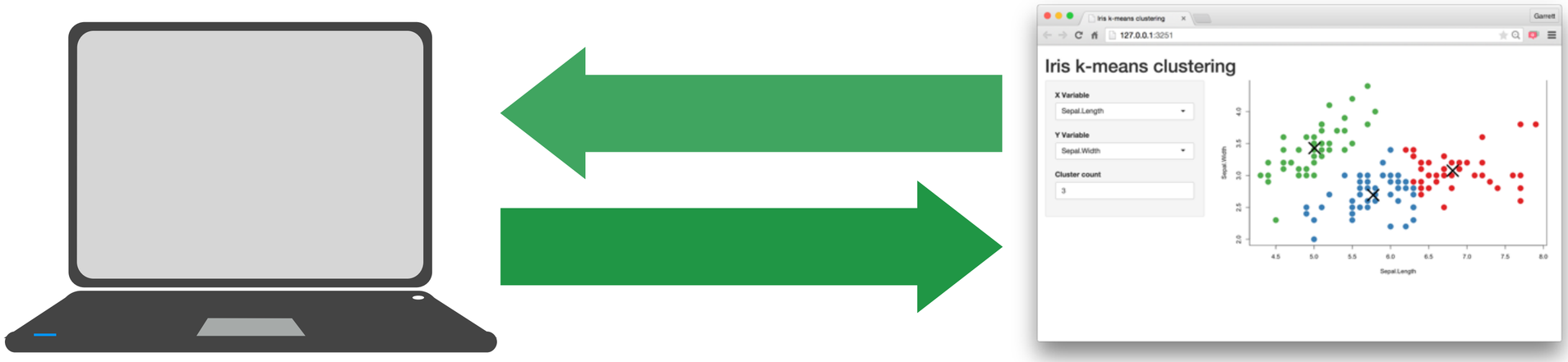
Shiny

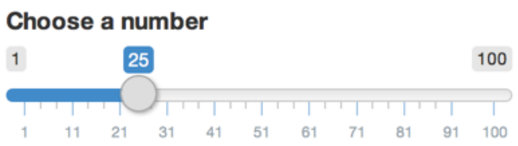
Every Shiny app is maintained by a computer running R

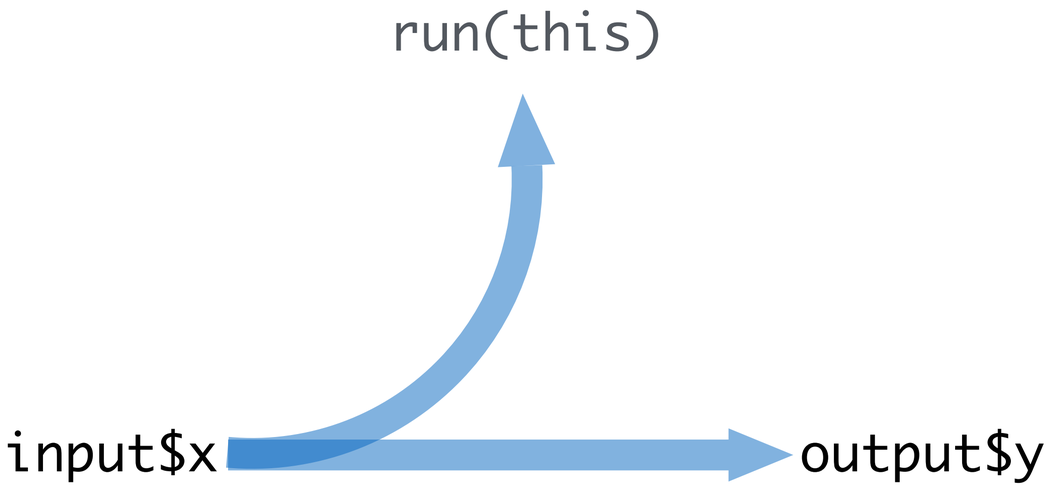


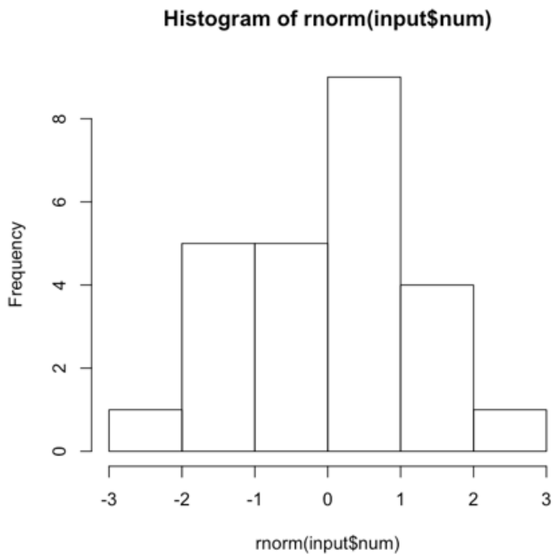
How to make an app

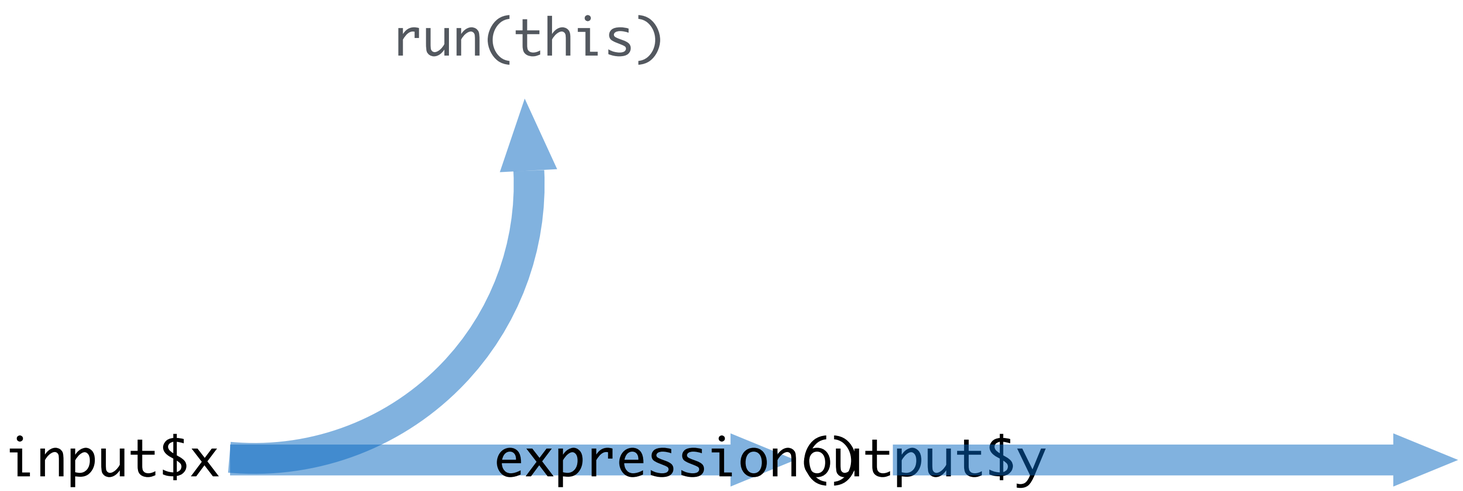
Every Shiny app is maintained by a computer running R

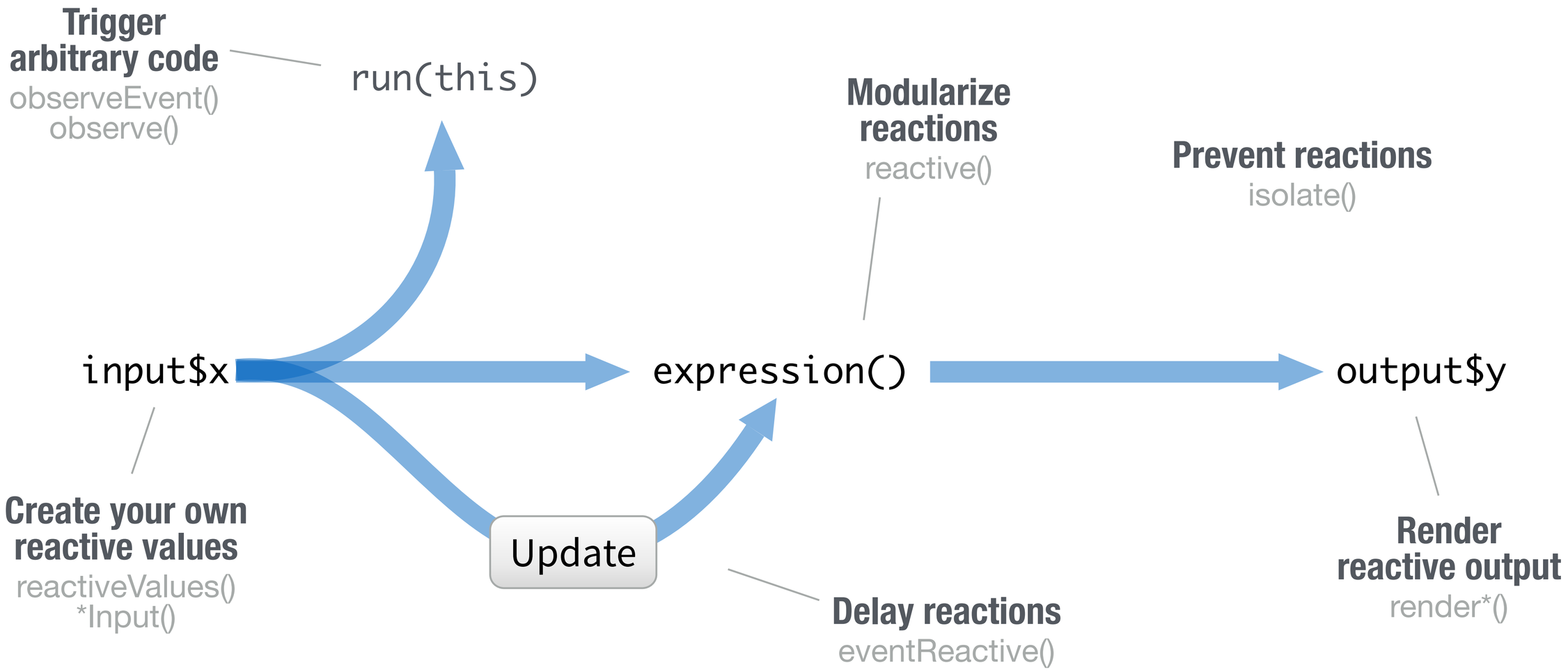










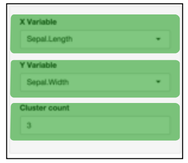


Recap: UI

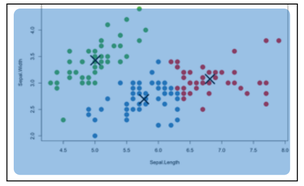
```
library(shiny)
ui <- fluidPage()
server <- function(input, output) {}
shinyApp(ui = ui, server = server)
```

Begin each app with the template

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



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



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

Recap: Server

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

`output$hist <-`

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

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

2. Build the output with a **render*()** function

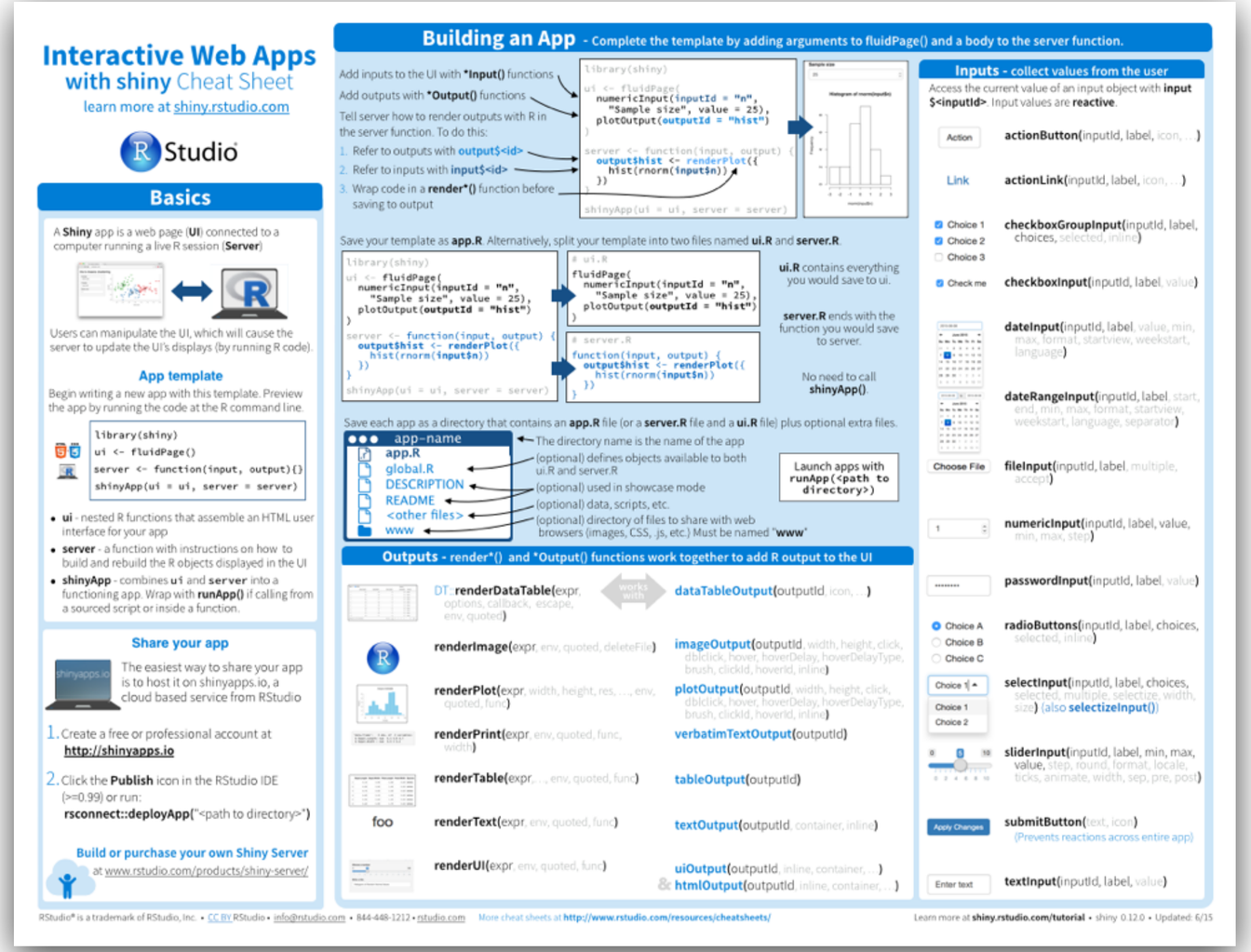
`input$num`

3. Access input values with **input$**

Teach yourself Shiny

The Shiny Cheat Sheet

www.rstudio.com/resources/cheatsheets/



Interactive Web Apps with shiny Cheat Sheet

learn more at shiny.rstudio.com

RStudio

Basics

A **Shiny** app is a web page (**UI**) connected to a computer running a live R session (**Server**)

Users can manipulate the UI, which will cause the server to update the UI's displays (by running R code).

App template

Begin writing a new app with this template. Preview the app by running the code at the R command line.

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

- **ui** - nested R functions that assemble an HTML user interface for your app
- **server** - a function with instructions on how to build and rebuild the R objects displayed in the UI
- **shinyApp** - combines **ui** and **server** into a functioning app. Wrap with **runApp()** if calling from a sourced script or inside a function.

Share your app

The easiest way to share your app is to host it on shinyapps.io, a cloud based service from RStudio

1. Create a free or professional account at **http://shinyapps.io**
2. Click the **Publish** icon in the RStudio IDE (>=0.99) or run: **rsconnect::deployApp("<path to directory>")**

Build or purchase your own Shiny Server at www.rstudio.com/products/shiny-server/

Building an App - Complete the template by adding arguments to fluidPage() and a body to the server function.

Add inputs to the UI with ***Input()** functions

Add outputs with ***Output()** functions

Tell server how to render outputs with R in the server function. To do this:

1. Refer to outputs with **output$<id>**
2. Refer to inputs with **input$<id>**
3. Wrap code in a **render*()** function before saving to output

```
library(shiny)
ui <- fluidPage(
  numericInput(inputId = "n",
    "Sample size", value = 25),
  plotOutput(outputId = "hist")
)
server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$n))
  })
}
shinyApp(ui = ui, server = server)
```

Save your template as **app.R**. Alternatively, split your template into two files named **ui.R** and **server.R**.

```
library(shiny)
ui <- fluidPage(
  numericInput(inputId = "n",
    "Sample size", value = 25),
  plotOutput(outputId = "hist")
)
server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$n))
  })
}
shinyApp(ui = ui, server = server)
```

```
# ui.R
fluidPage(
  numericInput(inputId = "n",
    "Sample size", value = 25),
  plotOutput(outputId = "hist")
)
```

ui.R contains everything you would save to ui.

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

server.R ends with the function you would save to server.

No need to call **shinyApp()**.

Save each app as a directory that contains an **app.R** file (or a **server.R** file and a **ui.R** file) plus optional extra files.

- app-name
  - app.R
  - global.R — (optional) defines objects available to both ui.R and server.R
  - DESCRIPTION — (optional) used in showcase mode
  - README — (optional) data, scripts, etc.
  - <other files> — (optional) directory of files to share with web browsers (images, CSS, .js, etc.) Must be named "**www**"
  - www

The directory name is the name of the app

Launch apps with `runApp(<path to directory>)`

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)
foo	**renderText**(expr, env, quoted, func)	**textOutput**(outputId, container, inline)
	renderUI(expr, env, quoted, func)	**uiOutput**(outputId, inline, container, ...) & **htmlOutput**(outputId, inline, container, ...)

Inputs - collect values from the user

Access the current value of an input object with **input $<inputId>**. Input values are **reactive**.

Action	**actionButton**(inputId, label, icon, ...)
Link	**actionLink**(inputId, label, icon, ...)
Choice 1, Choice 2, Choice 3	**checkboxGroupInput**(inputId, label, choices, selected, inline)
Check me	**checkboxInput**(inputId, label, value)
	dateInput(inputId, label, value, min, max, format, startview, weekstart, language)
	dateRangeInput(inputId, label, start, end, min, max, format, startview, weekstart, language, separator)
Choose File	**fileInput**(inputId, label, multiple, accept)
1	**numericInput**(inputId, label, value, min, max, step)
•••••••	**passwordInput**(inputId, label, value)
Choice A, Choice B, Choice C	**radioButtons**(inputId, label, choices, selected, inline)
Choice 1, Choice 1, Choice 2	**selectInput**(inputId, label, choices, selected, multiple, selectize, width, size) (also **selectizeInput()**)
0, 5, 10	**sliderInput**(inputId, label, min, max, value, step, round, format, locale, ticks, animate, width, sep, pre, post)
Apply Changes	**submitButton**(text, icon) (Prevents reactions across entire app)
Enter text	**textInput**(inputId, label, value)

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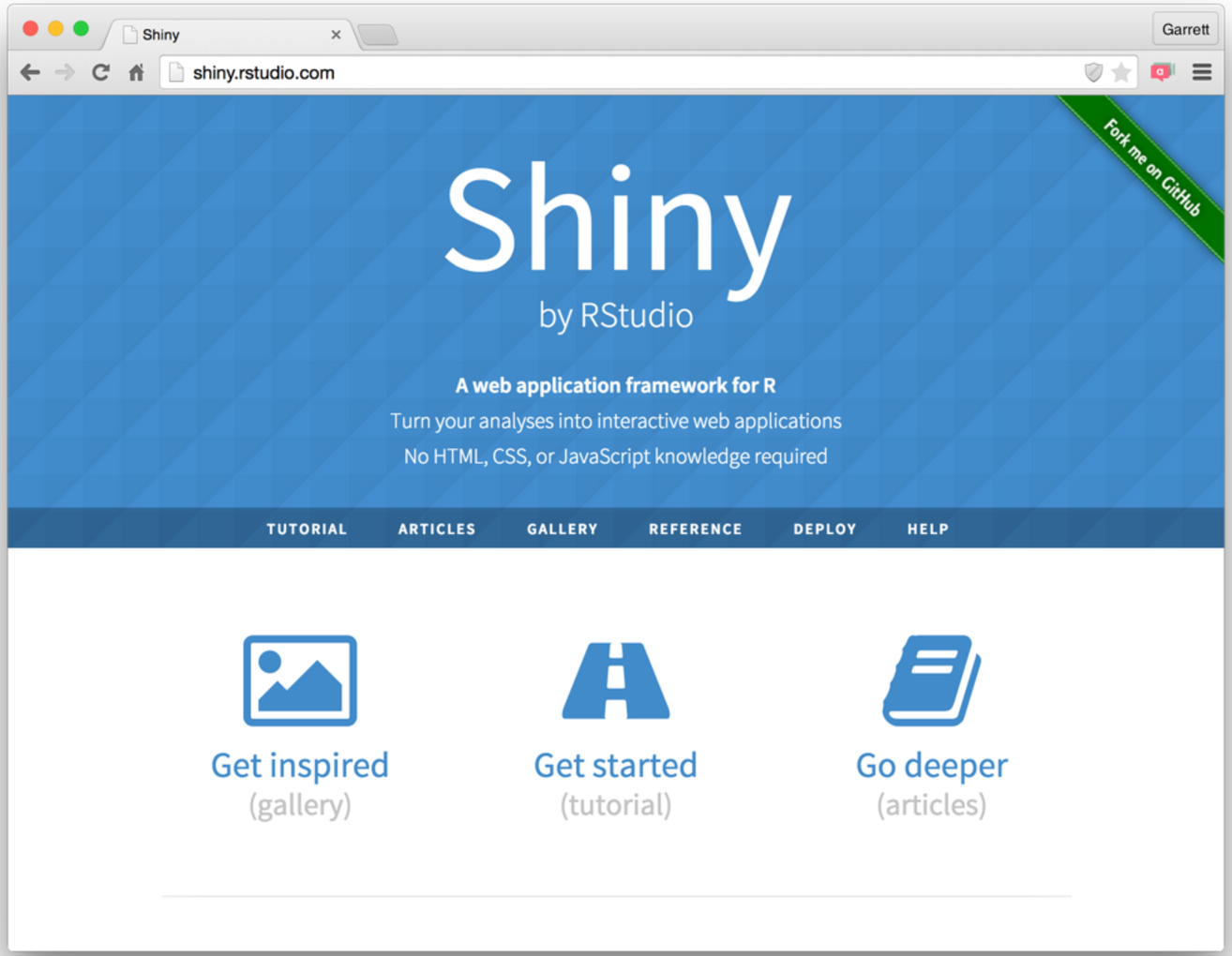
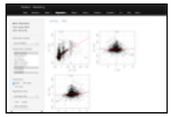
The Shiny Development Center

shiny.rstudio.com



What can an app do?

What can a Shiny app do?



Make R analysis accessible to **non-programmers**

Highly **customizable**, highly **shareable** HTML front end

Read and write to **databases**

Monitor **streaming data**

Require and use **authentication**

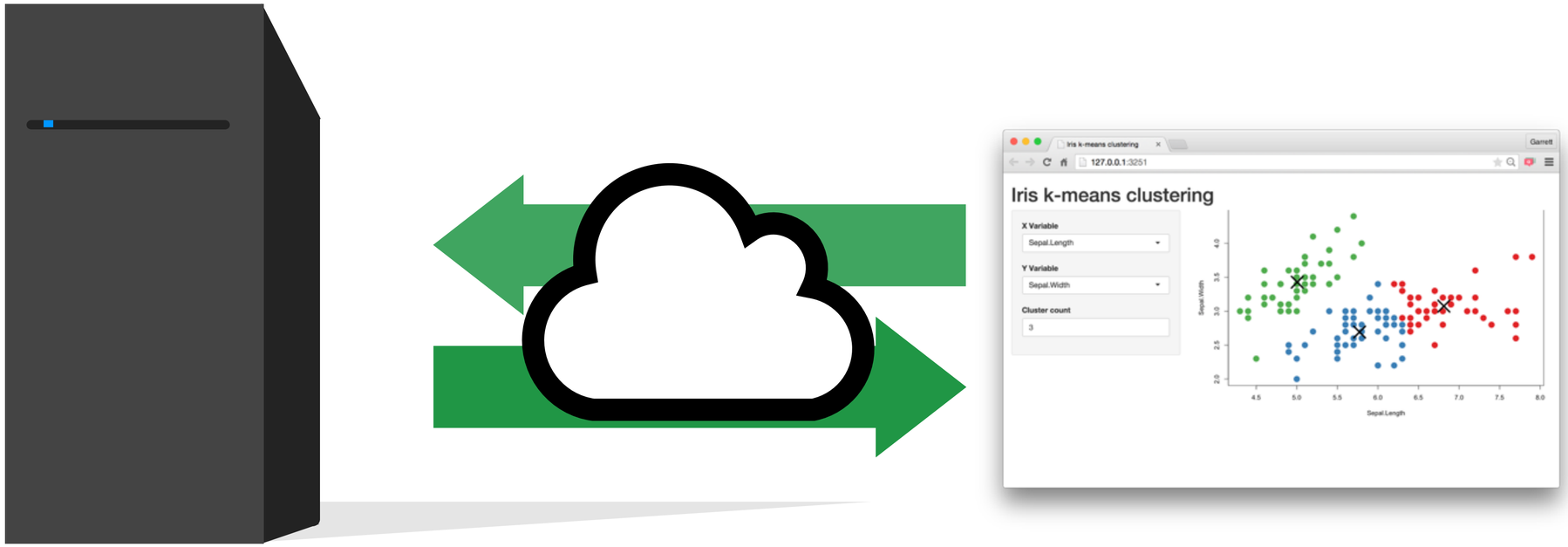
Ideal for Exploratory Data Analysis

Ideal Data Portal / Results Explorer / Simulation API / Dashboard

Share

your app

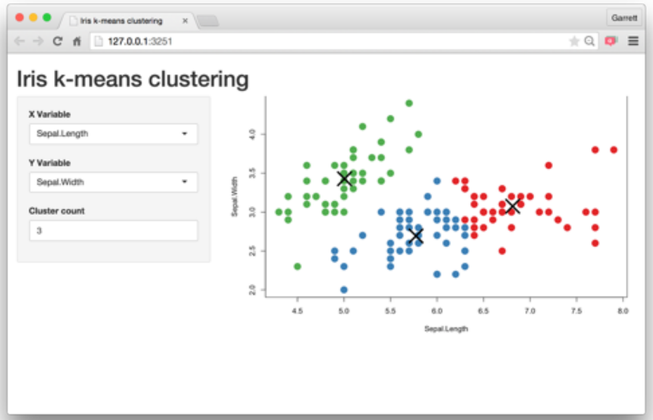
Every Shiny app is maintained by a computer running R



Shinyapps.io

A server maintained by RStudio

- free
- easy to use
- secure
- scalable

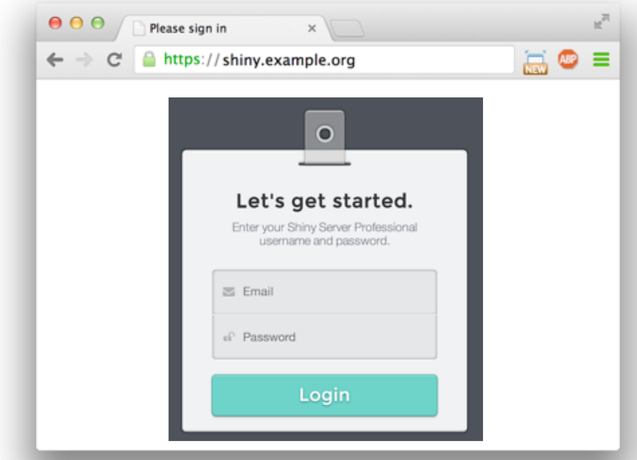


Build your own server

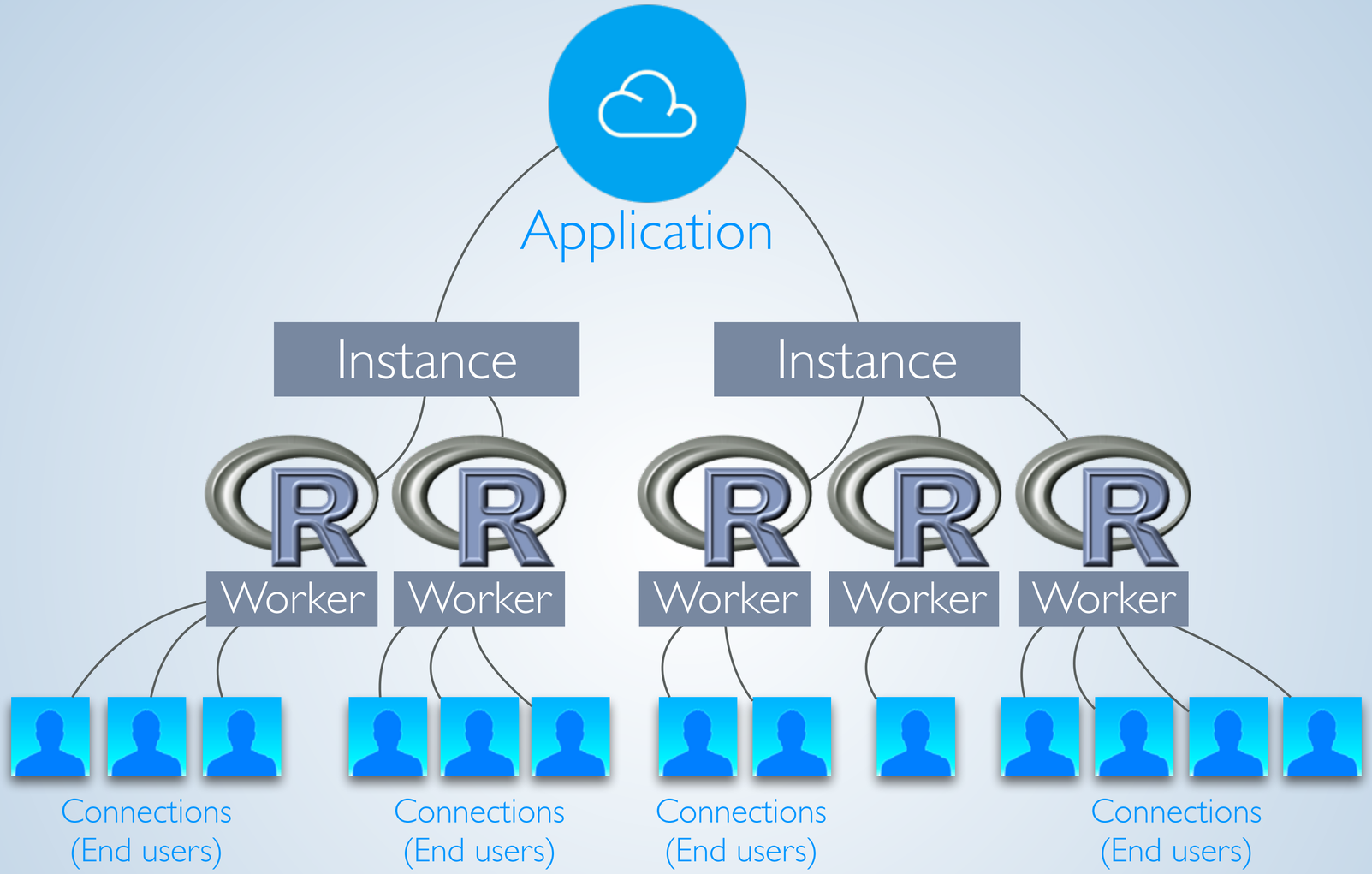
Shiny Server **Pro**

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

- ✔ **Secure access** - LDAP, GoogleAuth, SSL, and more
- ✔ **Performance** - fine tune at app and server level
- ✔ **Management** - monitor and control resource use
- ✔ **Support** - direct priority support



45 day evaluation free trial


Application
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Connections
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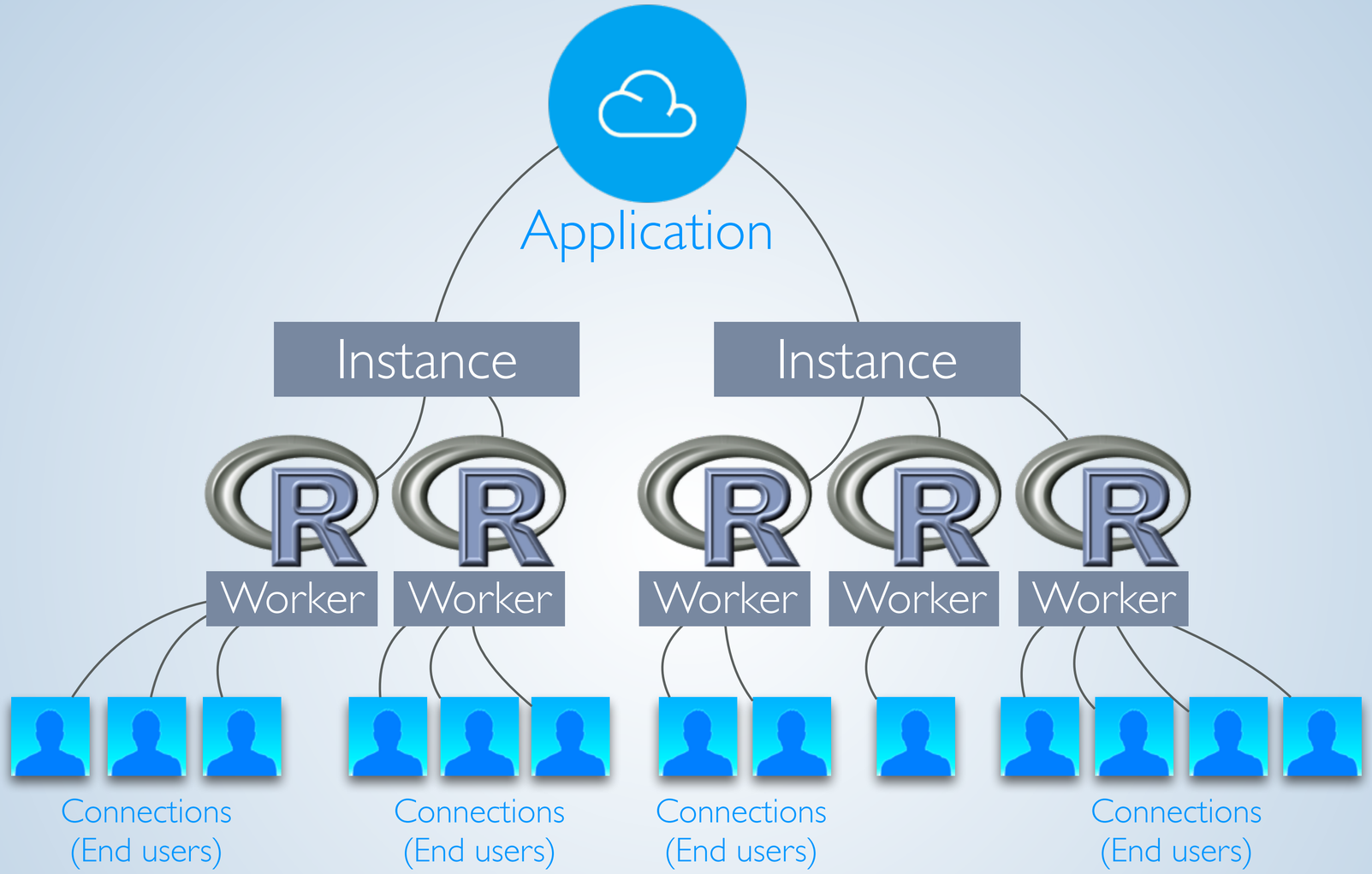
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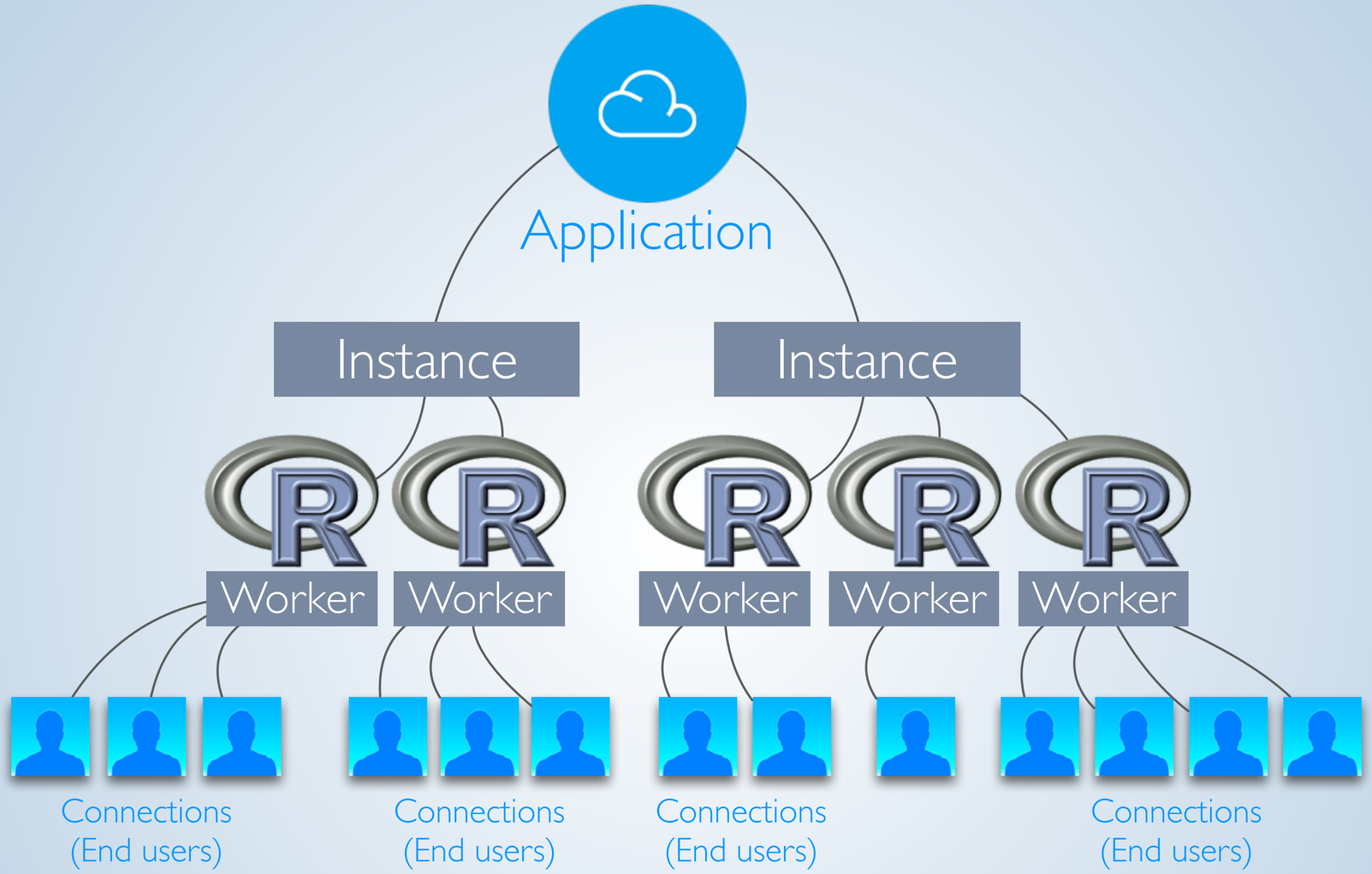
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Connections
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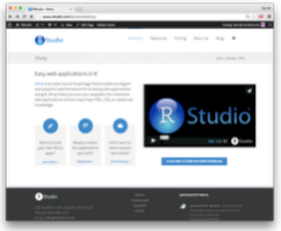
Useful websites

The Shiny development center:
shiny.rstudio.com

The R Markdown development center:
rmarkdown.rstudio.com

Shiny and R Markdown cheat sheets:
www.rstudio.com/resources/cheatsheets



RStudio products:
www.rstudio.com/products/shiny