Strata+ Hadoop WORLD

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RStudio

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#StrataHadoop

Reproducible Reports with Big Data

One format to rule them all

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Follow @rstudio

Stock symbol: FB

Recommendation: BUY

FB will increase in price during the next trading period.

Price History

The price of FB has increased in recent years.

The chart below is made with the quantmod R package, a widely used package for collecting and visualizing financial data in R. You can learn more about quantmod at the website www.quantmod.com.

Method

This forecast was predicted with the *recency algorithm*, a simple---probably useless---method for determining stock prices. The recency algorithm predicts that the next price movement, M_j, will be in the same direction as the most recent price movement, M_i, where $M_i = Close_i - Open_i$.

Raw Data

The table below displays the daily price data for FB.

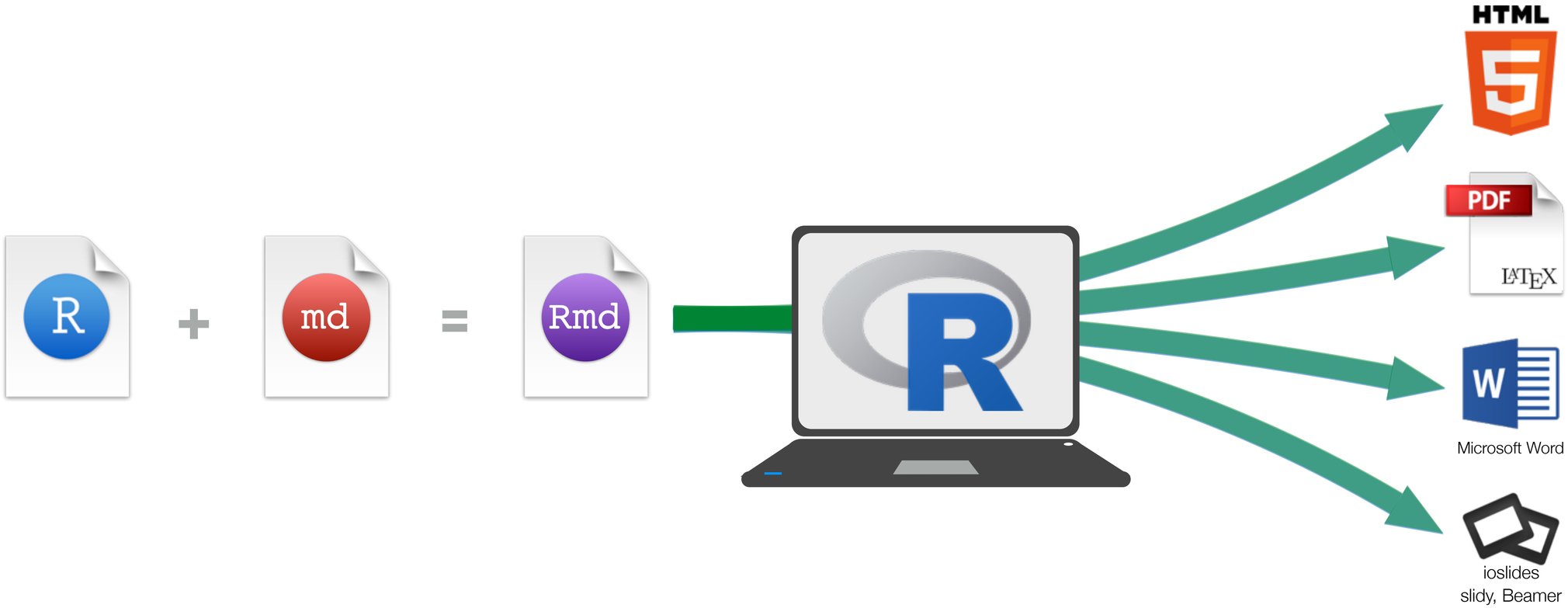
	FB.Open	FB.High	FB.Low	FB.Close
2012-05-18	42.05	45.00	38.00	38.23
2012-05-21	36.53	36.66	33.00	34.03
2012-05-22	32.61	33.59	30.94	31.00
2012-05-23	31.37	32.50	31.36	32.00
2012-05-24	32.95	33.21	31.77	33.03

How can you update the results?

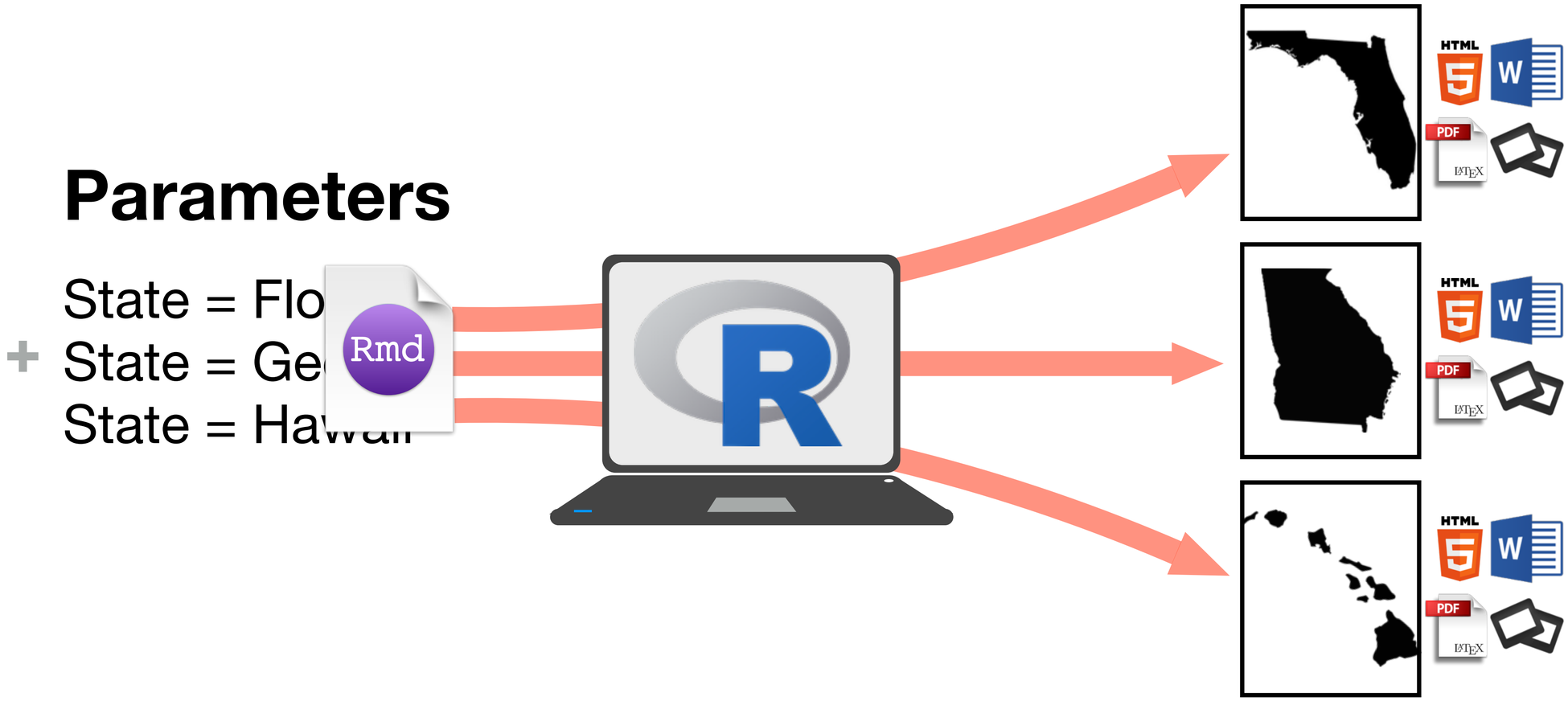
Ctrl + C (Copy)

Ctrl + V (Paste)

R Markdown


R
+
md
=
Rmd
HTML
PDF
LaTeX
W
Microsoft Word
ioslides
slidy, Beamer

R Markdown


Parameters
State = Flo
State = Ge
State = Hawa
Rmd
R
HTML
W
PDF
LaTeX
HTML
W
PDF
LaTeX
HTML
W
PDF
LaTeX

@StatGarrett


RStudio®

Outline

1. **Write** in Markdown
2. **Embed code** with knitr
3. **Parameterize** your report
4. Choose output **format**

Warm Up

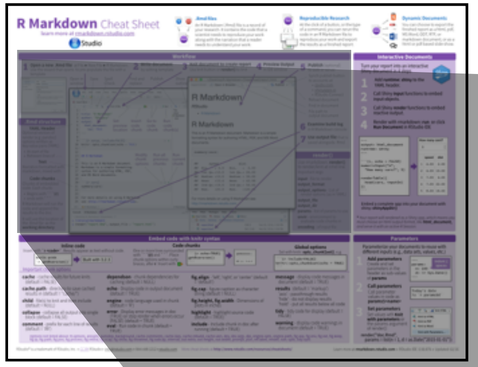
Open the **RMarkdownReports** project. Then open the **demos/01-flights.R** script in your working directory. Run the code and determine what it does.

Orientation

R Markdown Cheatsheet

Help ▶ Cheatsheets ▶ R Markdown Cheatsheet

www.rstudio.com/resources/cheatsheets/



Workflow

1 Open a new .Rmd file at File ▶ New File ▶ R Markdown. Use the wizard that opens to pre-populate the file with a template

2 Write document by editing template

3 Knit document to create report Use knit button or **render()** to knit

4 Preview Output in IDE window

5 Publish (optional) to web or server

Synch publish button to accounts at
- rpubs.com,
- shinyapps.io
- RStudio Connect

Reload document

Find in document

File path to output document

6 Examine build log in R Markdown console

7 Use output file that is saved alongside .Rmd

Open in window | Save | Spell Check | Find and replace | Publish | Show outline

Set preview location | Insert code chunk | Go to code chunk | Run code chunk(s)

Modify chunk options | Run all previous chunks | Run current chunk

```
---
title: "R Markdown"
author: "RStudio"
output:
  html_document:
    toc: TRUE
---

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

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents.

```{r cars}
summary(cars)
```

For more details on using R Markdown see <http://rmarkdown.rstudio.com>.
```

```
> library(rmarkdown)
> render("report.Rmd", output_file = "report.html")
```

.Rmd structure

YAML Header
Optional section of render (e.g. pandoc) options written as key:value pairs (YAML).
- At start of file
- Between lines of `---`

Text
Narration formatted with markdown, mixed with:

Code chunks
Chunks of embedded code. Each chunk:
- Begins with ```` ```{r} ````
- ends with ```` ``` ````

R Markdown will run the code and append the results to the doc.

It will use the location of the .Rmd file as the **working directory**

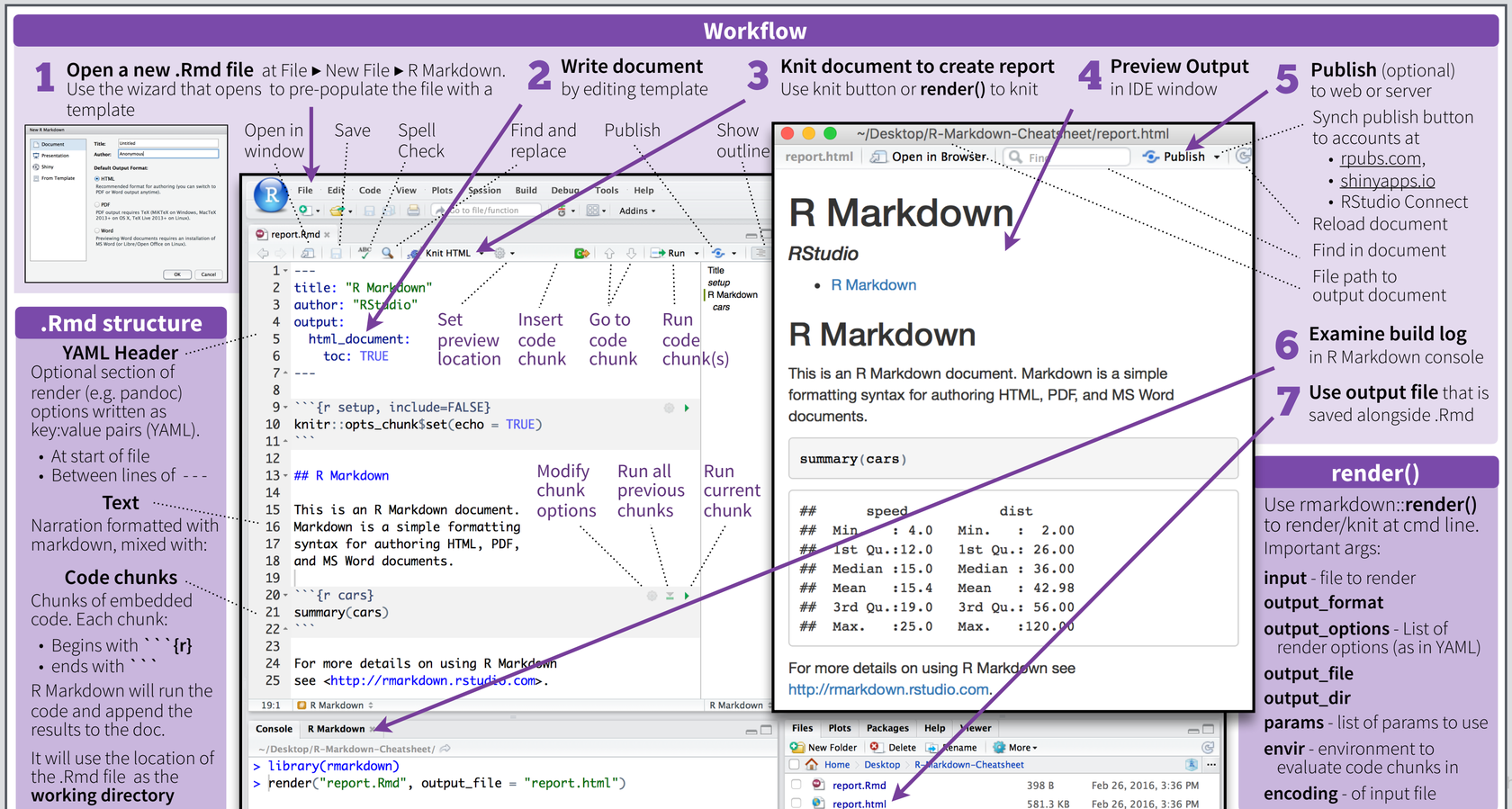
render()

Use rmarkdown::**render()** to render/knit at cmd line.
Important args:

input - file to render
output_format
output_options - List of render options (as in YAML)
output_file
output_dir
params - list of params to use
envir - environment to evaluate code chunks in
encoding - of input file

Your turn

Launch RStudio, and open your first R Markdown script.
Make sure you can knit the script into finished HTML output.



Markdown

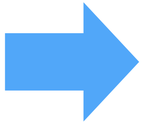
Web sites that use markdown

* **GitHub** www.github.com
* **StackOverflow** www.stackoverflow.com
* **Reddit** www.reddit.com
* **Meteor** www.meteor.com
* many more

Headers

Use # to create headers.
Multiple #'s create lower level headers.

```
# Header 1
## Header 2
### Header 3
#### Header 4
##### Header 5
###### Header 6
```



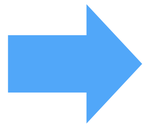
Header 1
Header 2
Header 3
Header 4
Header 5
Header 6

Text

Add two spaces at the end of a line to start a new line

Text is rendered as plain text. Use underscores (_) to make italics, two underscores (__) to make bold, back ticks to make code.

```
Text
_italics_
__bold__
`code`
```



Text

italics

bold

`code`

Lists

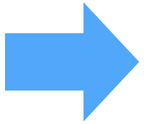
Use asterisks to make bullet points.
Use numbers to make numbered lists.

```
Bullets

* bullet 1
* bullet 2

Numbered list

1. item 1
2. item 2
```



Bullets

- bullet 1
- bullet 2

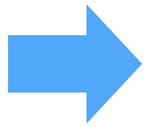
Numbered list

1. item 1
2. item 2

Hyperlinks

Use brackets to denote a link. Place the URL in parentheses.

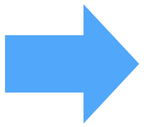
```
This is a
[link](www.git.com).
```



Equations

Write equations with latex math commands and surround them in $'s.

```
According to Einstein, $E=mc^{2}$
```



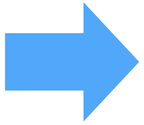
According to Einstein, $E = mc^2$

Equation blocks

Use two $'s to make centered equation blocks.

```
According to
Einstein,

$$E=mc^{2}$$
```



According to
Einstein,

$$E = mc^2$$

Images

Use a link preceded by an ! to insert an image.

The link text should be

- *a URL (if the image is hosted online)*
- *a file path (if the image is saved as a file)*

```
![](images/1.png)
The RStudio logo.
```

Note: You must save your .Rmd file before the preview will find the image

Your Turn

Open demos/02-text.Rmd. Read the report, then use R Markdown to format the report with

- headers
- three bullet points
- italicized text
- bold text
- a web link, etc.

knitr
code chunks

Quiz

How should we put our graph in the report?

Embed code

Insert a chunk of R code with

````
```{r}
# some code

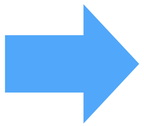
```
````

When you render the report, R Markdown will run the code and include its results. R Markdown will also remove the ```` ```{r} ```` and ```` ``` ````.

chunk options

By default, R markdown includes both the code and its results

````
Here's some code
```{r}
dim(iris)
```
````



Here's some code

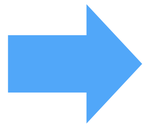
```
dim(iris)
```

```
## [1] 150   5
```

echo

Add options in the brackets after r.
echo = FALSE hides the code.

````
Here's some code
```{r echo=FALSE}
dim(iris)
```
````



Here's some code

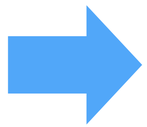
```
## [1] 150   5
```

echo

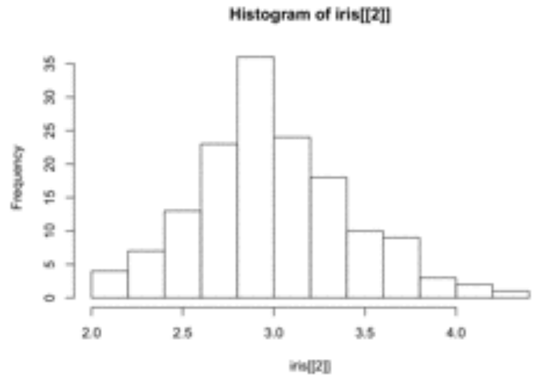
Add options in the brackets after r.
echo = FALSE hides the code.

````
Here's a plot

```{r echo=FALSE}
hist(iris[[2]])
```
````



Here's a plot



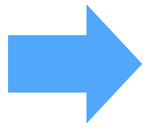
This is very useful for plots

eval

eval = FALSE prevents the code from being run.
As a result, no results will be displayed with the code

````
Here's some code

```{r eval=FALSE}
dim(iris)
```
````



Here's some code

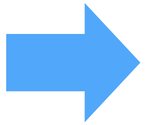
```
dim(iris)
```

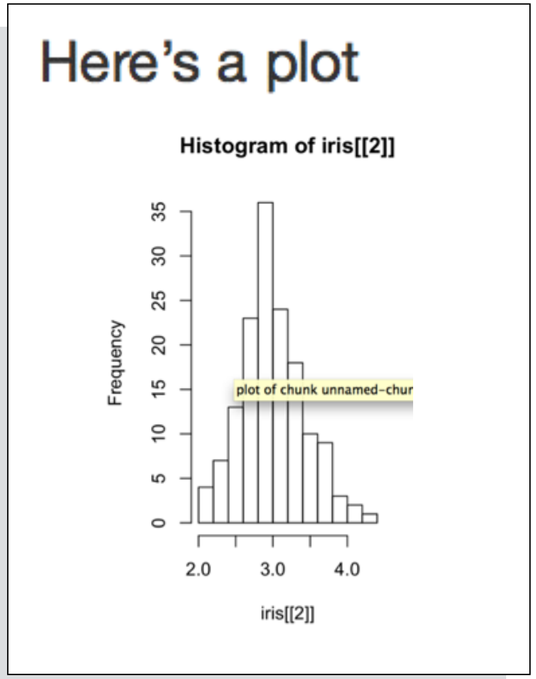
fig.height, fig.width

Specify the dimension of plots (in inches) with fig.width and fig.height. Separate multiple arguments with commas.

````
Here's a plot

```{r echo=FALSE, fig.width=3, fig.height=5}
hist(iris[[2]])
```
````



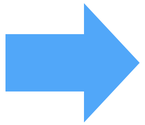


message

message = FALSE supresses messages from appearing in the output.

````
Here's some code

```{r message=FALSE}
library(forecast)
```
````



Here's some code

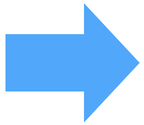
```
library(forecast)
```

warning

warning = FALSE supresses warnings from appearing in the output.

````
Here's some code

```{r warning=FALSE}
warning("Don't!")
```
````



Here's some code

```
warning("Don't!")
```

Logistics

1

Knitr runs the document in a fresh R session, which means you need to load the libraries that the document uses *in the document*

Logistics

1 Knitr runs the document in a fresh R session, which means you need to load the libraries that the document uses *in the document*

````
```{r}
delays <- flights
```
````

```
Error : object 'flights' not found
```

Logistics

1 Knitr runs the document in a fresh R session, which means you need to load the libraries that the document uses *in the document*

````
```{r}
library(nycflights13)
delays <- flights
```
````

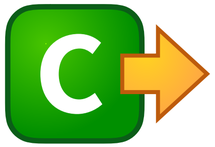
```
No Error (flights is loaded with nycflights13)
```

Logistics

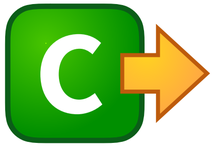
1. Knitr runs the document in a fresh R session, which means you need to load the libraries that the document uses *in the document*

2. Objects made in one code chunk will be available to code in later code chunks.

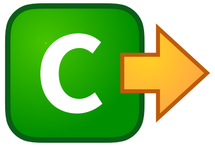
Recap



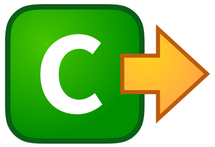
Place a **code chunk** where you would like code results to appear in your document



Begin a chunk with ```` ```{r} ````



End a chunk with ```` ``` ````



Add **named arguments** inside braces to customize execution of the code / display of results

Your Turn

Add the code from flights.R to your R Markdown file.

Arrange for the table and graph to appear in your report.

Prevent the library() and ggplot2 commands (and messages, and warnings) from appearing in the finished report.

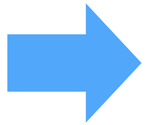
Advanced knitr

engine

To embed non R code, set the engine option to the language you want to embed.

````
Some python code,

```{r engine='python'}
x = 'hello, python world!'
print(x)
print(x.split(' '))
```
````



Some python code:

```
x = 'hello, python world!'
print(x)
print(x.split(' '))
```

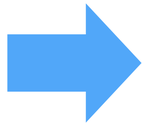
```
## hello, python world!
## ['hello,', 'python', 'world!']
```

engine

To embed non R code, set the engine option to the language you want to embed.

````
Some python code,

```{python}
x = 'hello, python world!'
print(x)
print(x.split(' '))
```
````



Some python code:

```
x = 'hello, python world!'
print(x)
print(x.split(' '))
```

```
## hello, python world!
## ['hello,', 'python', 'world!']
```

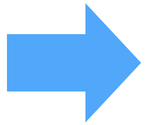
knitr comes with engines for the following languages, and can be extended to other languages

asis
asy
awk
bash
c
cat
coffee
dot
gawk
haskell
highlight
perl
python
Rcpp
Rscript
ruby
sas
scala
sed
sh
tikz
zsh

cache

R Markdown will cache the result of the code chunk to reuse (and thus avoid computation) when **cache = TRUE**

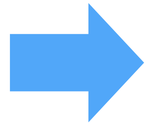
````
Here's some code
that takes a "long"
time to run.
```{r cache=TRUE}
Sys.sleep(5)
rnorm(1)
```
````



Here's some code that takes a "long" time to run.

```
Sys.sleep(5)
rnorm(1)
```

```
## [1] 1.582407
```



Here's some code that takes a "long" time to run.

```
Sys.sleep(5)
rnorm(1)
```

```
## [1] 1.582407
```

dependson

What if the cached code depends on another chunk that may have updated?

````
```{r c1, cache=TRUE}
m <- 5
```

```{r c2, cache=TRUE}
n <- 1
```

```{r cache=TRUE, dependson=c("c1","c2")}
Sys.sleep(m)
rnorm(n)
```
````

Give your chunks labels.
Then set dependson.

First, unnamed argument becomes the chunk's label

This chunk depends on the chunks labelled c1 and c2

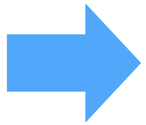
global options

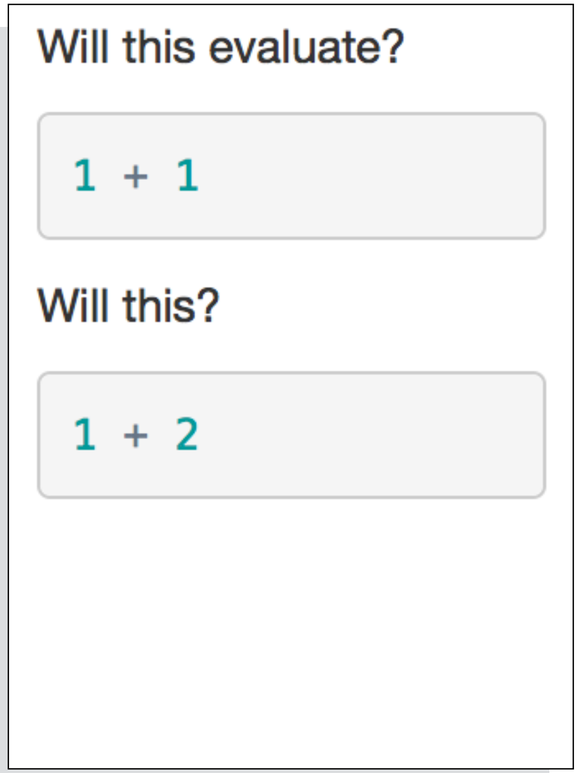
Use **knitr::opts_chunk$set()** to set global options (options that apply to ALL chunks)

````
```{r echo = FALSE}
knitr::opts_chunk$set(eval = FALSE)
```

Will this evaluate?
```{r}
1 + 1
```

Will this?
```{r}
1 + 2
```
````

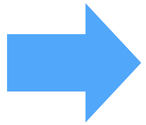




inline code

Place code in a sentence with `` `r #code` ``. R Markdown will replace the code with its results.

```
Today is
`r Sys.Date()`.
```



Today is 2015-04-16.

You cannot add options to inline code

Your Turn

Use inline R code to programmatically generate the following whenever they appear in your report (use the code in flights.R):

1. The Day of the Week
2. The airport with the shortest average delay
3. The length of the average delay

By embedding the code that returns the name (instead of typing the name) you expand the ways you can reuse the report.

tables

```
## Source: local data frame [3 x 2]
##
##   origin mean_delay
##    (chr)      (dbl)
## 1    EWR   7.680089
## 2    JFK   9.957611
## 3    LGA   4.226548
```

knitr::kable

```
```{r results = 'asis'}
knitr::kable(weekday)
```
```

Creates table for all output formats

Use with results = 'asis'

kable() comes in the knitr package

origin	mean_delay
EWR	7.680089
JFK	9.957610
LGA	4.226548

PDF

origin	mean_delay
EWR	7.680089
JFK	9.957610
LGA	4.226548

MS Word

captions

````
```{r results = 'asis'}
knitr::kable(weekday, caption = "Results by day")
```
````

See **xtable**, **stargazer**, or **DT** packages for advanced alternatives.

parameters

Pop Quiz

What is the IMRAD format?

Standard report structure for experimental science.

Introduction
What hypothesis was tested and why?

Methods
How was the study done?

Results
What answer was discovered?

And Discussion
What does the answer imply?

Pop Quiz

What is the IMRAD format?

Standard report structure for experimental science.

Why?

Introduction
What hypothesis was tested and why?

Methods
How was the study done?

Results
What answer was discovered?

And Discussion
What does the answer imply?

Pop Quiz

What would a person need to reproduce your report?

YAML

A section of key:value pairs separated by dashed lines ———

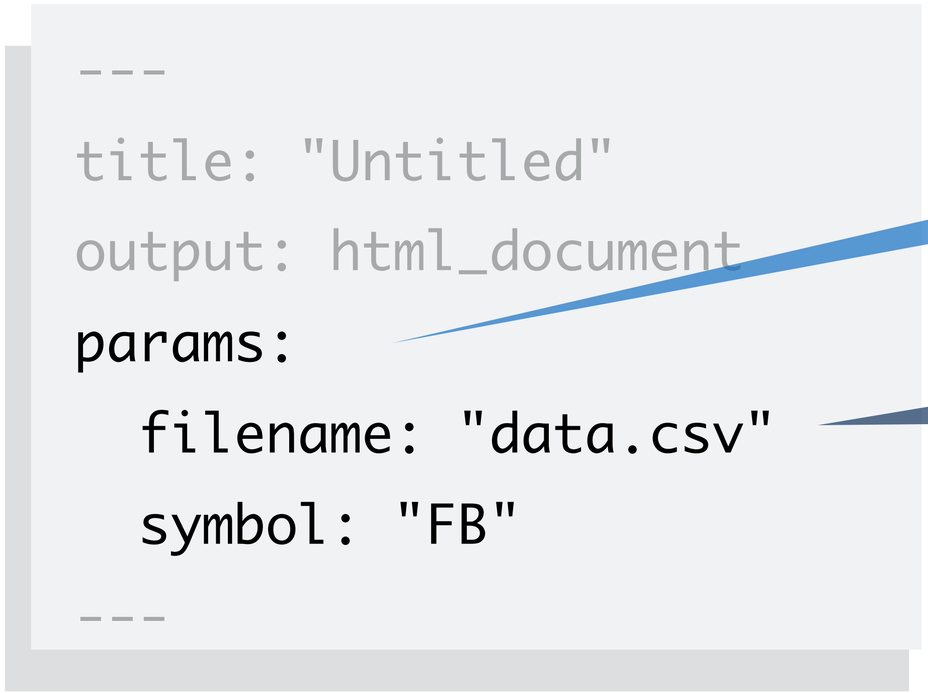
```
---
title: "Untitled"
author: "RStudio"
date: "February 4, 2015"
output: html_document
---
Text of document
```

Parameters

A list of values that you can call in R code chunks

params list

elements and values



Access as `params$filename` and `params$symbol`

Data types

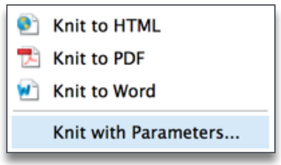
R Markdown will automatically parse **characters**, **numerics**, **integers**, and **logicals**. Create other types with an R expression.

```
---
title: "Untitled"
output: html_document
params:
  date: !r as.Date("2015-01-01")
---
```

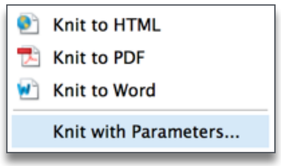
`!r`

R expression to coerce type

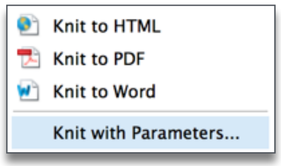
Recap



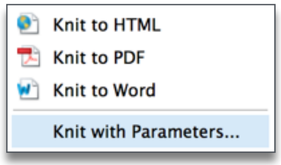
Place metadata in a **YAML header** at the very start of the file. Key value pairs surrounded by - - -



Add a **params** key and sub-keys to create parameter defaults



Access parameters in code as elements of **params$**



Render with **knit with parameters** or **render()** combined with a params argument

Your Turn

Add a day of the week parameter to your report.

Adjust your code to make the report update whenever the parameter changes. You will need to redefine **dow** in your code

Render a report for each of the 7 days.

output formats

/var/folders/c3/z24wjmw525710y8yxqtyplxw0000gn/T/Rtmp8bxdqu/Preview-1a1e4ca208.html

Preview-1a1e4ca208.html | Open in Browser | Publish | Find

Untitled

RStudio

April 16, 2015

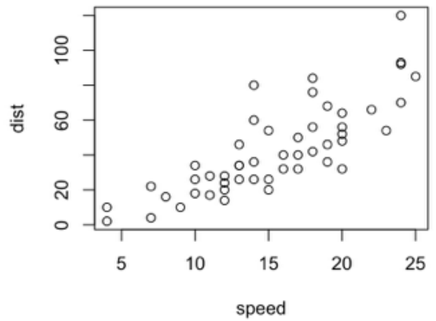
This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
##      speed           dist
##  Min.   : 4.0   Min.   :  2.00
##  1st Qu.:12.0   1st Qu.: 26.00
##  Median :15.0   Median : 36.00
##  Mean   :15.4   Mean   : 42.98
##  3rd Qu.:19.0   3rd Qu.: 56.00
##  Max.   :25.0   Max.   :120.00
```

You can also embed plots, for example:



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

HTML

RStudio: View PDF

Page: 1 of 1 | Automatic Zoom

Untitled

RStudio

April 16, 2015

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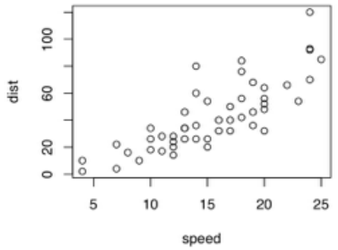
```

You can also embed plots, for example:



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

1

PDF

** preview requires tex*

Preview-1a13939b7b8.docx (1 page)

Search

Untitled

RStudio
April 16, 2015

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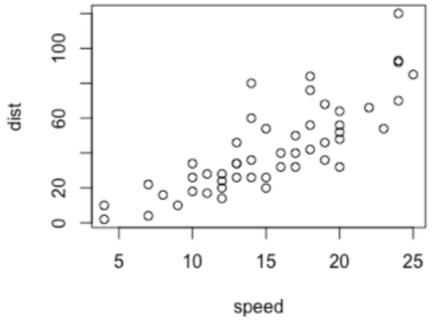
```

You can also embed plots, for example:



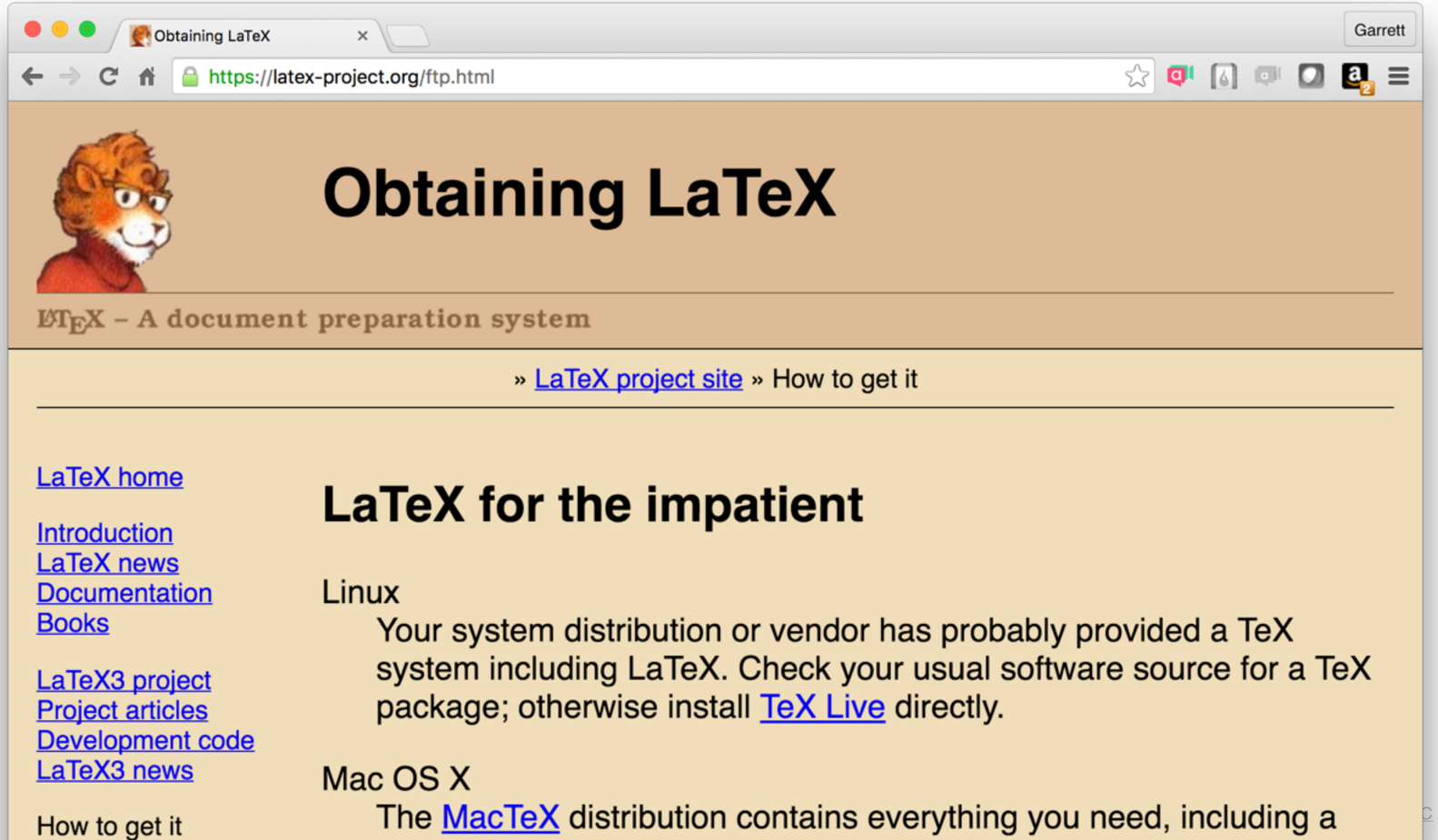
Note that the echo = FALSE parameter was added to the code chunk to prevent printing of the R code that generated the plot.

MS Word

** preview requires "Word"*

LaTeX

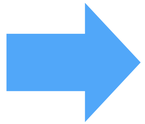
https://latex-project.org/ftp.html



YAML

A section of key:value pairs separated by dashed lines — — —

Most important option



```
---
title: "Untitled"
author: "RStudio"
date: "February 4, 2015"
output: html_document
---
Text of document
```

output templates

`html_document`	→	HTML
`pdf_document`	→	pdf
`word_document`	→	Microsoft Word (.docx)
`odt_document`	→	Open Document Text
`rtf_document`	→	Rich Text Format
`md_document`	→	markdown (converts R output to markdown)
`ioslides_presentation`	→	ioslides (HTML 5 slideshow)
`slidy_presentation`	→	slidy (HTML 5 slideshow)
`beamer_presentation`	→	beamer (pdf slideshow)

Your Turn

Use output: and the knit button (or render()) to create an ioslides slide show from your report.

slides
syntax

Slide divisions

R Markdown will start a new slide at each first (and second*) level header, and horizontal rule

** default for ioslides*

```
# Slide 1
text

## Slide 2
text

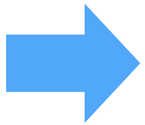
***
Slide 3
```

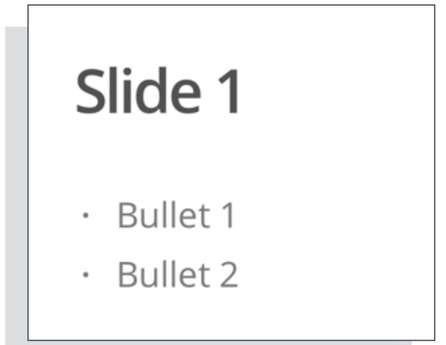
Slide bullets

Start bullets with -
Incremental bullets with >-

```
## Slide 1
- Bullet 1
- Bullet 2

## Slide 2
>- Bullet A
>- Bullet B
```





customizing output

sub options

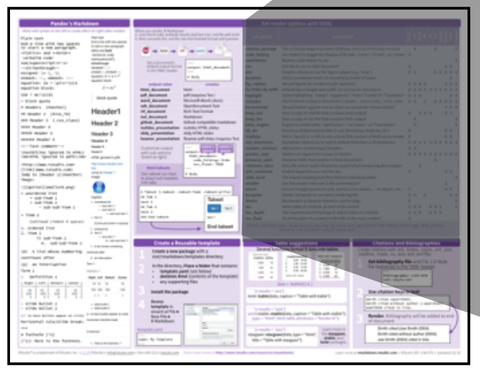
```
> args(rmarkdown::html_document)
function (toc = FALSE, toc_depth = 3, number_sections = FALSE,
    fig_width = 7, fig_height = 5, fig_retina = if (!fig_caption) 2,
    fig_caption = FALSE, smart = TRUE, self_contained = TRUE,
    theme = "default", highlight = "default", mathjax = "default",
    template = "default", css = NULL, includes = NULL, keep_md = FALSE,
    lib_dir = NULL, pandoc_args = NULL, ...)
```

demo

R Markdown Cheatsheet

Help ▶
Cheatsheets ▶
R Markdown Cheatsheet

www.rstudio.com/resources/cheatsheets/



Set render options with YAML

sub-option	description	html	pdf	word	odt	rtf	md	gituhb	ioslides	slidy	beamer
citation_package	The LaTeX package to process citations, `natbib`, `biblatex` or `none`		X				X				X
code_folding	Let readers to toggle the display of R code, `"none"`, `"hide"`, or `"show"`	X									
colortheme	Beamer color theme to use										X
css	CSS file to use to style document	X							X	X	
dev	Graphics device to use for figure output (e.g. `"png"`)	X	X				X	X	X	X	X
duration	Add a countdown timer (in minutes) to footer of slides									X	
fig_caption	Should figures be rendered with captions?	X	X	X	X				X	X	X
fig_height, fig_width	Default figure height and width (in inches) for document	X	X	X	X	X	X	X	X	X	X
highlight	Syntax highlighting: `"tango"`, `"pygments"`, `"kate"`,`"zenburn"`, `"textmate"`	X	X	X						X	X
includes	File of content to place in document (`in_header, before_body, after_body`)	X	X		X		X	X	X	X	X
incremental	Should bullets appear one at a time (on presenter mouse clicks)?								X	X	X
keep_md	Save a copy of .md file that contains knitr output	X		X	X	X			X	X	
keep_tex	Save a copy of .tex file that contains knitr output		X								X
latex_engine	Engine to render latex, `"pdflatex"`, `"xelatex"`, or `"lualatex"`		X								X
lib_dir	Directory of dependency files to use (Bootstrap, MathJax, etc.)	X							X	X	
mathjax	Set to `local` or a URL to use a local/URL version of MathJax to render	X							X	X	
md_extensions	Markdown extensions to add to default definition or R Markdown	X	X	X	X	X	X	X	X	X	X
number_sections	Add section numbering to headers	X	X								
pandoc_args	Additional arguments to pass to Pandoc	X	X	X	X	X	X	X	X	X	X
preserve_yaml	Preserve YAML front matter in final document?						X				
reference_docx	docx file whose styles should be copied when producing docx output			X							
self_contained	Embed dependencies into the doc	X							X	X	
slide_level	The lowest heading level that defines individual slides										X
smaller	Use the smaller font size in the presentation?								X		
smart	Convert straight quotes to curly, dashes to em-dashes, … to ellipses, etc.	X							X	X	
template	Pandoc template to use when rendering file	X	X		X					X	X
theme	Bootswatch or Beamer theme to use for page	X									X
toc	Add a table of contents at start of document	X	X	X		X	X	X			X
toc_depth	The lowest level of headings to add to table of contents	X	X	X		X	X	X			
toc_float	Float the table of contents to the left of the main content	X									

Options not listed: extra_dependencies, fig_crop, fig_retina, font_adjustment, font_theme, footer, logo, html_preview, reference_odt, transition, variant, widescreen

sub options

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

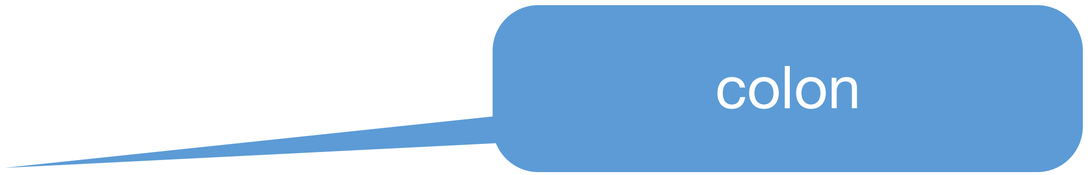
sub options

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

New line. Indented two spaces

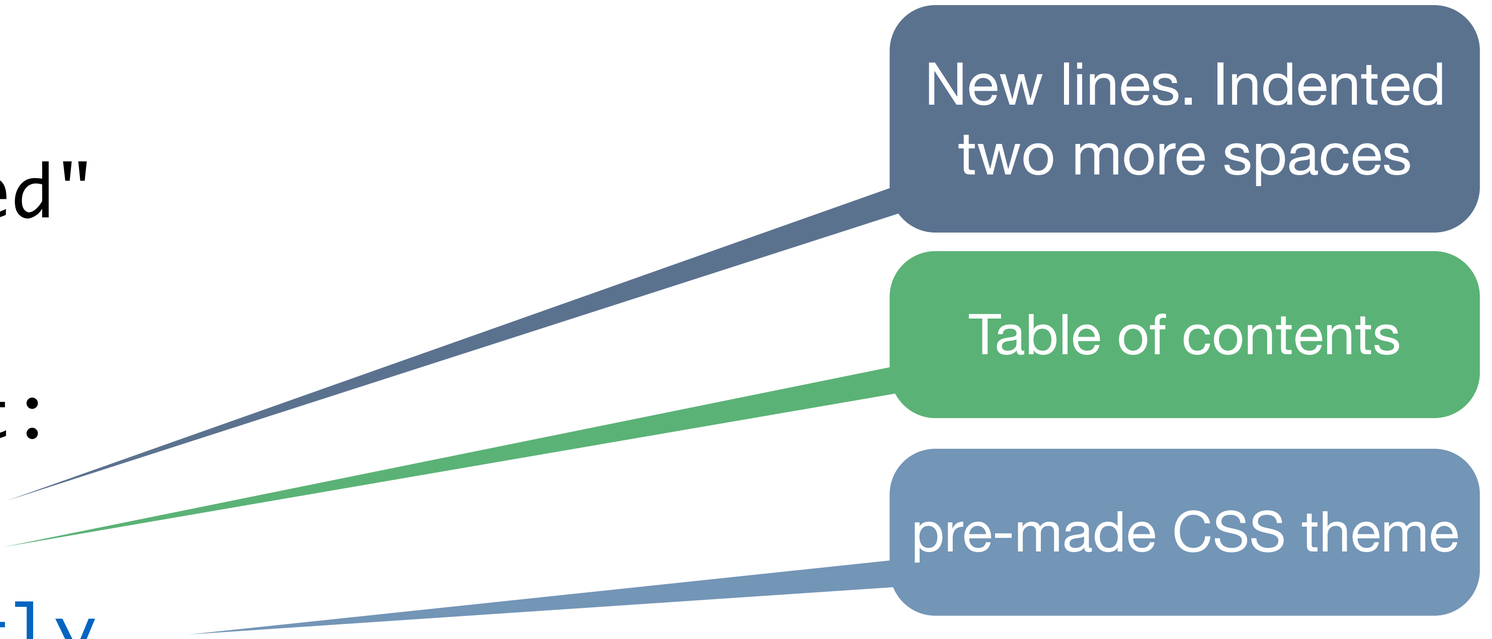
sub options

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



sub options

```
---
title: "Untitled"
output:
  html_document:
    toc: true
    theme: flatly
---
```

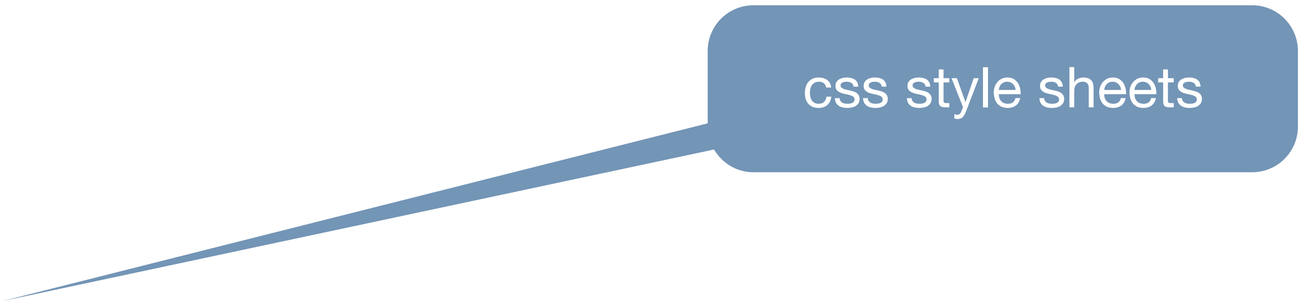


HTML themes

- default
- cerulean
- journal
- flatly
- readable
- spacelab
- united
- cosmo

follow up ideas

```
---
title: "Untitled"
output:
  html_document:
    css: my-file.css
---
```



Your Turn

`default`
`cerulean`
`journal`
`flatly`
`readable`
`spacelab`
`united`
`cosmo`

Revert your report to an html_document.

Then add a table of contents to your report.

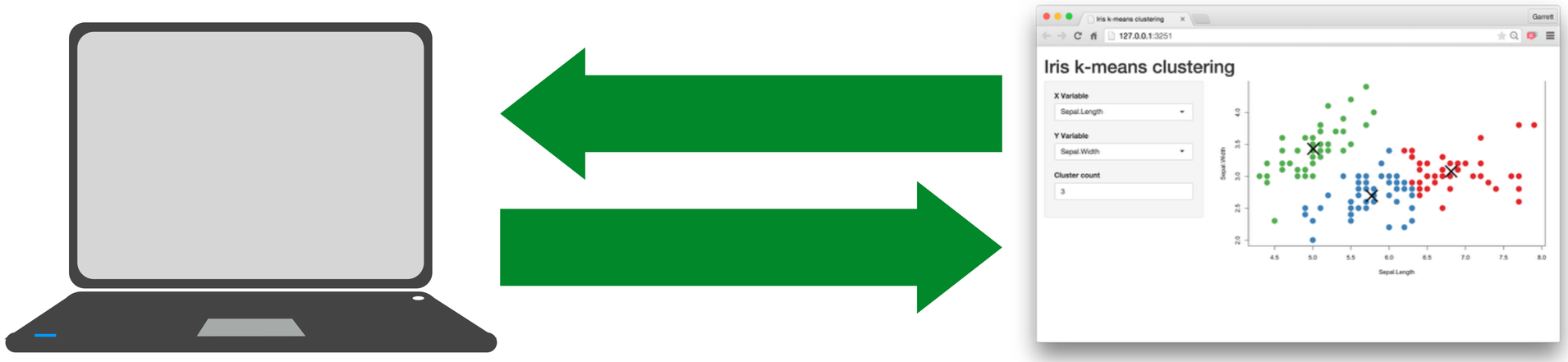
Then make the table of contents *float*, and choose your favorite style theme.

Interactive documents

An R package that let's you build interactive HTML based apps with R.

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

Every Shiny app is maintained by a computer running R



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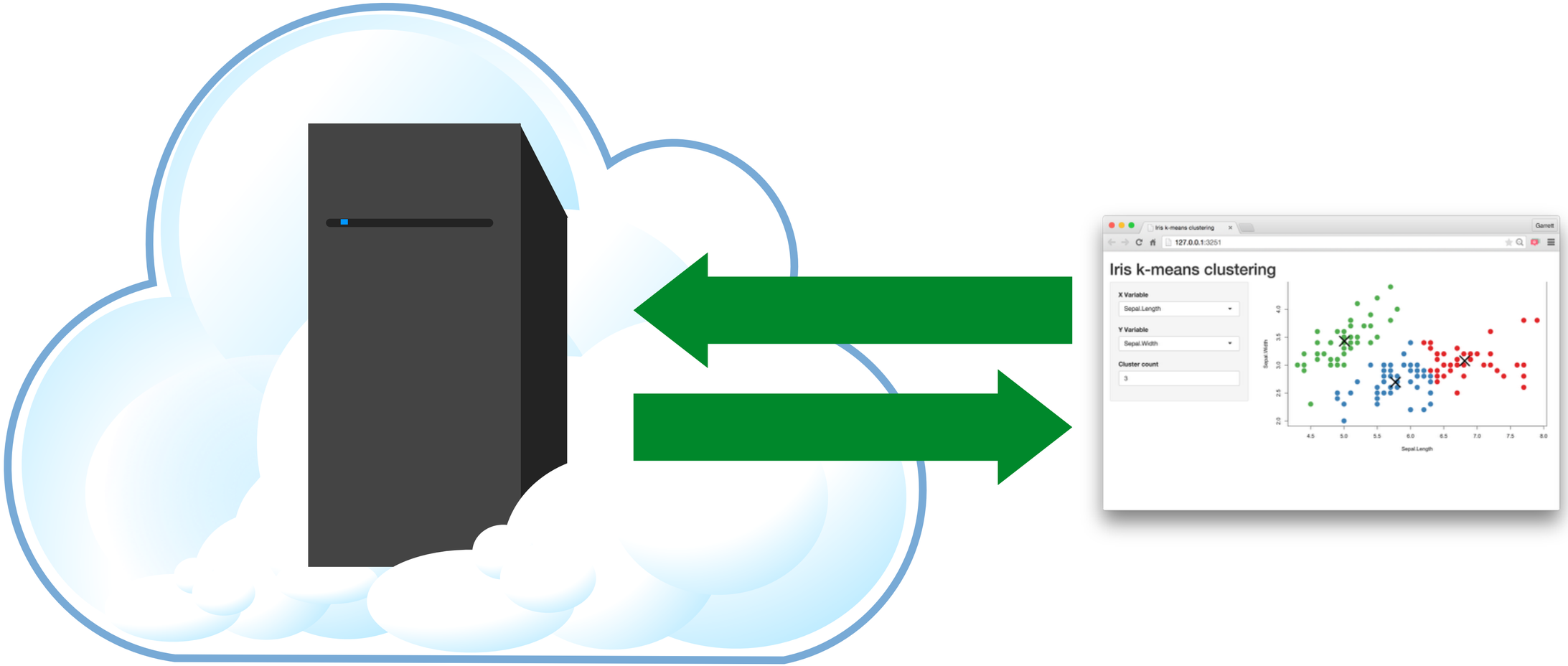
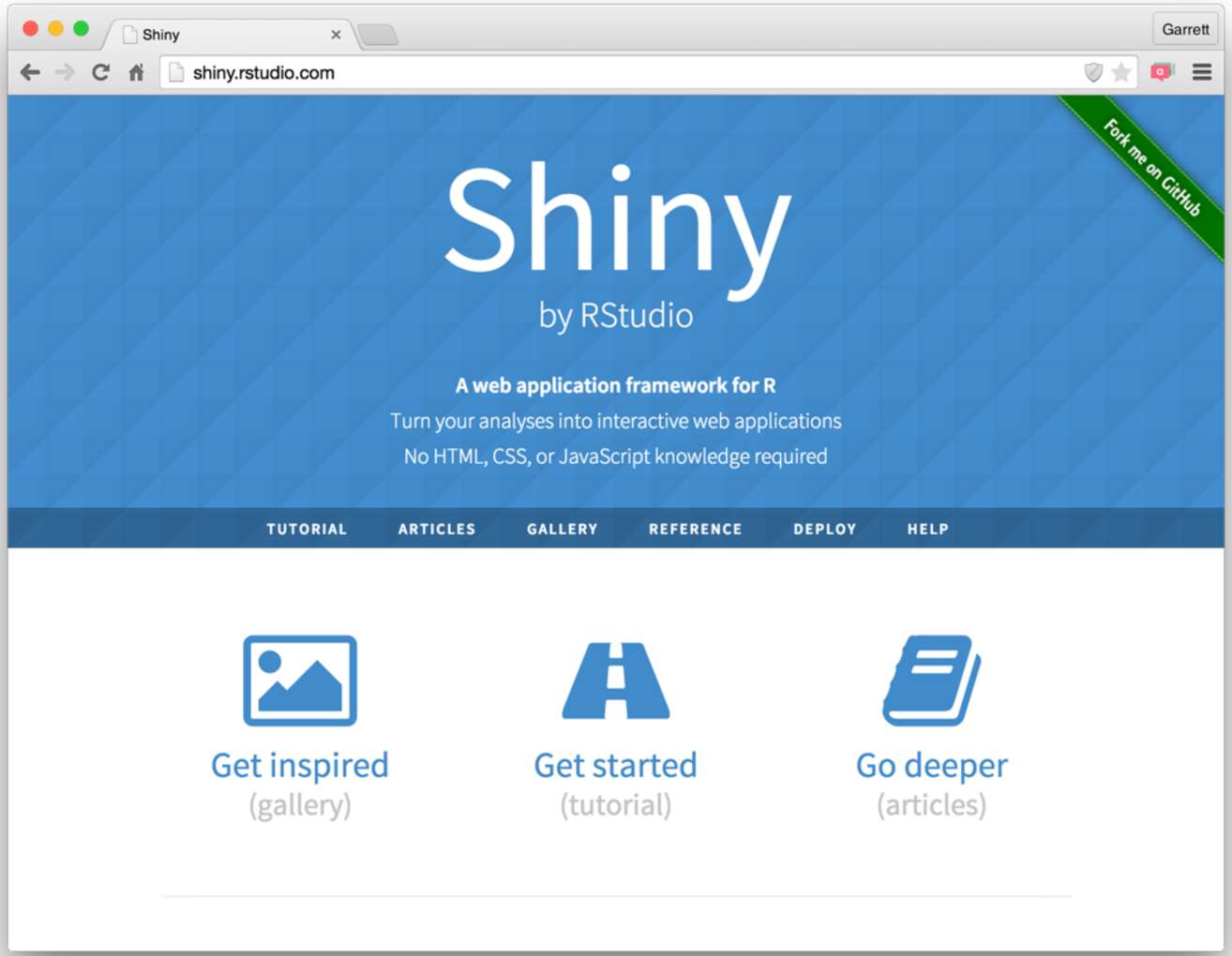


Learn more at

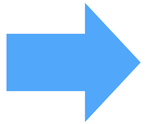
shiny.rstudio.com



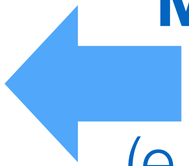
runtime:

Add **runtime: shiny** to any document that contains Shiny components.

Arranges for document to run as a shiny app



```
---
title: "Untitled"
author: "RStudio"
output: html_document
runtime: shiny
---
Text of document
```



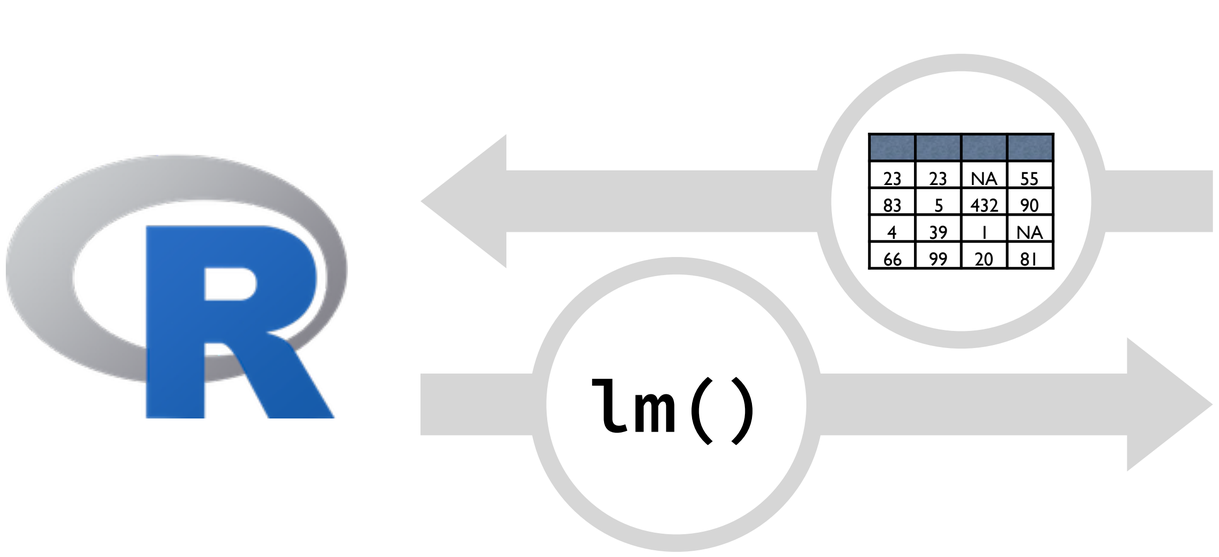
Must use an html based output
(e.g. html_document, ioslides_presentation, slidy_presentation)_

Big Data

General Strategy

Store big data in a data warehouse

1. Pass subsets of data from warehouse to R
2. Transform R code, pass to warehouse.



General Strategy

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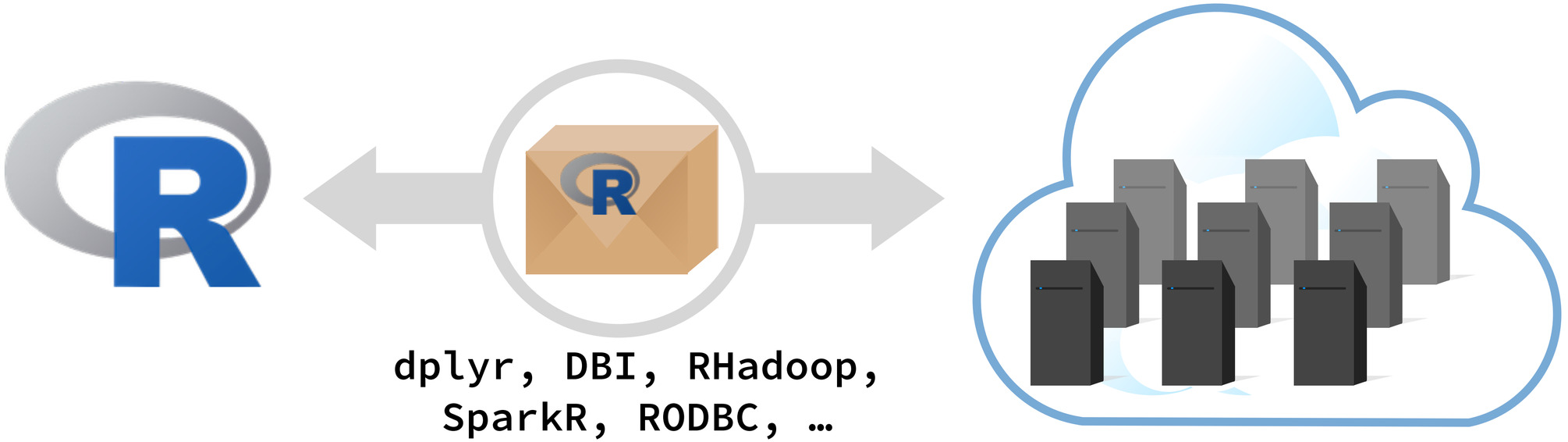


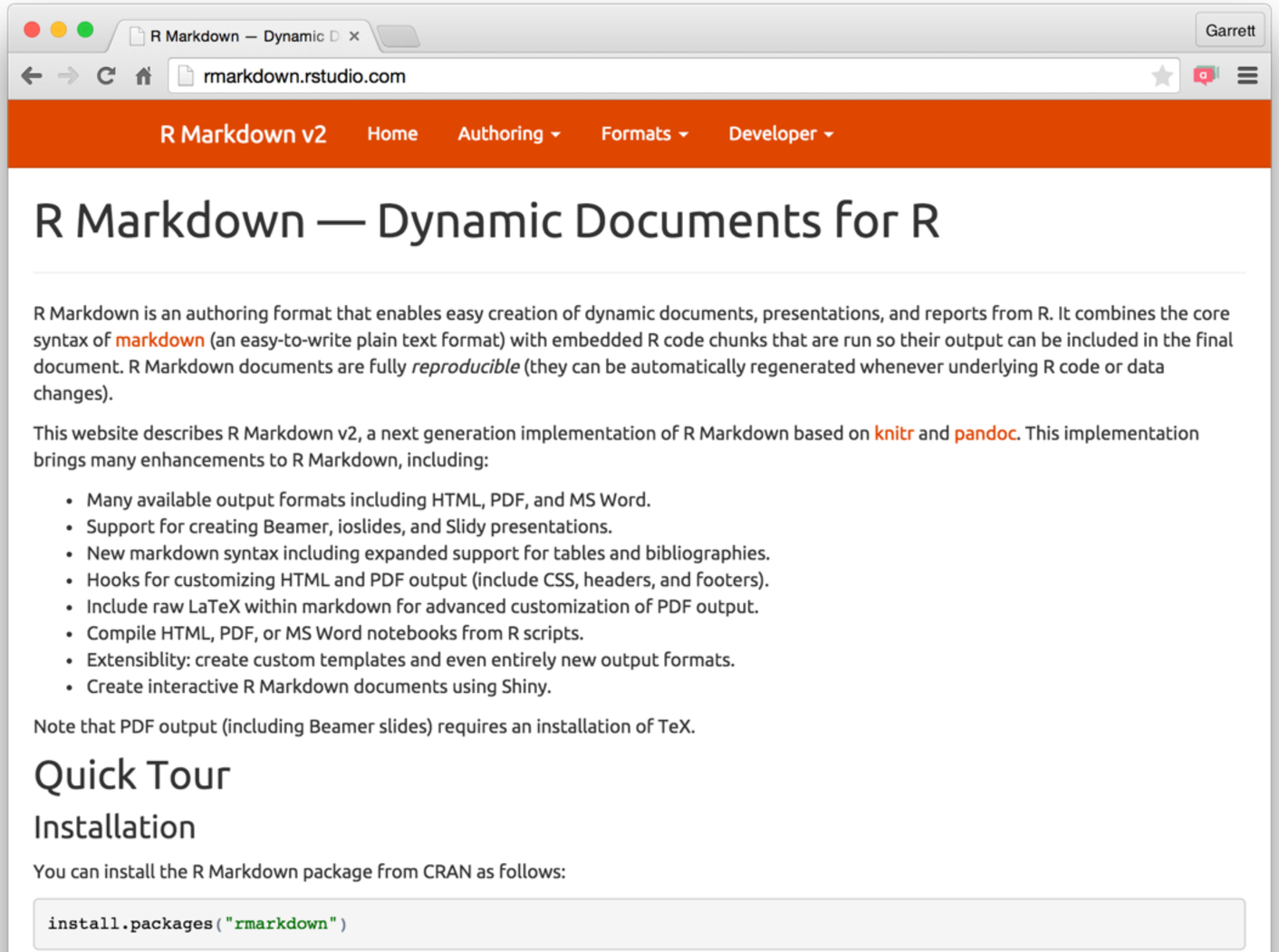
Recall

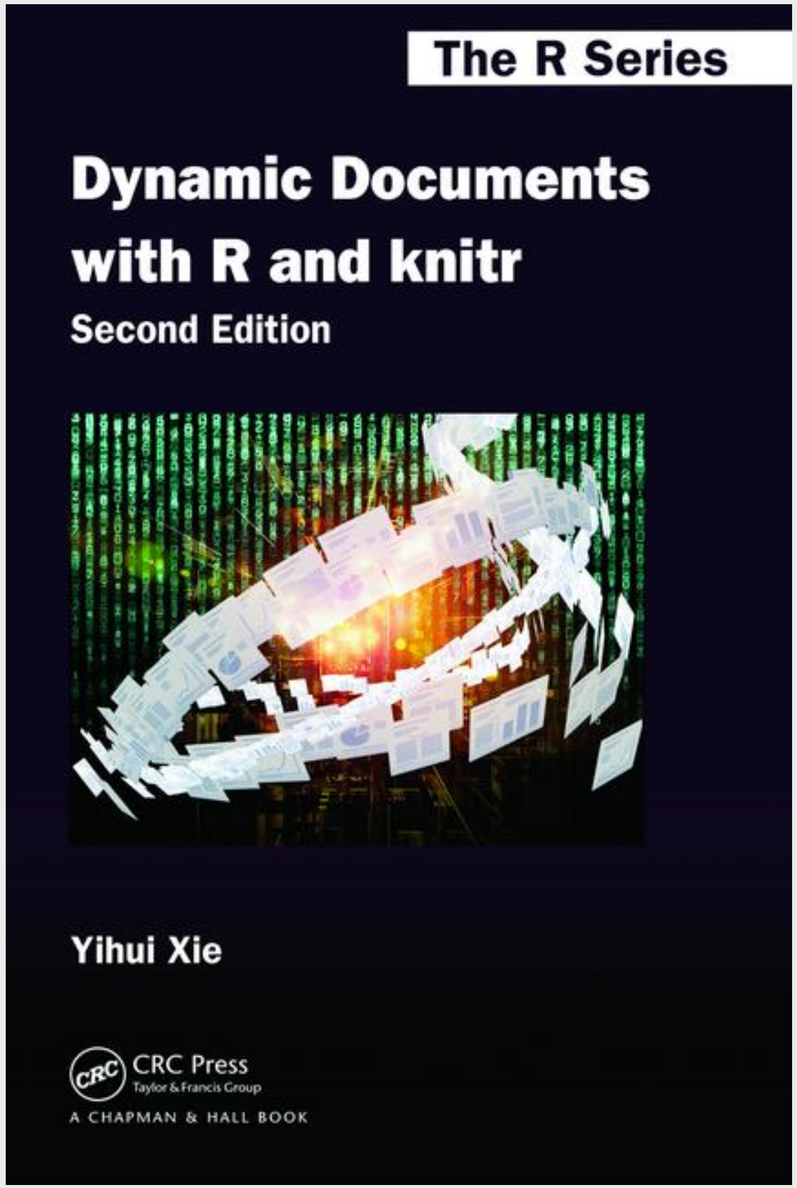
1. R code chunks are run "as is" in a fresh R session
2. Use the same techniques that you would use at the command line to access big, out of memory data.

Resources

The R Markdown Development Center

rmarkdown.rstudio.com

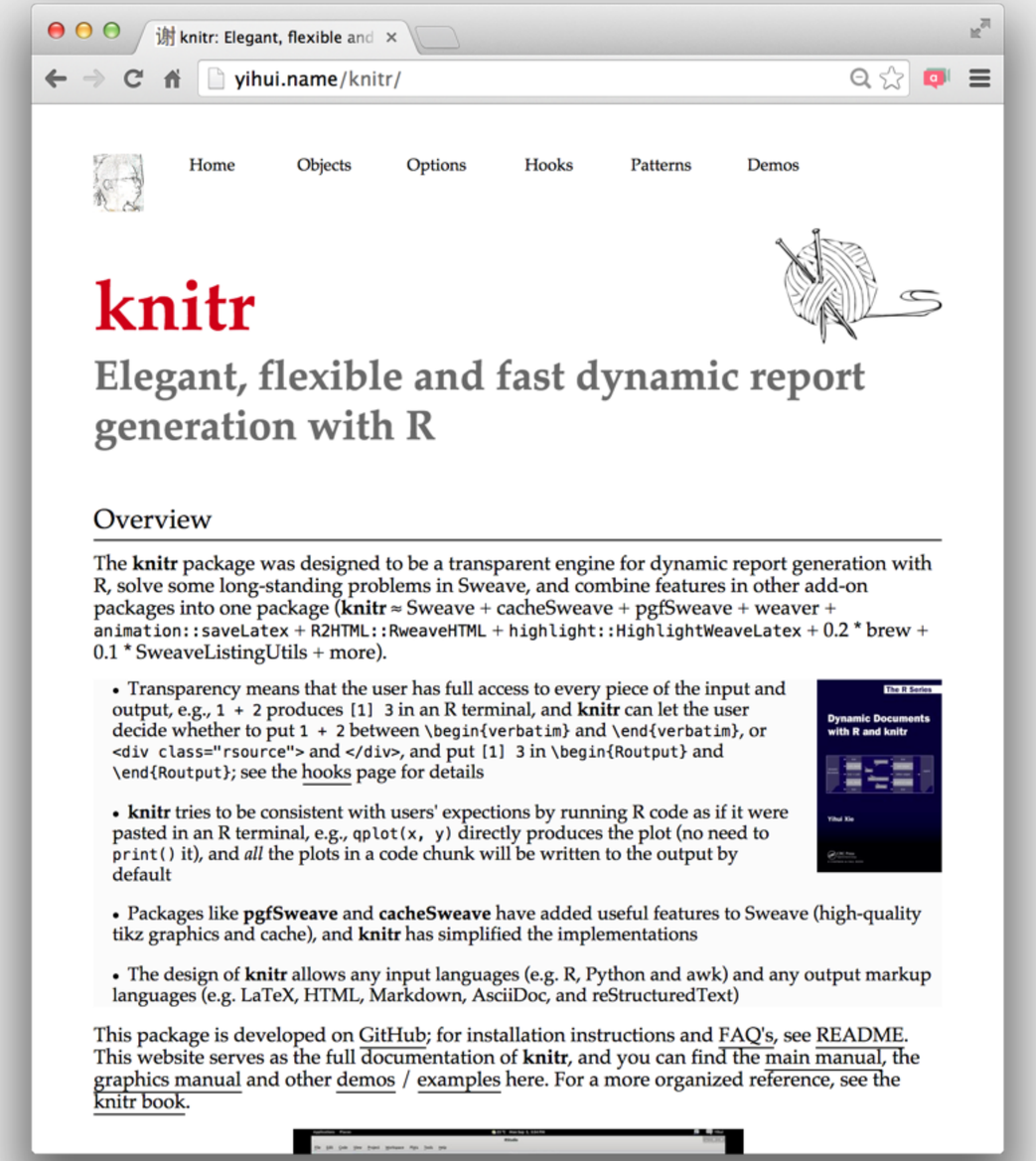




Dynamic Documents with R and knitr by Yihui Xie

Explains knitr and literate programming. Demonstrates how to extend knitr to other languages (e.g., python) and other formats (e.g. latex)

amzn.com/1498716962



http://yihui.name/knitr/

Demonstrates every knitr chunk option and has a gallery of example knitr projects