Structuring analysis with R Markdown

Daniel Kaplan

dtkaplan

dtkaplan@gmail.com

Embedding R code

"Knitting R into Markdown"

Two ways to run R inside Markdown

- Code chunks
  - *This is the most powerful*
    - provides the most control over computation, and
    - handles plots and other non-text output formats
- Inline code
  - *Simple, but handles only outputs that are easily converted to text, e.g.*
    - character strings (which can include HTML, Markdown, TeX, etc)
    - scalar numbers (not vectors)

Code chunks

- A code chunk is the main vehicle for connecting R code to Markdown
- "Fenced" regions of code with established (almost automatic) connections to Markdown
  - *Default: Rendering the .Rmd file runs each code chunk and embeds the results beneath the code chunk in your final report.*
  - *Chunks have an* engine, *a (unique) title and parameters for input/output/evaluation*
- Insert new chunks with
  - *the Add Chunk button in the editor toolbar, or*
  - *typing the chunk delimiters ```{r} and ```, or*
  - *the keyboard shortcut* ***Ctrl + Alt/Option + I***

Inline Code

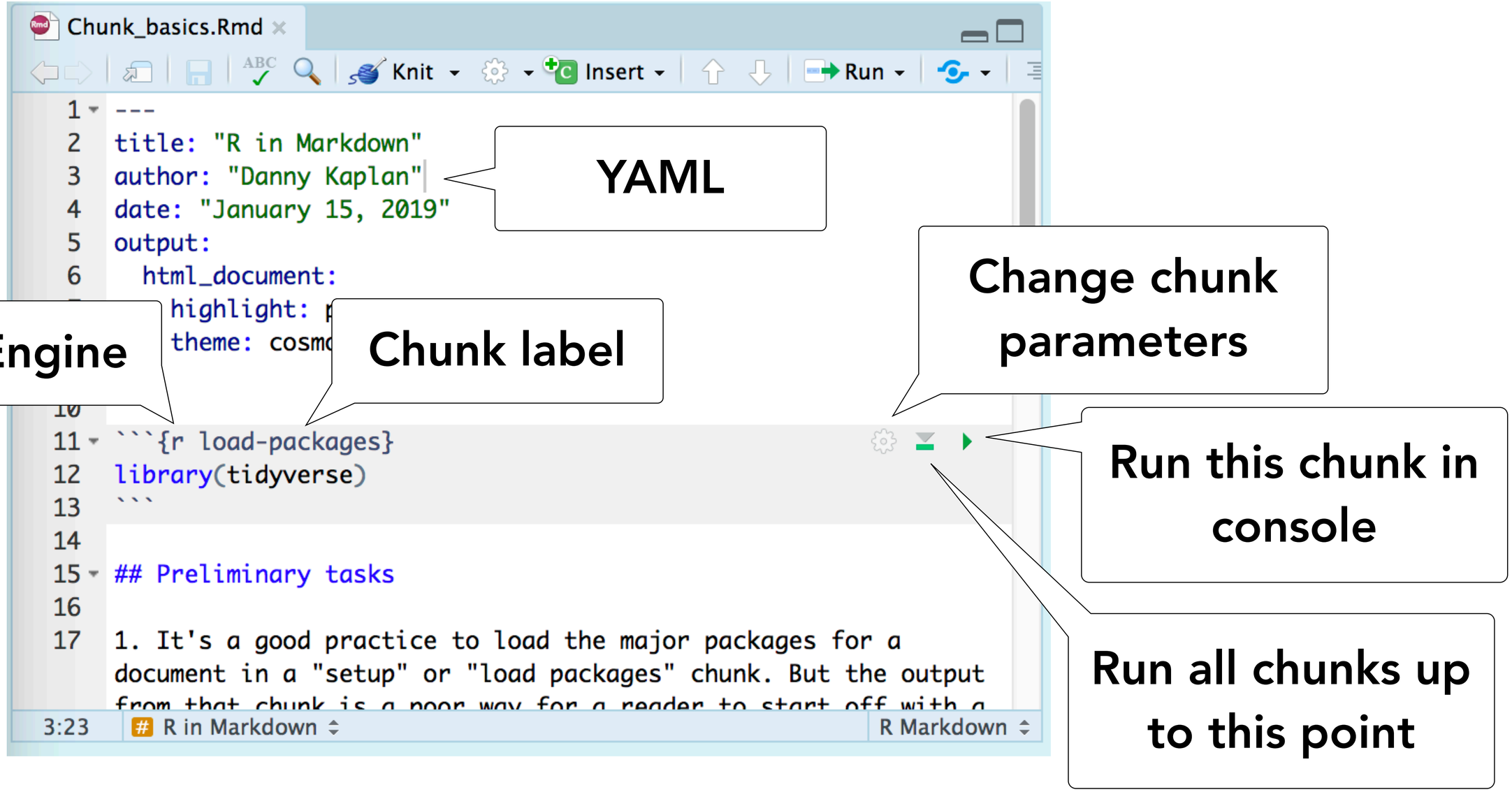
- Can be anywhere in the document … except a chunk.
- Fence is single back-ticks, opening with r-space: `` `r contents` ``
- "Contents" is typically a R expression evaluating to a character string or a number. No vectors.
  - *The character string can be plain text, HTML, Markdown, or TeX*
  - *Formatting reflects the active style at that point in the document.*
- Inline expressions do **not** take knitr options
- Uses current workspace
  - *Values are drawn from the current workspace.*
  - *Assignment is done in the current workspace.*

Your turn

(A) Open the file Chunk_basics.Rmd

(B) Compile it.

- We say “knit,” but better to think of it as a software source file and adopt software-like approaches to handling complexity, e.g.
  - Make small changes and test. Repeat until done.
- After a short tour … follow the instructions in the file


Chunk_basics.Rmd
Knit
Insert
Run
1 ---
2 title: "R in Markdown"
3 author: "Danny Kaplan"
4 date: "January 15, 2019"
5 output:
6 html_document:
highlight:
theme: cosmo
11 ```{r load-packages}
12 library(tidyverse)
13 ```
14
15 ## Preliminary tasks
16
17 1. It's a good practice to load the major packages for a
document in a "setup" or "load packages" chunk. But the output
3:23
R in Markdown
R Markdown
YAML
Engine
Chunk label
Change chunk parameters
Run this chunk in console
Run all chunks up to this point

Your turn

(A) Follow the numbered instructions in Chunk_basics.Rmd

5m 00s

Chunk options for figures

- fig.height: Plot canvas height in inches
- fig.width: Plot canvas width in inches
- out.width: Canvas scaling w.r.t. document, e.g. “50%”
- fig.align: “left”, “right”, or “center”
- fig.cap: Figure caption as character string

````
48
49 ```{r fig.height=5, fig.width=7, fig.align="right", fig.cap="Frequency distribution
   of reviewers"}
50 burritos_rev_count <- burritos %>%
51   mutate(Reviewer = fct_lump(Reviewer, n = 5)) %>%
52   count(Reviewer) %>%
53   mutate(Reviewer = fct_reorder(Reviewer, n, .desc = TRUE)) %>%
54   arrange(desc(n))
55 burritos_rev_count
56
57 ggplot(data = burritos_rev_count, mapping = aes(x = Reviewer, y = n)) +
58     geom_bar(stat = "identity") +
59     labs(title = "Distribution of reviewers", x = "", y = "")
60 ```
````

Tips

- Give chunks labels of your own. This helps you troubleshoot and navigate your source document.
- Avoid spaces in chunk labels, even though technically they are “allowed.” Especially if you work with GitHub — *more on this later!*
- If you’re having a hard time coming up with a short label that describes what the chunk is doing, consider breaking it down into shorter chunks ➡ especially useful for troubleshooting!

What happens when a chunk parameter is malformed? Misnamed?

What happens when there's an error in the R code in a chunk? What feedback/error does R give? (Activate chunk "neg_logs")

What about when there are multiple chunks with errors? (Activate chunk "another_error")

5m 00s

Chunk options

Safe to play with:

- `echo = FALSE`: code runs, code doesn't appear in rendered file, results do ➡ for when your audience doesn't need to see the code
- `include = FALSE`: code runs but neither code nor results appear in rendered file ➡ results can be used by other chunks
- `eval = FALSE`: code doesn't run but they appear in the rendered file ➡ when you want to show/teach code

Requires care:

- `message = FALSE`: hides messages ➡ especially useful/harmful for loading packages and data
- `warning = FALSE`: hides messages ➡ especially useful/harmful for functions that throw many warnings

Setting chunk options via GUI

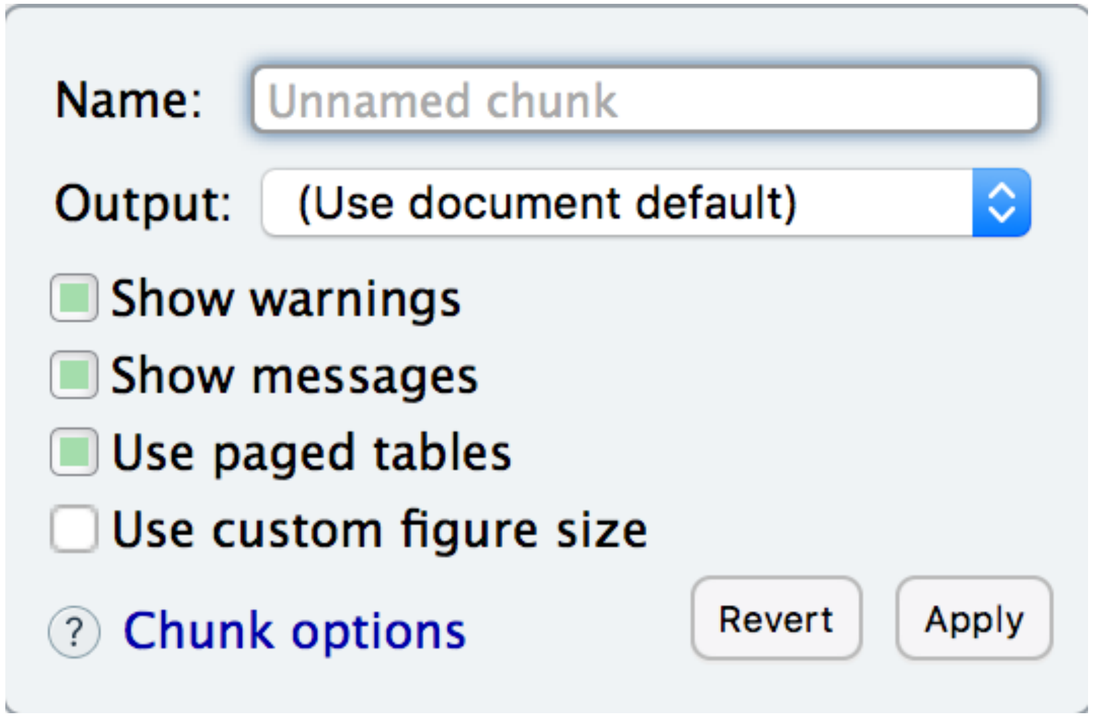
Some of the chunk options can be set via a handy GUI that you can access by clicking on the gear icon on a given chunk.

```
5, fig.width=7, fig.align="right", fig.cap="Frequency distribution

t <- burritos %>%
 = fct_lump(Reviewer, n =
 %>%
 = fct_reorder(Reviewer, n, .desc = TRUE)) %>%
)
t


ritos_rev_count, mapping = aes(x = Reviewer, y = n)) +
 = "identity") +
"Distribution of reviewers", x = "", y = "")
```

Options



So many more chunk options!

https://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:

1. **Markdown Syntax**
2. Knitr chunk options
3. Pandoc options

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

Global options

- To set global options that apply to every subsequent chunk in your file, call knitr::opts_chunk$set in a code chunk
- Knitr will treat each option that you pass to knitr::opts_chunk$set as a global default that can be overwritten in individual chunk headers

```
8  ```{r}
9  knitr::opts_chunk$set(echo=FALSE)
10 ```
```

Hide all code chunks

Your turn

(A) Add a new code chunk to **sd-burritos.Rmd** and set relevant options for that particular chunk. You create a plot, calculate summary statistics, or if you prefer, just do some basic calculation (without using the data).

(B) Remove the figure height and width options from individual chunks and set them as global options.

5m 00s

Output options

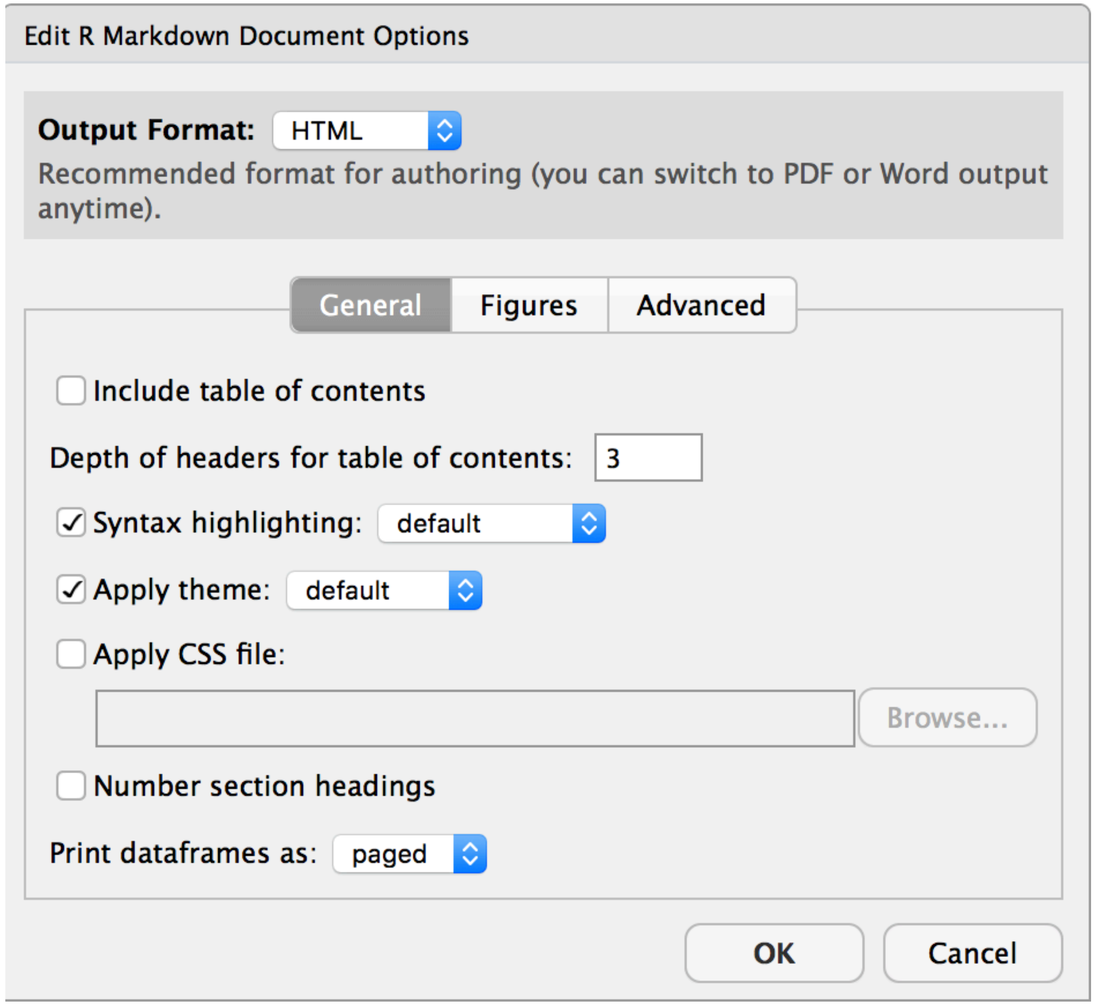
Output options

- Output options are defined in the YAML
- They are similar to setting global knitr options
- To learn which arguments a format takes, read the format's help page in R, e.g. ?html_document

```
html_notebook(toc = FALSE, toc_depth = 3, toc_float = FALSE,
  number_sections = FALSE, fig_width = 7, fig_height = 5,
  fig_retina = 2, fig_caption = TRUE, code_folding = "show",
  smart = TRUE, theme = "default", highlight = "textmate",
  mathjax = "default", extra_dependencies = NULL, css = NULL,
  includes = NULL, md_extensions = NULL, pandoc_args = NULL,
  output_source = NULL, self_contained = TRUE, ...)
```

Setting output options via GUI

Some of the output options for some of the output types can be set via a handy GUI that you can access by clicking on the gear icon on the toolbar



Your turn

(A) Add a floating table of contents to the html document output.

(B) Also set all figures to be 4 x 7.

3m 00s

Output formats

Documents

- Most commonly used output is html_document — HTML document w/ Bootstrap CSS

```
---
title: "San Diego Burritos"
author: "Mine Çetinkaya-Rundel"
date: "2018-01-23"
output:
  html_document:
    highlight: pygments
    theme: cosmo
---
```

- Other document options are as follows:
  - *html_notebook - Interactive R Notebooks*
  - *pdf_document - PDF document (via LaTeX template)*
  - *word_document - Microsoft Word document (docx)*
  - *odt_document - OpenDocument Text document*
  - *rtf_document - Rich Text Format document*
  - *md_document - Markdown document (various flavors)*

Your turn

Convert **html_document** output to **html_notebook**. What changed?

Presentations

- ioslides_presentation - HTML presentation with ioslides
- revealjs::revealjs_presentation - HTML presentation with reveal.js
- slidy_presentation - HTML presentation with W3C Slidy
- beamer_presentation - PDF presentation with LaTeX Beamer
- xaringan::moon_reader - remark.js slides

Other output formats

- flexdashboard::flex_dashboard - Interactive dashboards
- tufte::tufte_html - HTML handouts in the style of Edward Tufte
- html_vignette - R package vignette (HTML)
- github_document - GitHub Flavored Markdown document

Your turn

(A) **Before you start:** Delete any files and folders created during the caching exercise. Turn off caching, and remove the `Sys.sleep(60)` command.

(B) Change output to `github_document`. Knit the document.

(C) What changed, other than cosmetic changes in the output? Discuss with your neighbors.

(D) **Stretch goal (if you are a git/GitHub user):** Push this document, and any other necessary files, so that it can be previewed on Github (with figures and output).

3m 00s

Caching

> There are only two hard things in Computer Science:
> cache invalidation and naming things.
>
> *–Phil Karlton*

Martin Fowler, Two Hard Things. https://martinfowler.com/bliki/TwoHardThings.html.

Caching

- If document rendering becomes time consuming due to long computations you can use caching to improve performance
- If `cache = TRUE` is set:
  - *Cached chunks are skipped, but objects created in these chunks are (lazy-) loaded from previously saved databases (**.rdb** and **.rdx**) files*
  - *These files are saved when a chunk is evaluated for the first time, or when cached files are not found*
  - *Results of the code will still be included in the output even when cache is used, because knitr also caches the printed output of a code chunk as a character string*

Chunk options for caching

- cache.path: Directory to save cached results in (default = “cache/”)
- dependson: Chunk dependencies for caching (default = NULL)
- …

Your turn

(A) **Before you start:** Make sure all of your code chunks are labeled!

(B) Add the following to the chunk that creates your plot: `Sys.sleep(60)`

(C) Turn on caching for the code chunk that creates the bar plot by setting the relevant chunk option. Knit the document (this is going to take a while, a bit more than 60 seconds). Take a look at the folder where `Chunk_basics.Rmd` lives. What else is new there?

(D) Knit the document again without making any changes to this particular code chunk. How long did knitting the document take the second time around?

(E) Add a code chunk before this one and slice and overwrite the data so that `` `mtcars` `` is now just the first 5 observations in the original dataset. Knit the document again. What is the problem with your plot?

(F) **Stretch goal:** How do you fix this?

10m 00s

Other languages

Other languages

knitr can execute code in many languages besides R. Some of the available language engines include:

- Python
- SQL
- Bash
- Rcpp
- Stan
- JavaScript
- CSS

```
---
title: "Simple Language Demos"
output: html_document
---

You can wr                ges other than R with R Markdown, e.g.

## Bash

```{bash}
ls *.Rmd
```

Python

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

Engine

Simple Language Demos

You can write code in languages other than R with R Markdown, e.g.

Bash

```
ls *.Rmd
```

```
## 1-example.Rmd
## 2-chunks.Rmd
## 3-inline.Rmd
## 4-languages.Rmd
```

Python

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

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

Your turn

- Decide which you want to work on: **xaringan** slides or **tufte_html**
- Make sure the package for the one you choose (xaringan or tufte) is installed and loaded
- Go to New File ➡ R Markdown… ➡ From Template, and then choose either Ninja Presentation (xaringan) or Tufte Handout (tufte)
- Convert **sd-burritos.Rmd** into one of these format

San Diego Burritos

Mine Çetinkaya-Rundel

2018-01-31

The data

Kaggle: SD Burritos

The data come from Kaggle.com:

> Mexican cuisine is often the best food option is southern California. And the burrito is the hallmark of delicious taco shop food: tasty, cheap, and filling. Appropriately, an effort was launched to critique burritos across the county and make this data open to the lay burrito consumer.

```
burritos <- read_csv("../../data/burritos_01022018.csv")
```

San Diego Burritos

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2018-01-31

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10m 00s