Tidying Hierarchical Data from the Web

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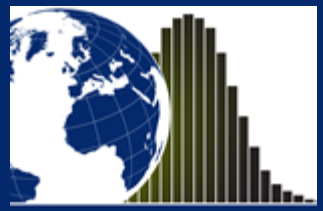
2018-11-13



Data and Visualization Services Department

http://bit.ly/Rundel-DVS

Getting Started

R environments

We will be going through several live demos today and I will be making my code available as we go via a Dropbox link.

It will likely be most useful for you to follow along by taking this code as it is produced and copying and pasting it to your own R session.

- For this to work well please make sure that you are running a reasonable current version of R (3.5.1 is the latest).
- If you can't or don't want to update your local install, I highly recommend:
  - https://vm-manage.oit.duke.edu/containers

Packages

Everythign we are going to use today is either part of or a dependency of the `tidyverse` metapackage. If you don't have that installed, now is a good time to install it. (It is better to do it now since installation can take awhile)

```
install.packages("tidyverse")
```

Additionally, even if you do have it installed now is also a good time to check that all of your packages are up-to-date.

```
update.packages()
```

My sessionInfo

```
sessioninfo::package_info() %>% .[.$attached,]
```

```
##  package  * version date       lib source
##  dplyr    * 0.7.8   2018-11-10 [1] CRAN (R 3.5.1)
##  jsonlite * 1.5     2017-06-01 [1] CRAN (R 3.5.0)
##  purrr    * 0.2.5   2018-05-29 [1] CRAN (R 3.5.0)
##  rvest    * 0.3.2   2016-06-17 [1] CRAN (R 3.5.0)
##  xml2     * 1.2.0   2018-01-24 [1] CRAN (R 3.5.0)
##
## [1] /usr/local/lib/R/3.5/site-library
## [2] /usr/local/Cellar/r/3.5.1/lib/R/library
```

Hierarchical Data?

Web data - html

```
<html>
  <body>

    <div>
      <span class="title">The Cat in the Hat</span>
      by <span class="author">Dr. Seuss</span>
      -  <span class="price">$6.99</span>
    </div>

    <div>
      <span class="title">Edgar Gets Ready for Bed</span>
      by <span class="author">Jennifer Adams</span>,
         <span class="author">Ron Stucki</span>
      -  <span class="price">$9.99</span>
    </div>

    <div>
      <span class="title">"More More More", Said the Baby</span>
      by <span class="author">Vera B Williams</span>
      -  <span class="price">$7.19</span>
    </div>

  </body>
</html>
```

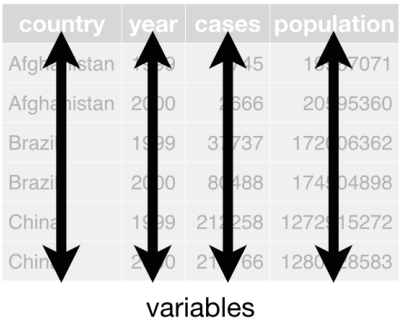
Web data - JSON

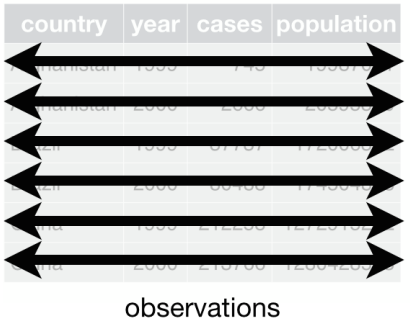
```
{
  "bookList": [
    {
      "title": "The Cat in the Hat",
      "author": "Dr. Seuss",
      "price": 6.99
    },
    {
      "title": "Edgar Gets Ready for Bed",
      "author": ["Jennifer Adams", "Ron Stucki"],
      "price": 9.99
    },
    {
      "title": "\"More More More\", Said the Baby",
      "author": "Vera B Williams",
      "price": 7.19
    }
  ]
}
```

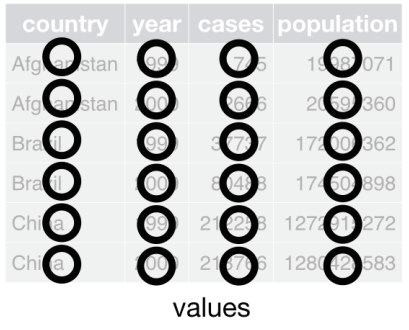
Web data - XML

```
<bookList>
  <book>
    <title>The Cat in the Hat</title>
    <author>Dr. Seuss</author>
    <price>6.99</price>
  </book>
  <book>
    <title>Edgar Gets Ready for Bed</title>
    <author>Jennifer Adams</author>
    <author>Ron Stucki</author>
    <price>9.99</price>
  </book>
  <book>
    <title>"More More More," Said the Baby</title>
    <author>Vera B Williams</author>
    <price>7.19</price>
  </book>
</bookList>
```

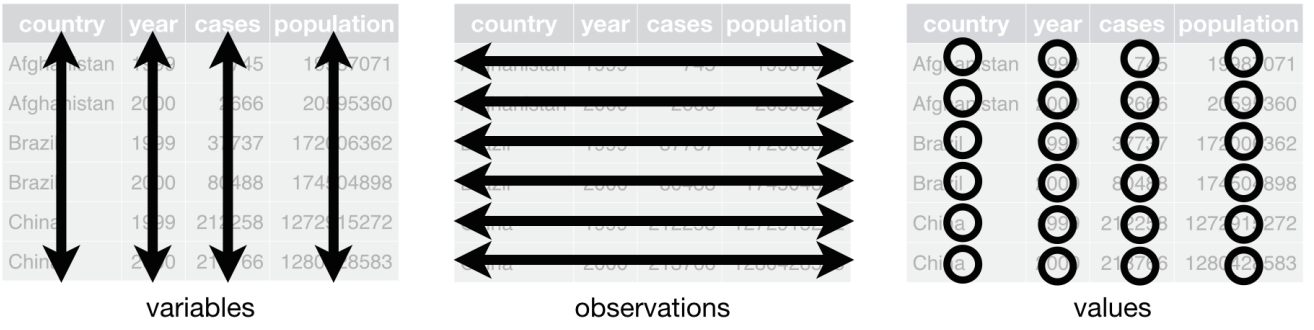
Tidy data


country
year
cases
population
variables


country
year
cases
population
observations


country
year
cases
population
values

Tidy data




```
## # A tibble: 4 x 3
##   title                                 author          price
##   <chr>                                 <chr>           <dbl>
## 1 The Cat in the Hat                    Dr. Seuss        6.99
## 2 Edgar Gets Ready for Bed              Jennifer Adams   9.99
## 3 Edgar Gets Ready for Bed              Ron Stucki       9.99
## 4 "\"More More More,\" Said the Baby"   Vera B Williams  7.19
```

From R4DS - tidy data chapter,

Motivating Examples


Denny's
LA QUINTA

Dark Sky API

The easiest, most advanced, weather API on the web.

TRY FOR FREE

Easy to Use

Weather Conditions

Advanced Data

Web Scraping

rvest

`rvest` is a tidyverse package that makes basic processing and manipulation of HTML data straight forward. It wraps core functionality from the `xml2` package with a more user friendly interface, as such it can also be used for processing XML data.

Core functions:

- `read_html`
- `html_nodes`
- `html_table`
- `html_text`
- `html_name`
- `html_attrs`
- `html_attr`

html + rvest

```
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p align="center">Hello world!</p>
    <br/>
    <div class="name" id="first">John</div>
    <div class="name" id="last">Doe</div>
    <div class="contact">
      <div class="home">555-555-1234</div>
      <div class="home">555-555-2345</div>
      <div class="work">555-555-9999</div>
      <div class="fax">555-555-8888</div>
    </div>
  </body>
</html>
```

```
read_html(html)
```

```
## {xml_document}
## <html>
## [1] <head>\n<meta http-equiv="Content-Type" content="text/html; charset=UTF-8">\n<title
## [2] <body>\n    <p align="center">Hello world!</p>\n    <br><div class="name" id="first
```

css selectors

We will be using a tool called **Selector Gadget** to help identify and extract the html elements / attributes of interest - it does this by interactively constructing a css selector using an example html document.

Selector	Example	Description
element	`p`	Select all <p> elements
element element	`div p`	Select all <p> elements inside a element
element>element	`div > p`	Select all <p> elements with as a parent
.class	`.title`	Select all elements with class="title" attribute
#id	`#name`	Select all elements with id="name" attribute
[attribute]	`[class]`	Select all elements with a class attribute
[attribute=value]	`[class=title]`	Select all elements with class="title"

Selecting and Extracting

```
...
<p align="center">Hello world!</p>
...
```

```
read_html(html) %>% html_nodes("p")
```

```
## {xml_nodeset (1)}
## [1] <p align="center">Hello world!</p>
```

Selecting and Extracting

```
...
<p align="center">Hello world!</p>
...
```

```
read_html(html) %>% html_nodes("p")
```

```
## {xml_nodeset (1)}
## [1] <p align="center">Hello world!</p>
```

```
read_html(html) %>% html_nodes("p") %>% html_text()
```

```
## [1] "Hello world!"
```

Selecting and Extracting

```
...
<p align="center">Hello world!</p>
...
```

```
read_html(html) %>% html_nodes("p")
```

```
## {xml_nodeset (1)}
## [1] <p align="center">Hello world!</p>
```

```
read_html(html) %>% html_nodes("p") %>% html_text()
```

```
## [1] "Hello world!"
```

```
read_html(html) %>% html_nodes("p") %>% html_attrs()
```

```
## [[1]]
##    align
## "center"
```

Selecting and Extracting

```
...
<p align="center">Hello world!</p>
...
```

```
read_html(html) %>% html_nodes("p")
```

```
## {xml_nodeset (1)}
## [1] <p align="center">Hello world!</p>
```

```
read_html(html) %>% html_nodes("p") %>% html_text()
```

```
## [1] "Hello world!"
```

```
read_html(html) %>% html_nodes("p") %>% html_attrs()
```

```
## [[1]]
##    align
## "center"
```

```
read_html(html) %>% html_nodes("p") %>% html_attr("align")
```

```
## [1] "center"
```

Nesting

```
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p align="center">Hello world!</p>
    <br/>
    <div class="name" id="first">John</div>
    <div class="name" id="last">Doe</div>
    <div class="contact">
      <div class="home">555-555-1234</div>
      <div class="home">555-555-2345</div>
      <div class="work">555-555-9999</div>
      <div class="fax">555-555-8888</div>
    </div>
  </body>
</html>
```

```
read_html(html) %>% html_nodes("body div")
```

```
## {xml_nodeset (7)}
## [1] <div class="name" id="first">John</div>
## [2] <div class="name" id="last">Doe</div>
## [3] <div class="contact">\n      <div class="home">555-555-1234</div>\n      <div class=
## [4] <div class="home">555-555-1234</div>
## [5] <div class="home">555-555-2345</div>
## [6] <div class="work">555-555-9999</div>
## [7] <div class="fax">555-555-8888</div>
```

Nesting

```
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p align="center">Hello world!</p>
    <br/>
    <div class="name" id="first">John</div>
    <div class="name" id="last">Doe</div>
    <div class="contact">
      <div class="home">555-555-1234</div>
      <div class="home">555-555-2345</div>
      <div class="work">555-555-9999</div>
      <div class="fax">555-555-8888</div>
    </div>
  </body>
</html>
```

```
read_html(html) %>% html_nodes("body>div")
```

```
## {xml_nodeset (3)}
## [1] <div class="name" id="first">John</div>
## [2] <div class="name" id="last">Doe</div>
## [3] <div class="contact">\n      <div class="home">555-555-1234</div>\n      <div class=
```

Nesting

```
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p align="center">Hello world!</p>
    <br/>
    <div class="name" id="first">John</div>
    <div class="name" id="last">Doe</div>
    <div class="contact">
      <div class="home">555-555-1234</div>
      <div class="home">555-555-2345</div>
      <div class="work">555-555-9999</div>
      <div class="fax">555-555-8888</div>
    </div>
  </body>
</html>
```

```
read_html(html) %>% html_nodes("body div div")
```

```
## {xml_nodeset (4)}
## [1] <div class="home">555-555-1234</div>
## [2] <div class="home">555-555-2345</div>
## [3] <div class="work">555-555-9999</div>
## [4] <div class="fax">555-555-8888</div>
```

classes and ids

```
read_html(html) %>% html_nodes(".name")
```

```
## {xml_nodeset (2)}
## [1] <div class="name" id="first">John</div>
## [2] <div class="name" id="last">Doe</div>
```

classes and ids

```
read_html(html) %>% html_nodes(".name")
```

```
## {xml_nodeset (2)}
## [1] <div class="name" id="first">John</div>
## [2] <div class="name" id="last">Doe</div>
```

```
read_html(html) %>% html_nodes("div.name")
```

```
## {xml_nodeset (2)}
## [1] <div class="name" id="first">John</div>
## [2] <div class="name" id="last">Doe</div>
```

classes and ids

```
read_html(html) %>% html_nodes(".name")
```

```
## {xml_nodeset (2)}
## [1] <div class="name" id="first">John</div>
## [2] <div class="name" id="last">Doe</div>
```

```
read_html(html) %>% html_nodes("div.name")
```

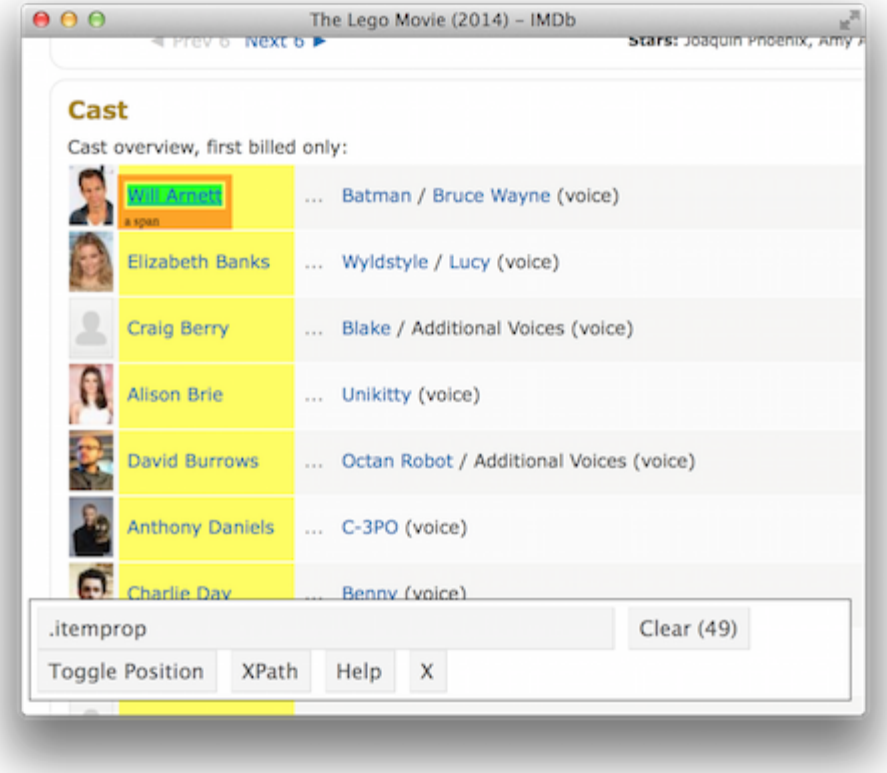
```
## {xml_nodeset (2)}
## [1] <div class="name" id="first">John</div>
## [2] <div class="name" id="last">Doe</div>
```

```
read_html(html) %>% html_nodes("#first")
```

```
## {xml_nodeset (1)}
## [1] <div class="name" id="first">John</div>
```

SelectorGadget

Is a javascript scriptlet / Chrome extension that helps you interactively build a CSS selector for the content you are interested in.



Live Demo

Putting `rvest` and `Selector Gadget` to work

http://bit.ly/Rundel-DVS_dennys

Dark Sky API

Dark Sky API Details

Go to https://darksky.net/dev and sign up for an account.

Every account gets up to 1000 free API calls / day which should be more than enough for our purposed today.

Dark Sky API Details

Go to https://darksky.net/dev and sign up for an account.

Every account gets up to 1000 free API calls / day which should be more than enough for our purposed today.

This API uses a **Re**presentational **S**tate **T**ransfer (REST) design, we can make two kinds of requests with this API.

- Forecast Request:

```
https://api.darksky.net/forecast/{key}/{latitude},{longitude}
```

- Time Machine Request:

```
https://api.darksky.net/forecast/{key}/{latitude},{longitude},{time}
```

Durham Forecast results

The latitude and longitude of Durham, NC are 35.9940° N, 78.8986° W which means we need to request

https://api.darksky.net/forecast/24e13b35a014e3ca53a36a217243f61d/35.9940,-78.8986

from the API.

Durham Forecast results

The latitude and longitude of Durham, NC are 35.9940° N, 78.8986° W which means we need to request

https://api.darksky.net/forecast/24e13b35a014e3ca53a36a217243f61d/35.9940,-78.8986

from the API.

The results look something like the following, where each ⊕ represents hidden nested values.


```
{
  "latitude":35.994,
  "longitude":-78.8986,
  "timezone":"America/New_York",
  "currently":{ ⊕ },
  "minutely":{ ⊕ },
  "hourly":{ ⊕  },
  "daily":{ ⊕ },
  "flags":{ ⊕ },
  "offset":-5
}
```


Note - We can check our coordinates using google maps: https://www.google.com/maps?q=35.9940,-78.8986

jsonlite

To get things into R we can use the `jsonlite` package to directly read the url.

```
durham = jsonlite::fromJSON(
  "https://api.darksky.net/forecast/24e13b35a014e3ca53a36a217243f61d/35.9940,-7
  simplifyDataFrame = FALSE
)
```

```
str(durham)
```

```
## List of 9
##  $ latitude : num 36
##  $ longitude: num -78.9
##  $ timezone : chr "America/New_York"
##  $ currently:List of 18
##   ..$ time                : int 1542120235
##   ..$ summary             : chr "Mostly Cloudy"
##   ..$ icon                : chr "partly-cloudy-day"
##   ..$ nearestStormDistance: int 0
##   ..$ precipIntensity     : int 0
##   ..$ precipProbability   : int 0
##   ..$ temperature         : num 44.4
##   ..$ apparentTemperature : num 44.4
##   ..$ dewPoint            : num 44.4
##   ..$ humidity            : int 1
##   ..$ pressure            : num 1017
```

Complex lists - str

```
str(durham, max.level=1)
```

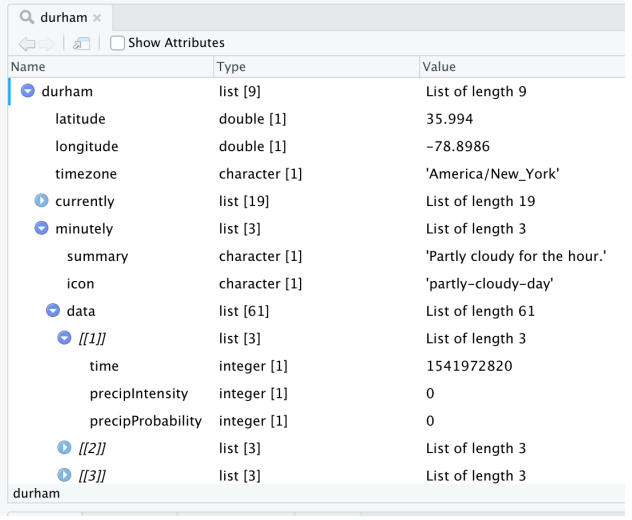
```
## List of 9
##  $ latitude : num 36
##  $ longitude: num -78.9
##  $ timezone : chr "America/New_York"
##  $ currently:List of 18
##  $ minutely :List of 3
##  $ hourly   :List of 3
##  $ daily    :List of 3
##  $ flags    :List of 3
##  $ offset   : int -5
```

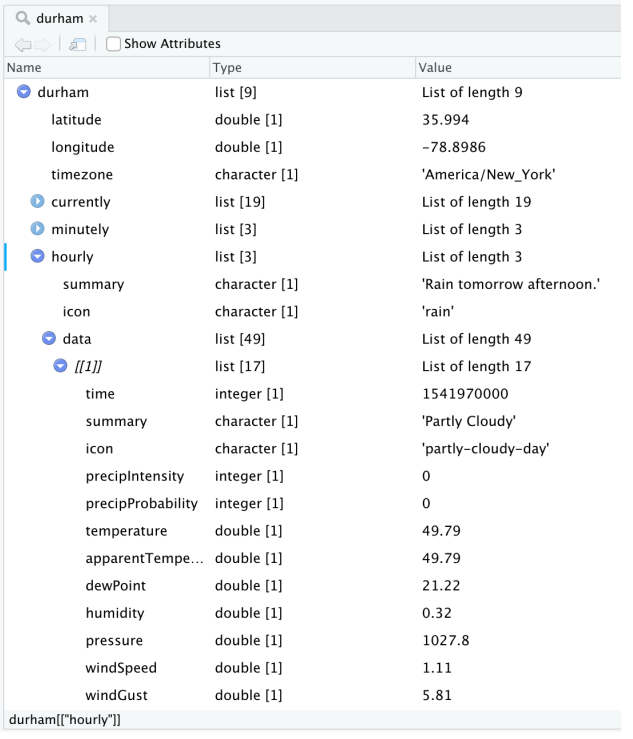
```
str(durham$currently, max.level=1)
```

```
## List of 18
##  $ time                : int 1542120235
##  $ summary             : chr "Mostly Cloudy"
##  $ icon                : chr "partly-cloudy-d
##  $ nearestStormDistance: int 0
##  $ precipIntensity     : int 0
##  $ precipProbability   : int 0
##  $ temperature         : num 44.4
##  $ apparentTemperature : num 44.4
##  $ dewPoint            : num 44.4
##  $ humidity            : int 1
##  $ pressure            : num 1017
##  $ windSpeed           : num 1.98
##  $ windGust            : num 3.07
##  $ windBearing         : int 331
##  $ cloudCover          : num 0.87
##  $ uvIndex             : int 2
##  $ visibility          : num 8.94
##  $ ozone               : num 232
```

Complex `lists` - `View`

```
View(durham)
```





purrr

`purrr` is a tidyverse package which improves the functional programming tools in R (i.e. `lapply`, `sapply`, etc.). It focuses on providing *pure* and *type stable* functions as well as several convenient shortcuts for common tasks.

purrr

`purrr` is a tidyverse package which improves the functional programming tools in R (i.e. `lapply`, `sapply`, etc.). It focuses on providing *pure* and *type stable* functions as well as several convenient shortcuts for common tasks.

Key functions:

- `map()`
- `map_lgl()`
- `map_int()`
- `map_dbl()`
- `map_chr()`
- `map_df()` / `map_dfr()`
- `map_dfc()`
- `walk()`

Type Consistency

R is a weakly / dynamically typed language which means there is no simple way to define a function which enforces the argument or return types of a function.

This flexibility can be useful at times, but often it makes it hard to reason about your code and requires more verbose code to handle edge cases.

```
x = list(1:3, 4:6, 7:9)
```

```
sapply(x, mean)
```

```
## [1] 2 5 8
```

```
lapply(x, mean)
```

```
## [[1]]
## [1] 2
##
## [[2]]
## [1] 5
##
## [[3]]
## [1] 8
```

```
map_dbl(x, mean)
```

```
## [1] 2 5 8
```

```
map_chr(x, mean)
```

```
## [1] "2.000000" "5.000000" "8.000000"
```

```
map_int(x, mean)
```

```
## Error: Can't coerce element 1 from a double to a integer
```

Purrr shortcut - Lookups

Very often we want to extract only certain (named) values from a list, `purrr` provides a shortcut for this operation by providing either a character or numeric value instead of a function to the `map` function.

```
json = jsonlite::fromJSON(
'{
  "bookList": [
    {"title": "The Cat in the Hat",
     "author": "Dr. Seuss",
     "price": 6.99},
    {"title": "Edgar Gets Ready for Bed",
     "author": ["Jennifer Adams", "Ron Stucki"]
     "price": 9.99},
    {"title": "\\"More More More\\", Said the B
     "author": "Vera B Williams",
     "price": 7.19}
  ]
}', simplifyVector = FALSE
)
```

```
str(json)
```

```
## List of 1
##  $ bookList:List of 3
##   ..$ :List of 3
##   .. ..$ title : chr "The Cat in the Hat"
##   .. ..$ author: chr "Dr. Seuss"
##   .. ..$ price : num 6.99
##   ..$ :List of 3
##   .. ..$ title : chr "Edgar Gets Ready for Bed"
##   .. ..$ author:List of 2
##   .. .. ..$ : chr "Jennifer Adams"
##   .. .. ..$ : chr "Ron Stucki"
##   .. ..$ price : num 9.99
##   ..$ :List of 3
##   .. ..$ title : chr "\"More More More\", Said the Baby"
##   .. ..$ author: chr "Vera B Williams"
##   .. ..$ price : num 7.19
```

Purrr shortcut - Lookups

```
map_chr(json$bookList, "title")
```

```
## [1] "The Cat in the Hat"                "Edgar Gets Ready for Bed"
## [3] "\"More More More\", Said the Baby"
```

Purrr shortcut - Lookups

```
map_chr(json$bookList, "title")
```

```
## [1] "The Cat in the Hat"                 "Edgar Gets Ready for Bed"
## [3] "\"More More More\", Said the Baby"
```

```
map_dbl(json$bookList, "price")
```

```
## [1] 6.99 9.99 7.19
```

Purrr shortcut - Lookups

```
map_chr(json$bookList, "title")
```

```
## [1] "The Cat in the Hat"                 "Edgar Gets Ready for Bed"
## [3] "\"More More More\", Said the Baby"
```

```
map_dbl(json$bookList, "price")
```

```
## [1] 6.99 9.99 7.19
```

```
map_chr(json$bookList, "author")
```

```
## Error: Result 2 is not a length 1 atomic vector
```

Purrr shortcut - Lookups

```
map_chr(json$bookList, "title")
```

```
## [1] "The Cat in the Hat"                "Edgar Gets Ready for Bed"
## [3] "\"More More More\", Said the Baby"
```

```
map_dbl(json$bookList, "price")
```

```
## [1] 6.99 9.99 7.19
```

```
map_chr(json$bookList, "author")
```

```
## Error: Result 2 is not a length 1 atomic vector
```

```
map_chr(json$bookList, list("author", 1))
```

```
## [1] "Dr. Seuss"       "Jennifer Adams"  "Vera B Williams"
```

Live Demo

Putting `purrr` to work

http://bit.ly/Rundel-DVS_darksky

Further Reading

- Tidy Data
  - R for Data Science tidy data chapter
  - Hadley's J. Stat Soft Paper (2014)
- Rvest
  - Selector Gadget Vignette
- purrr
  - RStudio's purrr cheatsheet
  - Jenny Bryan's purrr tutorial
  - Advanced R - Functional Programming Chapters: Functional Programming, Functionals, Function Operators