Webscraping in R - DRAFT

a short primer

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February 27, 2018

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  as well as the underlying construction of the web page (site)
  often times *(but not always)* determines the level of effort required to do the job...
- HMTL/CSS complexity? HTML tables rendered via javascript? deciphering XML hierarchy?
  Password protected site?....
  - all can determine which packages/functions to utilize in your effort and the overall approach to take

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  - after that, we'll go through dealing with XML-based webdata (using the *XML2R* package)
  - and finish up with using *rdom* or *RSelenium* to parse data from sites that use javascript to dynamically create website content (rvest can't help here...)

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  - And, a link to an interactive doc on the selectr::css_to_xpath function...(likely to come in handy at some point)

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- Additionally, here's a link to a *css-for-dummies* interactive game for getting over the hump
  - going though this will greatly ease anxiety when navigating webpages with complex HTML/CSS structures...
  - And, a link to an interactive doc on the selectr::css_to_xpath function...(likely to come in handy at some point)

    Just a ***little*** bit of knowledge on deciphering CSS (and later, xpath hierarchies for XML-based data) will go a **looooong** ways!

ok - enough now - let's parse some (html) webdata

Example 1:

- from a webpage listing all R User Groups (*website #1*), grab the groups located in the U.S., and filter on the (fairly large) subset that use meetup.com (*website #2*) as their organizational hub.....so we can gather the following attributes:

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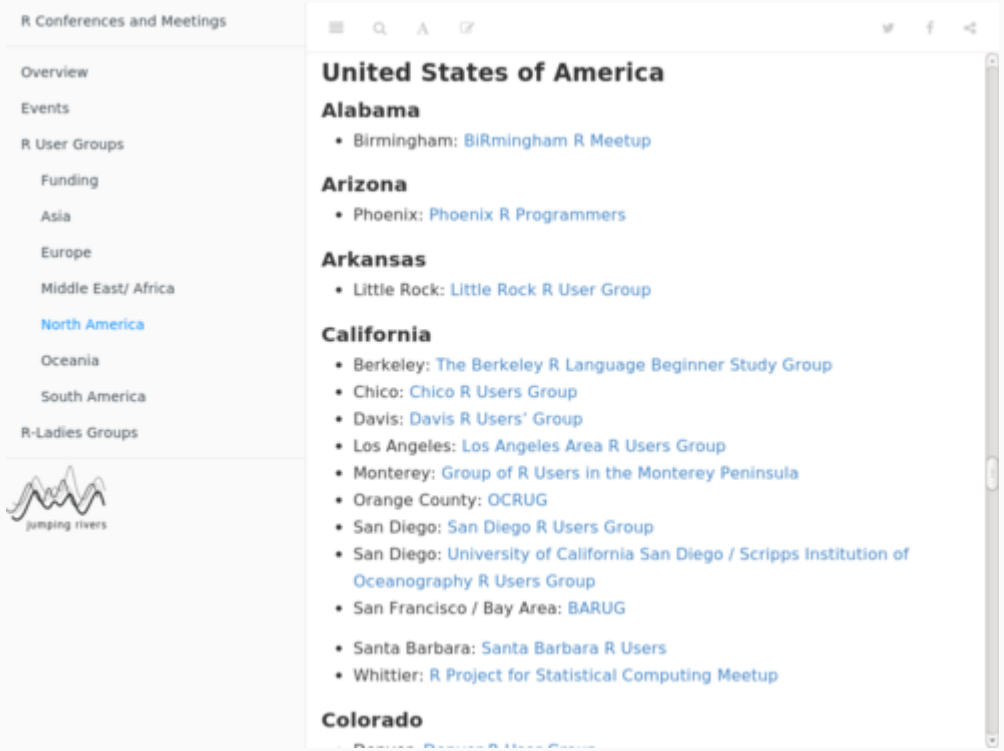
    - location
    - inception date
    - nbr of members
    - nbr of meetings since inception

    NOTE: the 2nd website will be parsed as many times as there are user groups that use meetup.com...not just once!

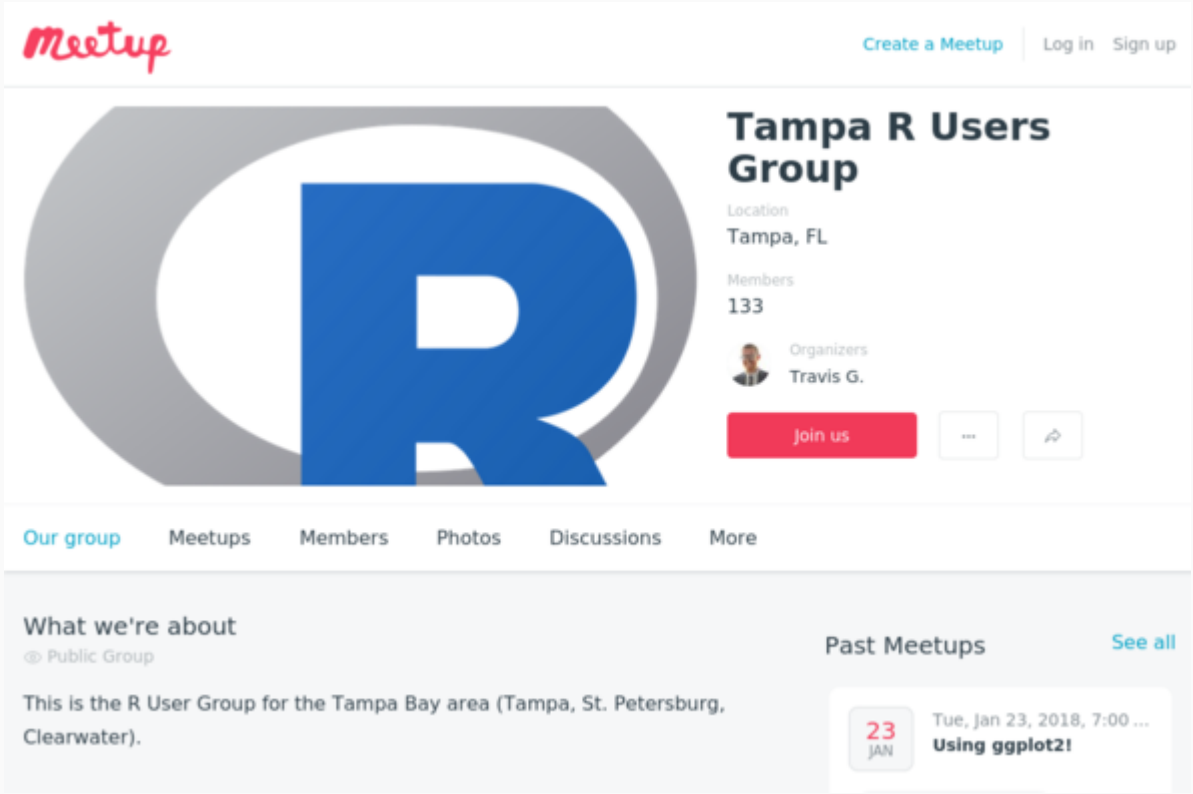
Example 1 - Website 1: R User Groups (in U.S.) parsed one time

https://jumpingrivers.github.io/meetingsR/r-user-groups.html#united-states-of-america



Example 1 - Website 2: meetup.com (parsed multiple times)

https://www.meetup.com/Tampa-R-Users-Group/

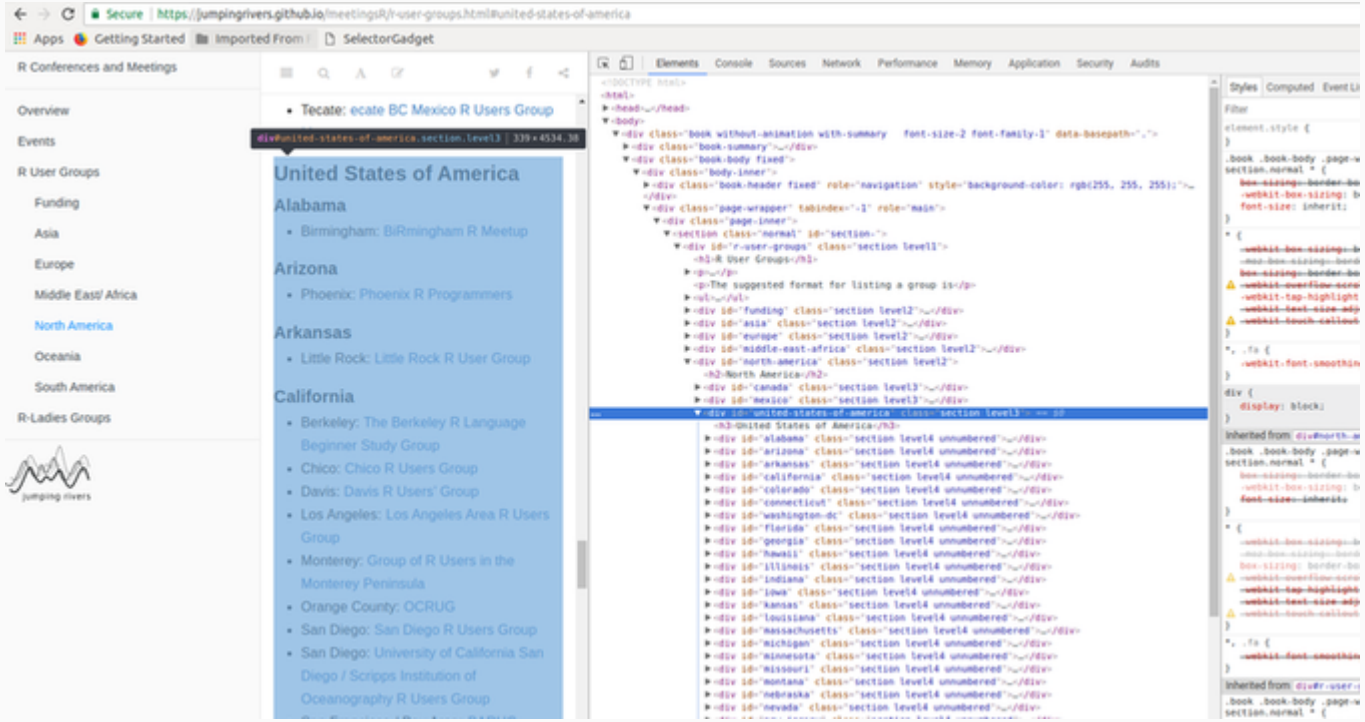


right-click-inspect-element (website #1)

In chrome, *right-click-inspect-element*, and mouse-over the list of R user groups highlighted (in blue!).

The CSS to pass to rvest::html_nodes() is in the **black retangular box**

div#united-states-of-america.section.level3



scrape URLs via css (& xpath)

Now that we have the css, we can use it in the **rvest::html_nodes()** method... as well as pass it to the **selectr::css_to_xpath** method (as a way to show the results will be the same when using **css** or **xpath** parms in the call to **rvest::html_nodes()**

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Now that we have the css, we can use it in the **rvest::html_nodes()** method... as well as pass it to the **selectr::css_to_xpath** method (as a way to show the results will be the same when using **css** or **xpath** parms in the call to **rvest::html_nodes()**

Remember, for website #1, we will scrape just URLs within the U.S.

```
library(rvest)
library(selectr)
url1 <- "https://jumpingrivers.github.io/meetingsR/r-user-groups.html#united-states-of-america"

us_rugs <- read_html(url1)                                  # read url1 to create object for US R User Grps

css1a <- "div#united-states-of-america.section.level3"      # from "right-click-inspect"" method

xp1a  <- css_to_xpath(selector=css1a)                       # get xpath equivalent for css (to show all.equal==TRUE)

rugs_urls1a <- html_nodes(us_rugs,css=css1a) %>%
               html_nodes(.,"a") %>%
                html_attr(.,"href")

rugs_urlsxp1a <- html_nodes(us_rugs,xpath=xp1a) %>% # use xpath this time ... "a" -->  denotes nodes w/a URL (with "href" attribute)
                 html_nodes(.,"a") %>%
                 html_attr(.,"href")

all.equal(rugs_urls1a,rugs_urlsxp1a)
```

```
## [1] TRUE
```

filter & clean URLs before passing to website #2

Not **all** of the 83 URLs use meetup.com (but most do), and we'll clean them up **before the next step**:

```
mu_urls ← rugs_urls1a[grep("meetup.com",rugs_urls1a)] %>%
          gsub("\\d+{4}|events/|members|files/","",.)
length(mu_urls)
```

```
## [1] 64
```

```
mu_urls[1:5]     # 64 out of 83 R User Groups in U.S. use meetup.com
```

```
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## [3] "https://www.meetup.com/r-enthusiasts/"
## [4] "https://www.meetup.com/Chico-R-Users-Group/"
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- OK...for the R-User Groups using meetup.com, *we've got their urls*
- and since **meetup.com** is a "well-formatted" website (i.e. consistent in HTML/CSS structure)....
- it should be quick work to get the CSS (xpath) info we need to parse it

right-click-inspect-element (website #2)

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browseURL(paste0(mu_urls[1],'/members/'))
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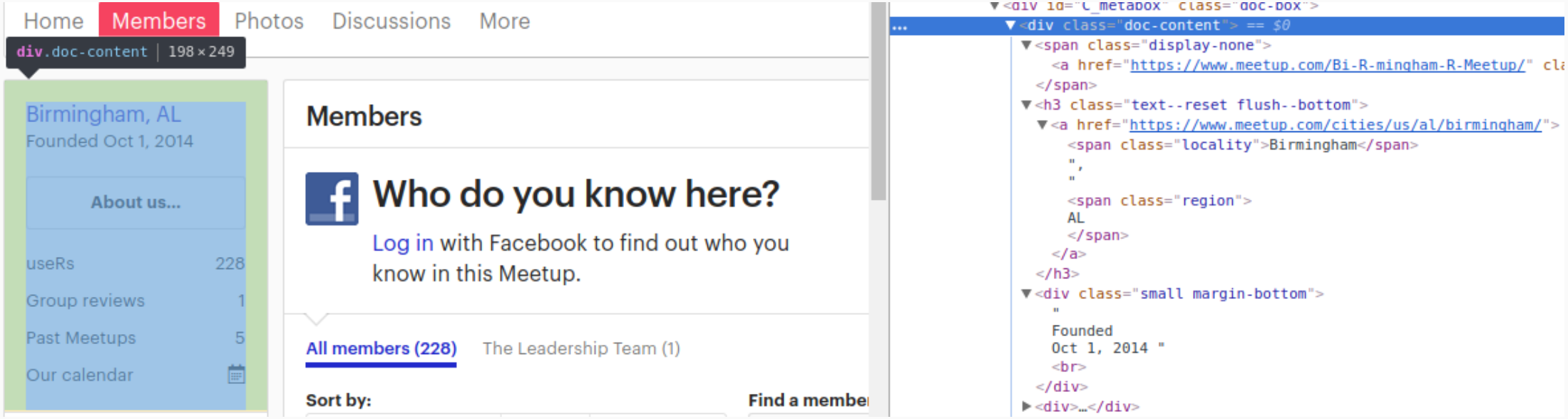
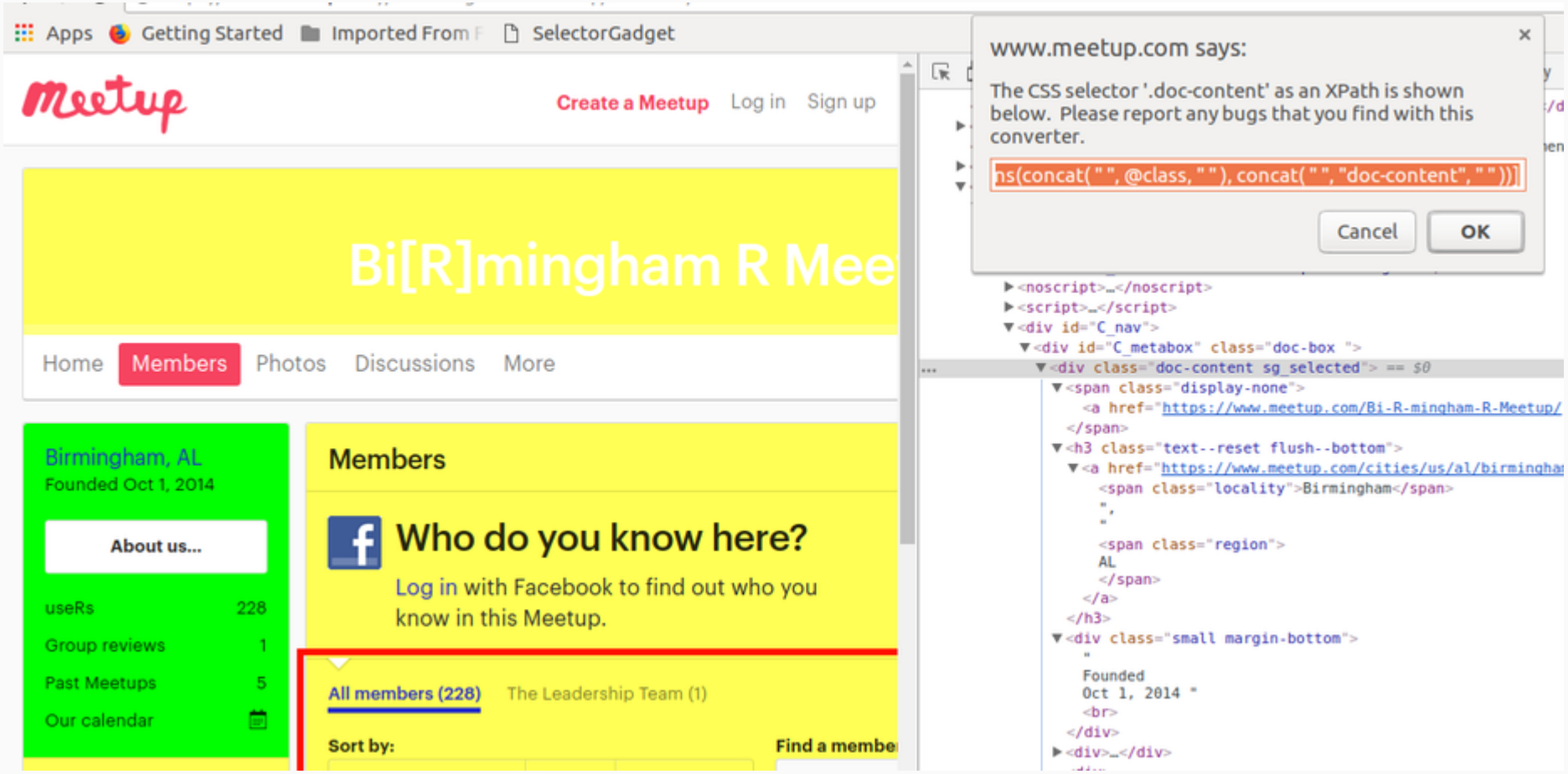
then, use selectorgadget and/or *right-click-inspect-method* to grab xpath to blue (or green) shaded box



selectorgadget method (website #2)

The gadget info box has the xpath to use (click xpath when green area is correctly set)



scrape meetup.com/meetings for all R User Groups

```
#xpath for to obtain group's attributes
```

```
#from the meetup.com/members page
```

```
mu_htm ← read_html(paste0(mu_urls[1],'/members/'))
```

```
mu_infoxp ← '//*[@id="C_metabox"]/div[1]'
```

```
mu_info ← html_nodes(mu_htm,xpath=mu_infoxp)
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```
## founded on date has this CSS

dob_css ← 'div.small.margin-bottom'

mu_dob ← gsub("Founded\n","",html_text(html_nodes(mu_info,css=dob_css),trim=T))
```

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```
# CSS for citi and state
```

```
mu_city ← html_text(html_nodes(mu_info,css=".locality"))
```

```
mu_st ← gsub("\\n","",html_text(html_nodes(mu_info,css=".region")))
```

```
# CSS for (text of) "data" elements
```

```
mu_datacss ← 'ul.paddedList.small.margin-bottom'
```

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putting it together: run code for scraping & parsing the metrics....

```
all_grpinfo ← matrix(nrow=length(mu_urls), ncol=6)
colnames(all_grpinfo) ← c('mu_city', 'mu_st', 'mu_dob', 'mu_nbrmems', 'mu_pstmtgs', 'mu_urls')

mu_infoxp ← '//*[@id="C_metabox"]/div[1]'  # xpath for selecting group attributes from the meetup.com/members page for a given R user group URL
dob_css ← 'div.small.margin-bottom'        # CSS locator for founded date for group
mu_datacss ← 'ul.paddedList.small.margin-bottom' # CSS for (text of) data elements

n ← 5 # scraping 1st 5 urls - see later footnote on wrapping up scrape websites that may limit HTML requests
for (i in 1:n) {
mu_htm ← read_html(paste0(mu_urls[i],'/members/'))
mu_info ← html_nodes(mu_htm,xpath=mu_infoxp)
mu_city ← html_text(html_nodes(mu_info,css=".locality"))
mu_st ← html_text(html_nodes(mu_info,css=".region")) %>%
         gsub("\\n","",.)

mu_dob ← html_text(html_nodes(mu_info,css=dob_css),trim=T) %>%
          gsub("Founded\n","",.)

mu_data ← html_nodes(mu_info,css=mu_datacss) %>%
           html_nodes(.,css="a") %>%
           html_text(.)
mu_nbrmems ← strsplit(mu_data[1],"\n")[[1]][2]
mu_pstmtgs ← strsplit(mu_data[grep("Past Meet", mu_data)],"\n")[[1]][3]

all_grpinfo[i,] ← cbind(mu_city, mu_st, mu_dob, mu_nbrmems, mu_pstmtgs, mu_urls[i])
}
```

sample output

OK - what does it look like?.....

```
options(width = 150)
all_grpinfo[1:n,]
```

```
##      mu_city        mu_st mu_dob         mu_nbrmems mu_pstmtgs mu_urls
## [1,] "Birmingham"   "AL"  "Oct 1, 2014"  "227"      "5"        "https://www.meetup.com/Bi-R-mingham-R-Meetup/"
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[1] https://stackoverflow.com/questions/39056103/iterating-rvest-scrape-function-gives-error-in-open-connectionx-rb-time/39057166/

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- or, one could parse meetings for the topic/subject matter, and *number of attendees*...etc etc etc
  - as a *pedagogical device*, one could create an animated *shiny app* showing growth of R over time and geography (*West Coast to East Coast?*)
  - and on and on and on.....(what about expanding to non-U.S. groups?)

Summary take-away....

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And now, let's move on to scraping some XML-formatted data

Scraping and Parsing XML

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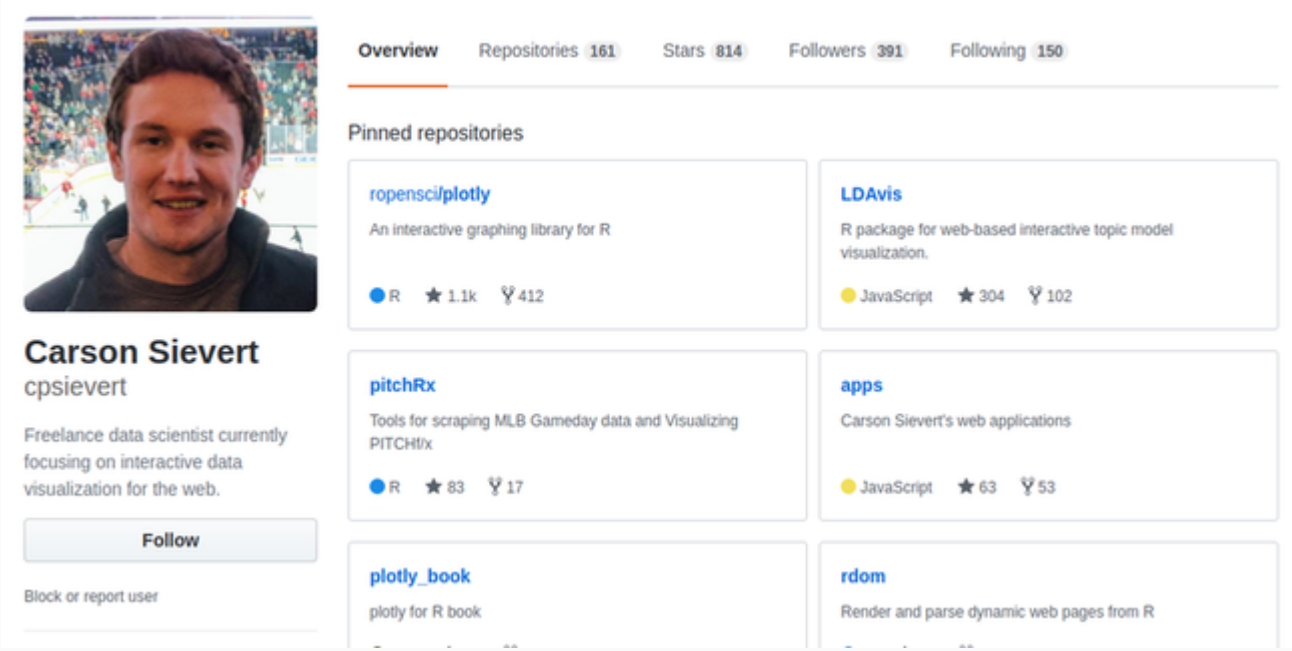
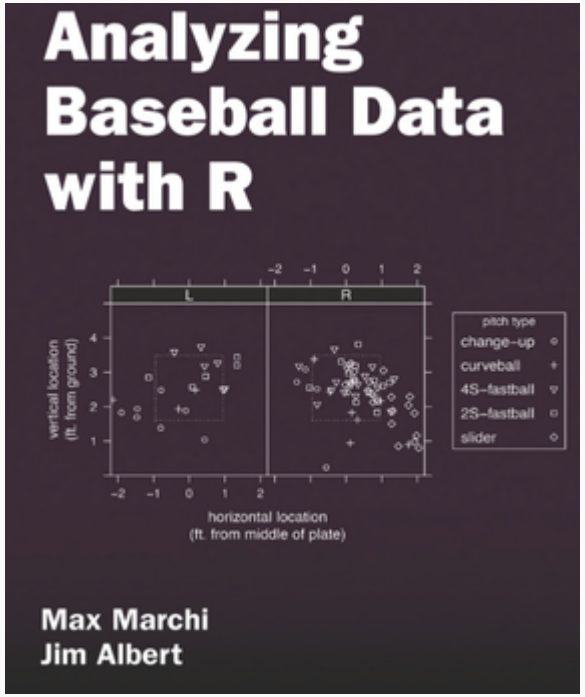
- Carson Seivert wrote the *pitchRx* package (for scraping MLB's "gameday" XML data)



Scraping and Parsing XML

- as referenced in the book *Analyzing Baseball Data in R*



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Scraping and Parsing XML

- If there's one way to learn how to deal with XML, it's in putting together your own database of EVERY pitch thrown in EVERY MLB game over the past x years!
- Since Carson has provided detailed examples of using XML2R[2] in the context of *baseball*, let's do something related to a *different* sport....

[2] https://xml2r.cpsievert.me/

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In the spirit of ***March Madness***, let's grab some NCAA Basketball **"market"** data (i.e., Vegas Oddslines) from *wagertalk.com*

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College Basketball
Tuesday, February 20th, 2018

Time	Gm#	(-) Team	Score	Opener	Public%	Bookmaker	Pincle	Grande	Bovada	Greek	5Dimes	BOnline
02/20 7:00p	501 502	Boston College NC State		159u-116 8	52% 52%	157 5-105	157 5-106	5-105	157 5	157 5-105	157 5	157½u-115 4½-115
02/20 7:00p	503 504	West Virginia Baylor		143u-115 1	51% 51%	1-115 140½	1-106 140½	1	1-115 141u-115	142 pk	1 140½	1-111 140½u-115

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7:00p	502	NC State		8	52%	5-105	5-106	5-105	5	5-105	5	4½-115
02/20	503	West Virginia		143u-115	51%	1-115	1-106	1	1-115	142	1	1-111
7:00p	504	Baylor		1	51%	140½	140½		141u-115	pk	140½	140½u-115

The above shows the odds/lines for NCAA BB as of around noon EST on Feb. 20th 2018....

Scraping and Parsing XML

Fortunately, that data is available in XML format here:

http://www.wagertalk.com/spt-opt/schedule.php?host=WAGERTALK&sport=ncaabb&period=0

```
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    <LOADED value="Schedule loaded at (1519140317)(1519140318)"/>
  - <LEAGUE number="4" name="College Basketball">
    - <GAME date="20180220" time="1600" seconds="1519113600">
      - <TEAM number="501" name="Boston College">
          <OPENER value="159u-116"/>
          <LINE book="1" value="157" seconds="5798"/>
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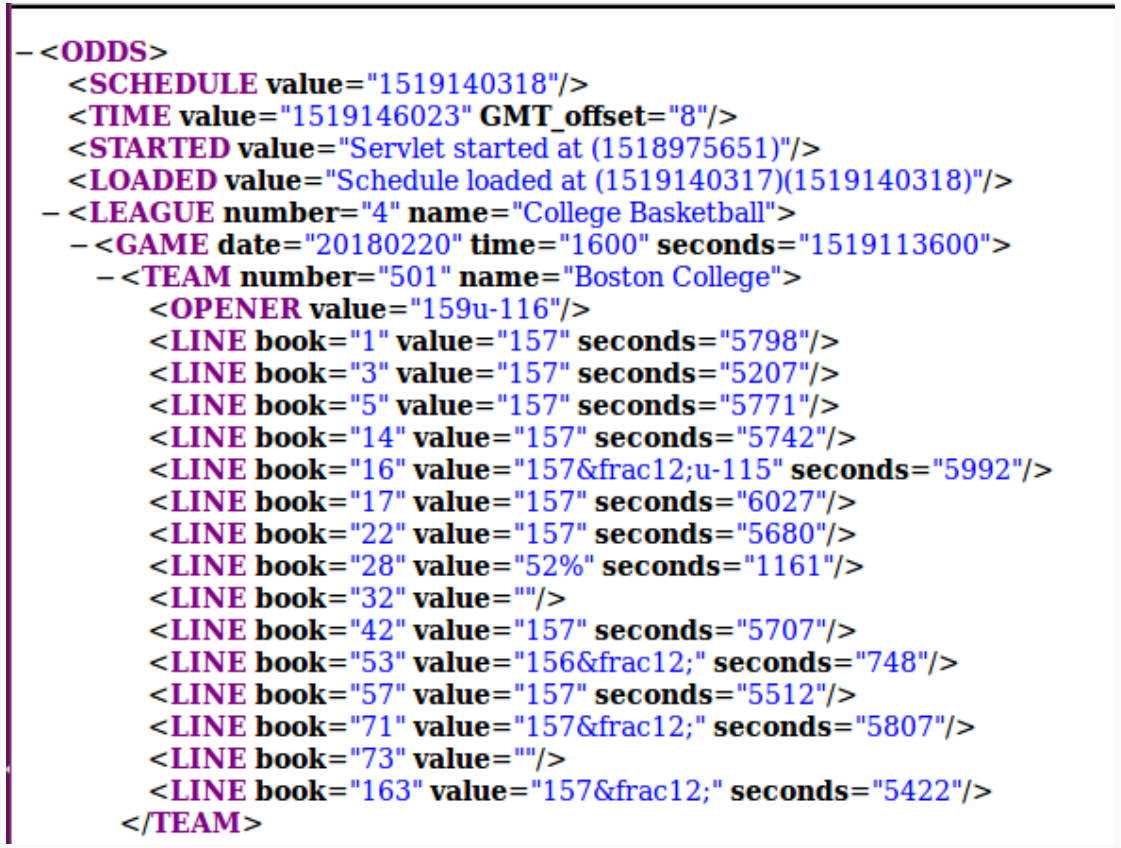
.....now left's examine the XML hierarchy....

.....before running some simple code....

Examining the XML structure

XML Hierarchy

1. open the file and example the structure
   - expand and collapse the XML hierarchy to geta feel for how the parent/child relationships are formatted
2. think of the XML in terms of *facts* and *dimensions*[3], and in terms of 'global' information.
   - in this case, the (my phrase) 'global' tags are SCHEDULE, TIME, STARTED, LOADED, LEAGUE
3. each GAME node has associated date/datetime elements, but also has 2 TEAM child nodes....
4. finally, TEAM node has set of LINE tags
   - LINE tags relate to the line's "provider" (bookmaker)
   - one set of LINEs relate to "point spread", and the other relates to game totals (OVER/UNDER)



[3] https://en.wikipedia.org/wiki/Dimensional_modeling

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- for this exercise, we'll use just 3 functions:
  - XML2R::XML2Obs
  - XML2R::add_key
  - XML2R::collapse_obs

Parsing the XML via XML2R functions

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xmlobs1 ← XML2Obs(xml1, quiet=TRUE)
table(names(xmlobs1))
```

```
##
##                     ODDS//LEAGUE              ODDS//LEAGUE//GAME        ODDS//LEAGUE//GAME//TEAM   ODDS//LEAGUE//GAME//TEAM//LINE
##                                1                              71                             142                              1608
## ODDS//LEAGUE//GAME//TEAM//OPENER                 ODDS//LOADED                 ODDS//SCHEDULE                 ODDS//STARTED
##                              142                               1                               1                               1
##                       ODDS//TIME
##                                1
```

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## ODDS//LEAGUE//GAME//TEAM//OPENER                ODDS//LOADED                ODDS//SCHEDULE                 ODDS//STARTED
##                               142                               1                               1                                 1
##                       ODDS//TIME
##                                 1
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After having perused the XML file by collapsing/expanding nodes, the output *makes sense*....

- each GAME has **2** TEAMS

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## ODDS//LEAGUE//GAME//TEAM//OPENER                ODDS//LOADED                ODDS//SCHEDULE                 ODDS//STARTED
##                               142                               1                               1                                 1
##                       ODDS//TIME
##                                 1
```

After having perused the XML file by collapsing/expanding nodes, the output *makes sense*....

- each GAME has **2** TEAMS
- the 'global' information is associated with a **single** count of a node ('time', 'loaded', etc)
- now, we'll make sure the PARENT node data is passed to the CHILD nodes (before creating data.frame type output)

mapping parent-to-child (via XML2R::add_key)

Remember - the LINE nodes are the "facts", and we need to be able to map those facts to their parent attributes...

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```

```
xmlobs1 ← add_key(xmlobs1, parent="ODDS//LEAGUE//GAME", recycle="date", key.name="gamedate")
```

```
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```

- under GAME//TEAM, we want the (team) "name" and the (game-wager) "number" passed down

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# adding key - new col of "gametime"
xmlobs1 ← add_key(xmlobs1, parent="ODDS//LEAGUE//GAME", recycle="time", key.name="gametime")
```

- under GAME//TEAM, we want the (team) "name" and the (game-wager) "number" passed down

```
# new col of "gamewgrnbr"
xmlobs1 ← add_key(xmlobs1, parent="ODDS//LEAGUE//GAME//TEAM", recycle="number", key.name="gamewgrnbr")
# new col of "teamname"
xmlobs1 ← add_key(xmlobs1 , parent="ODDS//LEAGUE//GAME//TEAM", recycle="name", key.name="teamname")
```

collapsing observations (via XML2R::collapse_obs)

Now, we can simply use XML2R::collapse_obs to get a matrix

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```
#collapse observations from the ....//LINE nodes

#and remove the "url" colname (don't need it)

oddsline ← collapse_obs(xmlobs1[grep("^ODDS//LEAGUE//GAME//TEAM//LINE$",names(xmlobs1))])

oddsline ← oddsline[,-grep("url",colnames(oddsline))]
```

run code and show output

We'll just run the previously shown code and show some output to verify all 3 XML2R functions we've used did their job...

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```
xmlobs1 ← add_key(xmlobs1, parent="ODDS//LEAGUE//GAME", recycle="date", key.name="gamedate") # adding key - new col of "gamedate"
xmlobs1 ← add_key(xmlobs1, parent="ODDS//LEAGUE//GAME", recycle="time", key.name="gametime") # adding key - new col of "gametime"
xmlobs1 ← add_key(xmlobs1, parent="ODDS//LEAGUE//GAME//TEAM", recycle="number", key.name="gamewgrnbr") # new col of "gamewgrnbr"
xmlobs1 ← add_key(xmlobs1 , parent="ODDS//LEAGUE//GAME//TEAM", recycle="name", key.name="teamname")
oddsline ← collapse_obs(xmlobs1[grep("^ODDS//LEAGUE//GAME//TEAM//LINE$",names(xmlobs1))])  # this returns a matrix
oddsline ← oddsline[,-grep("url",colnames(oddsline))]            # get rid of the long "url" colname
head(oddsline)
```

```
##      book value         seconds gamedate   gametime gamewgrnbr teamname
## [1,] "1"  "132"         "834"   "20180222" "1600"   "563"      "Connecticut"
## [2,] "3"  "131&frac12;" "13546" "20180222" "1600"   "563"      "Connecticut"
## [3,] "5"  "132"         "767"   "20180222" "1600"   "563"      "Connecticut"
## [4,] "14" "132"         "797"   "20180222" "1600"   "563"      "Connecticut"
## [5,] "16" "131o-115"    "1024"  "20180222" "1600"   "563"      "Connecticut"
## [6,] "17" "132"         "840"   "20180222" "1600"   "563"      "Connecticut"
```

Post-processing: task list

Here's a list of things to do to get the data into a "usable" data frame....

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- parse the lines for half-points (gsub the "ampersand frac12")
- perform necessary character-to-numeric conversions
- ...and then for dates/datetimes, convert to appropriate POSIX.. classes
- get the "datetime-line-refresh" from the global //TIME attribute and...
- use that with the "seconds" value to calculate the datetime for a given "LINE"
- calculate an "hours-to-gametime" column (optional - but easier to digest!)
- load to a database table (mysql is my preference) for tracking line movements over time

Final resting place (for the parsed & processed XML)

sportlinetype_x	book	gamedttm	game_id	game_name	gamewgri	game	teamname_x	teamname_y	away_	home_	away_ps_	home_ps_	favetes	favet	ps_dttmlinevalue	pshrs2gt
ncaabb_ps	1	2017-11-28 18:30:00	511_512	Baylor_@_Xavier	511	512	Baylor	Xavier	4.5	-4.5	-110	-110	1	0	2017-11-27 17:59:22	24.5
ncaabb_ps	1	2017-11-28 19:00:00	513_514	Appalachian State_@_VA Co...	513	514	Appalachian State	VA Commo...	11	-11	-110	-110	1	0	2017-11-27 17:42:54	25.3
ncaabb_ps	1	2017-11-28 19:00:00	515_516	Brown_@_Rhode Island	515	516	Brown	Rhode Island	20	-20	-110	-110	1	0	2017-11-27 17:43:04	25.3
ncaabb_ps	1	2017-11-28 19:00:00	517_518	Florida State_@_Rutgers	517	518	Florida State	Rutgers	-4.5	4.5	-111	-109	0	1	2017-11-27 17:43:41	25.3

Notice the "pshr2gt" column...(point-spread-hours-to-gametime)

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sportlinetype_x	book	gamedttm	game_id	game_name	gamewgri	game	teamname_x	teamname_y	away_	home_	away_ps_	home_ps_	favetes	favet	ps_dttmlinevalue	pshrs2gt
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Notice the "pshr2gt" column...(point-spread-hours-to-gametime)

- that's from adding "seconds" to the global "TIME" attribute and subtracting game-datetime

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ncaabb_ps	1	2017-11-28 19:00:00	513_514	Appalachian State_@_VA Co...	513	514	Appalachian State	VA Commo...	11	-11	-110	-110	1	0	2017-11-27 17:42:54	25.3
ncaabb_ps	1	2017-11-28 19:00:00	515_516	Brown_@_Rhode Island	515	516	Brown	Rhode Island	20	-20	-110	-110	1	0	2017-11-27 17:43:04	25.3
ncaabb_ps	1	2017-11-28 19:00:00	517_518	Florida State_@_Rutgers	517	518	Florida State	Rutgers	-4.5	4.5	-111	-109	0	1	2017-11-27 17:43:41	25.3

Notice the "pshr2gt" column...(point-spread-hours-to-gametime)

- that's from adding "seconds" to the global "TIME" attribute and subtracting game-datetime

Moving on - knowing when it's time to use RSelenium

Final resting place (for the parsed & processed XML)

sportlinetype_x	book	gamedttm	game_id	game_name	gamewgri	game	teamname_x	teamname_y	away_	home_	away_ps_	home_ps_	favetes	favet	ps_dttmlinevalue	pshrs2gt
ncaabb_ps	1	2017-11-28 18:30:00	511_512	Baylor_@_Xavier	511	512	Baylor	Xavier	4.5	-4.5	-110	-110	1	0	2017-11-27 17:59:22	24.5
ncaabb_ps	1	2017-11-28 19:00:00	513_514	Appalachian State_@_VA Co...	513	514	Appalachian State	VA Commo...	11	-11	-110	-110	1	0	2017-11-27 17:42:54	25.3
ncaabb_ps	1	2017-11-28 19:00:00	515_516	Brown_@_Rhode Island	515	516	Brown	Rhode Island	20	-20	-110	-110	1	0	2017-11-27 17:43:04	25.3
ncaabb_ps	1	2017-11-28 19:00:00	517_518	Florida State_@_Rutgers	517	518	Florida State	Rutgers	-4.5	4.5	-111	-109	0	1	2017-11-27 17:43:41	25.3

Notice the "pshr2gt" column...(point-spread-hours-to-gametime)

- that's from adding "seconds" to the global "TIME" attribute and subtracting game-datetime

  Moving on - knowing when it's time to use RSelenium

- (or its easy-to-use wrapper form via the rdom package)

Intro to RSelenium