Assignment 09: Data Scraping

Emma DeAngeli

Total points:

OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics on data scraping.

Directions

1. Change "Student Name" on line 3 (above) with your name.
2. Work through the steps, **creating code and output** that fulfill each instruction.
3. Be sure to **answer the questions** in this assignment document.
4. When you have completed the assignment, **Knit** the text and code into a single PDF file.
5. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai. Add your last name into the file name (e.g., "Fay_09_Data_Scraping.Rmd") prior to submission.

Set up

1. Set up your session:

- Check your working directory
- Load the packages `tidyverse`, `rvest`, and any others you end up using.
- Set your ggplot theme

```
#1
getwd()
```

```
## [1] "C:/Users/Emma DeAngeli/Documents/Environmental Data Analytics/Assignments"
```

```
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.0.5

## Warning: package 'ggplot2' was built under R version 4.0.5

## Warning: package 'tibble' was built under R version 4.0.5

## Warning: package 'tidyr' was built under R version 4.0.5

## Warning: package 'readr' was built under R version 4.0.5
```

```
## Warning: package 'purrr' was built under R version 4.0.5

## Warning: package 'dplyr' was built under R version 4.0.5

## Warning: package 'stringr' was built under R version 4.0.5

## Warning: package 'forcats' was built under R version 4.0.5
```

```
library(rvest)
```

```
## Warning: package 'rvest' was built under R version 4.0.5
```

```
library(ggplot2)
library(lubridate)
```

```
## Warning: package 'lubridate' was built under R version 4.0.5
```

```
mytheme <- theme_classic(base_size = 14) +
  theme(axis.text = element_text(color = "darkgreen"),
        legend.position = "right")
theme_set(mytheme)
```

2. We will be scraping data from the NC DEQs Local Water Supply Planning website, specifically the Durham's 2020 Municipal Local Water Supply Plan (LWSP):

- Navigate to https://www.ncwater.org/WUDC/app/LWSP/search.php
- Change the date from 2021 to 2020 in the upper right corner.
- Scroll down and select the LWSP link next to Durham Municipality.
- Note the web address: https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=03-32-010&year=2020

Indicate this website as the as the URL to be scraped. (In other words, read the contents into an `rvest` webpage object.)

```
#2
webpage <- read_html('https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=03-32-010&year=2020')
webpage
```

```
## {html_document}
## <html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
## [1] <head>\n<title>DWR :: Local Water Supply Planning</title>\n<meta http-equ ...
## [2] <body id="plan">\r\n<!--<div id="division-header">\r\n<a name="top" href= ...
```

3. The data we want to collect are listed below:

- From the "1. System Information" section:
- Water system name
- PWSID

- Ownership
- From the "3. Water Supply Sources" section:
- Average Daily Use (MGD) - for each month

In the code chunk below scrape these values, assigning them to three separate variables.

> HINT: The first value should be "Durham", the second "03-32-010", the third "Municipality", and the last should be a vector of 12 numeric values, with the first value being 36.0100.

```
#3
water.system.name <- webpage %>%
  html_nodes("div+ table tr:nth-child(1) td:nth-child(2)") %>%
  html_text()

pwsid <- webpage %>%
  html_nodes("td tr:nth-child(1) td:nth-child(5)") %>%
  html_text()

ownership <- webpage %>%
  html_nodes("div+ table tr:nth-child(2) td:nth-child(4)") %>%
  html_text()

max.withdrawals.mgd <- webpage %>%
  html_nodes("th~ td+ td") %>%
  html_text()
```

4. Convert your scraped data into a dataframe. This dataframe should have a column for each of the 4 variables scraped and a row for the month corresponding to the withdrawal data. Also add a Date column that includes your month and year in data format. (Feel free to add a Year column too, if you wish.)

   > TIP: Use `rep()` to repeat a value when creating a dataframe.

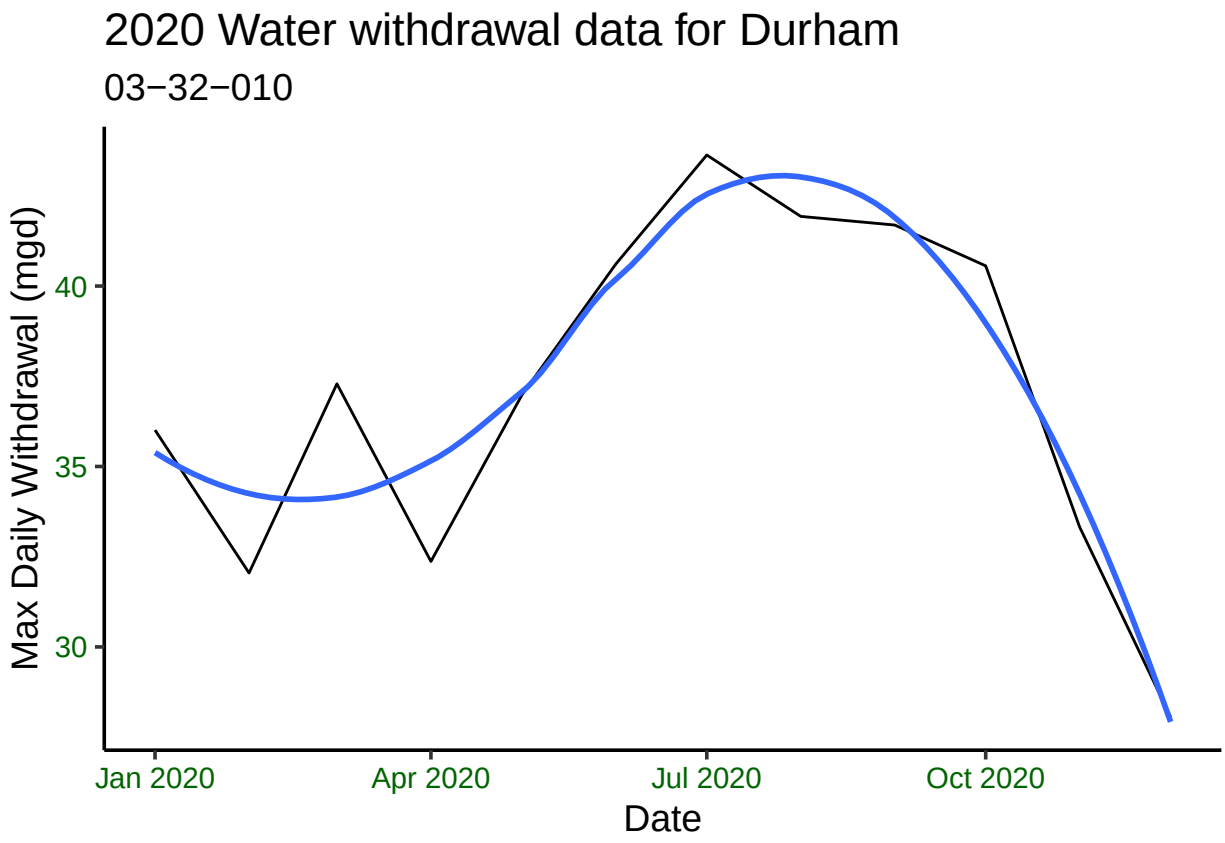
   > NOTE: It's likely you won't be able to scrape the monthly widthrawal data in order. You can overcome this by creating a month column in the same order the data are scraped: Jan, May, Sept, Feb, etc...

5. Plot the max daily withdrawals across the months for 2020

```
#4

months = c("Jan", "May", "Sept", "Feb", "June", "Oct", "Mar", "July", "Nov", "Apr", "Aug", "Dec")

df_withdrawals <- data.frame("Month" = months,
                             "Year" = rep(2020,12),
                             "System_name" = water.system.name,
                             "PWSID" = pwsid,
                             "Ownership" = ownership,
                             "Max_withdrawals" = as.numeric(max.withdrawals.mgd))
```

```r
#Modify the dataframe to include the facility name and type as well as the date (as date object)
df_withdrawals <- df_withdrawals %>%
  mutate(Date = my(paste(Month,"-",Year)))

#5

#Plot
ggplot(df_withdrawals,aes(x=Date,y=Max_withdrawals)) +
  geom_line() +
  geom_smooth(method="loess",se=FALSE) +
  labs(title = paste("2020 Water withdrawal data for",water.system.name),
       subtitle = pwsid,
       y="Max Daily Withdrawal (mgd)",
       x="Date")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



6. Note that the PWSID and the year appear in the web address for the page we scraped. Construct a function using your code above that can scrape data for any PWSID and year for which the NC DEQ has data. **Be sure to modify the code to reflect the year and site scraped**.

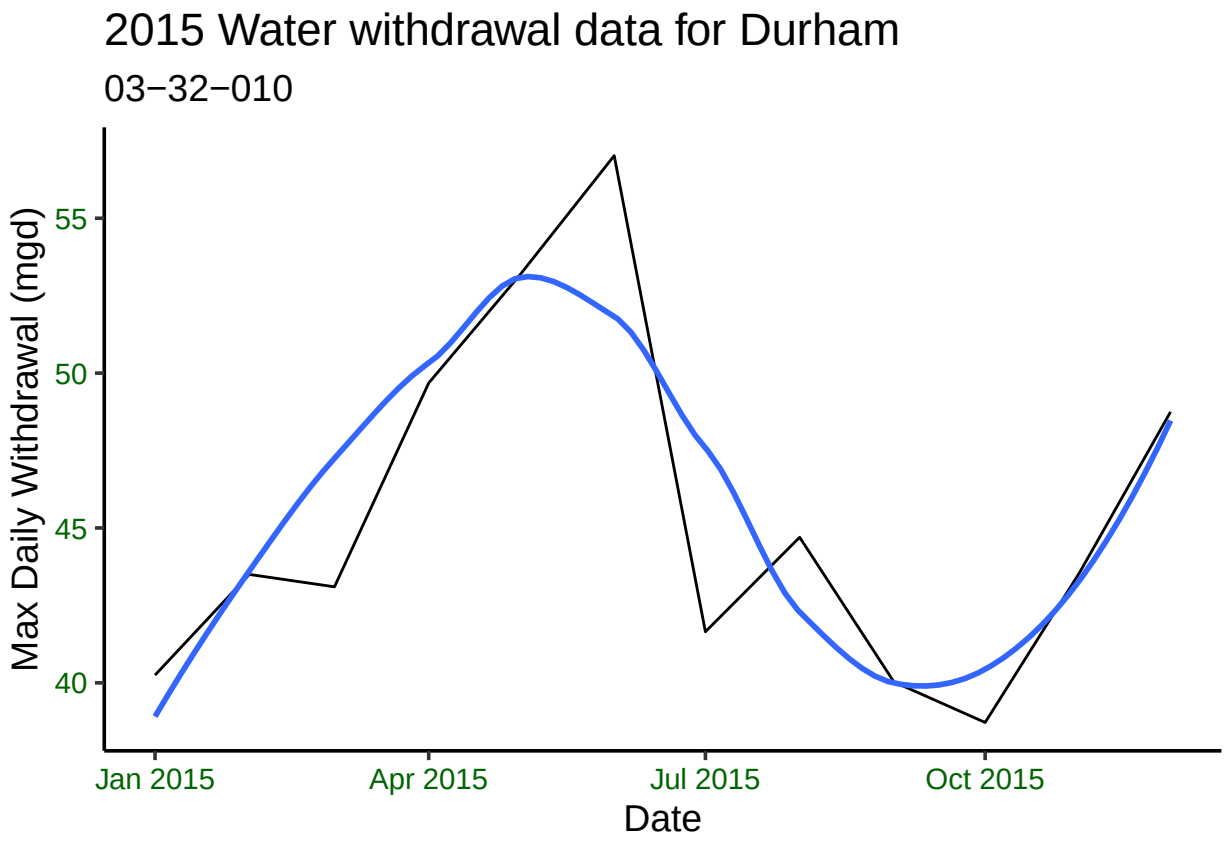
```r
#6.

scrape.it <- function(the_year, the_PWSID){
```

```
  #Retrieve the website contents
  the_website <- read_html(paste0('https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=', the_PWSID,

  #Set the element address variables (determined in the previous step)
  water.system.name.tag <- "div+ table tr:nth-child(1) td:nth-child(2)"
  pwsid.tag <- "td tr:nth-child(1) td:nth-child(5)"
  ownership.tag <- "div+ table tr:nth-child(2) td:nth-child(4)"
  max.withdrawals.mgd.tag <- "th~ td+ td"


  #Scrape the data items
  water.system.name <- the_website %>% html_nodes(water.system.name.tag) %>% html_text()
  pwsid <- the_website %>% html_nodes(pwsid.tag) %>% html_text()
  ownership <- the_website %>% html_nodes(ownership.tag) %>% html_text()
  max.withdrawals.mgd <- the_website %>% html_nodes(max.withdrawals.mgd.tag) %>% html_text()

  #Convert to a dataframe
  df_withdrawals <- data.frame("Month" = months,
                               "Year" = rep(the_year,12),
                               "System_name" = water.system.name,
                               "PWSID" = pwsid,
                               "Ownership" = ownership,
                              "Max_withdrawals" = as.numeric(max.withdrawals.mgd))
  df_withdrawals <- df_withdrawals %>%
    mutate(Date = my(paste(Month,"-",Year)))



  #Pause for a moment - scraping etiquette
  #Sys.sleep(1) #uncomment this if you are doing bulk scraping!

  #Return the dataframe
  return(df_withdrawals)
}
```

7. Use the function above to extract and plot max daily withdrawals for Durham (PWSID='03-32-010') for each month in 2015

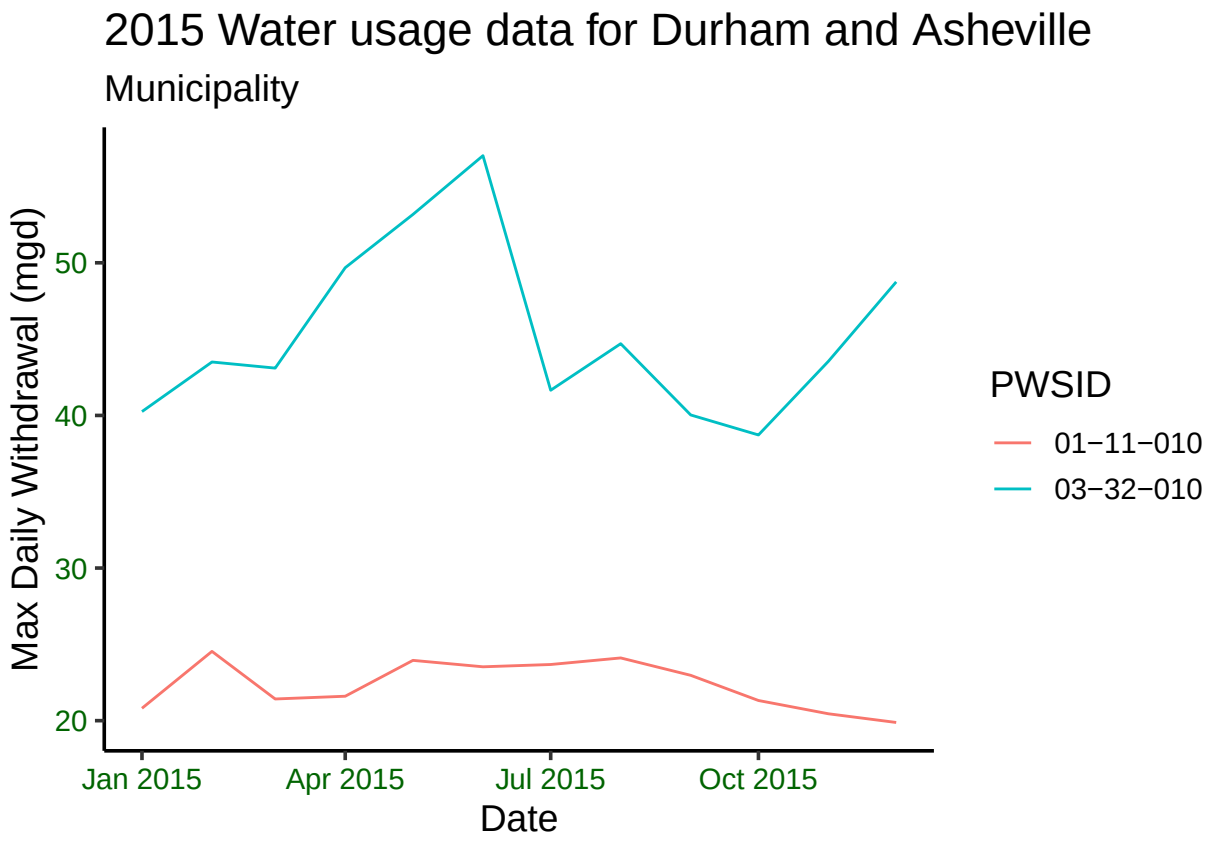
```
#7
df_withdrawals_2015 <- scrape.it(2015, "03-32-010")

ggplot(df_withdrawals_2015,aes(x=Date,y=Max_withdrawals)) +
  geom_line() +
  geom_smooth(method="loess",se=FALSE) +
  labs(title = paste("2015 Water withdrawal data for",water.system.name),
       subtitle = pwsid,
       y="Max Daily Withdrawal (mgd)",
       x="Date")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



8. Use the function above to extract data for Asheville (PWSID = 01-11-010) in 2015. Combine this data with the Durham data collected above and create a plot that compares the Asheville to Durham's water withdrawals.

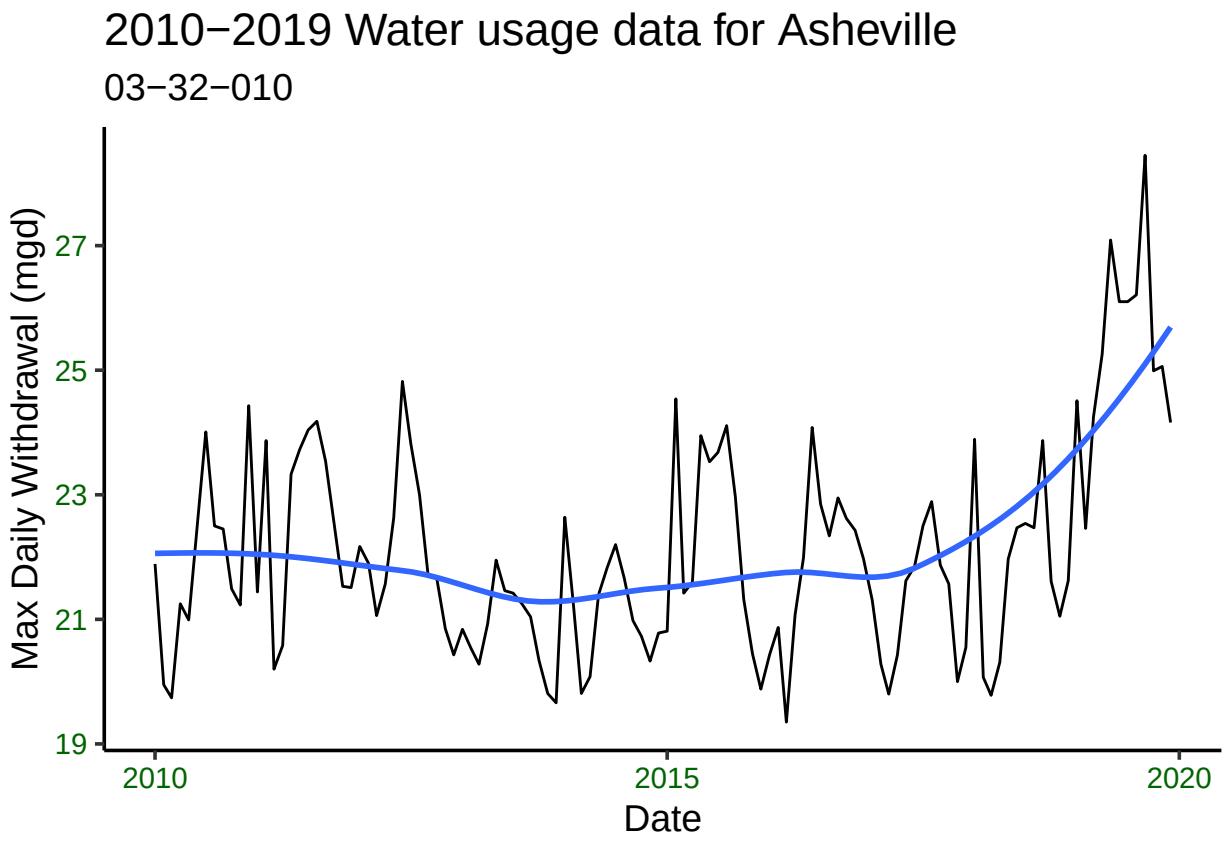
```
#8
df_withdrawals_Ash <- scrape.it(2015, "01-11-010")

the_df <- bind_rows(df_withdrawals_2015, df_withdrawals_Ash)

ggplot(the_df,aes(x= Date, y=Max_withdrawals, color=PWSID)) +
  geom_line() +
  labs(title = paste("2015 Water usage data for Durham and Asheville"),
       subtitle = ownership,
       y="Max Daily Withdrawal (mgd)",
       x="Date")
```



9. Use the code & function you created above to plot Asheville's max daily withdrawal by months for the years 2010 thru 2019.Add a smoothed line to the plot.

```
#9

#Set the inputs to scrape
the_years = rep(2010:2019)
my_pwsid = '01-11-010'

#Use lapply to apply the scrape function
the_dfs <- lapply(X = the_years,
                  FUN = scrape.it,
                  the_PWSID=my_pwsid)

#Conflate the returned dataframes into a single dataframe
the_df_2 <- bind_rows(the_dfs)

#Plot, because it's fun and rewarding
ggplot(the_df_2,aes(x=Date,y=Max_withdrawals)) +
  geom_line() +
  geom_smooth(method="loess",se=FALSE) +
  labs(title = paste("2010-2019 Water usage data for Asheville"),
       subtitle = pwsid,
       y="Max Daily Withdrawal (mgd)",
       x="Date")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



Question: Just by looking at the plot (i.e. not running statistics), does Asheville have a trend in water usage over time?

Yes– although the water usage stayed fairly steady until around 2017, there has been a clear upward trend since then.