Assignment 09: Data Scraping

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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/lwa8/Documents/R/ENV872/Environmental_Data_Analytics_2022/Assignments"
```

```
library(tidyverse)
library(rvest)
```

```
## Warning: package 'rvest' was built under R version 4.1.3
```

```
library(lubridate)
library(purrr)

mytheme <- theme_classic() +
  theme(axis.text = element_text(color = "black"))
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 2020 to 2019 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')
```

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

- From the "1. System Information" section:
- Water system name
- PSWID
- 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()
pswid <- 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
month <- c(1,5,9,2,6,10,3,7,11,4,8,12)
year <- 2020
maxuse.df <- data.frame(
  "Month" = as.factor(month),
  "Max_Withdrawl" = as.numeric(max.withdrawals.mgd),
  "System_Name" = water.system.name,
  "Ownership" = ownership,
```

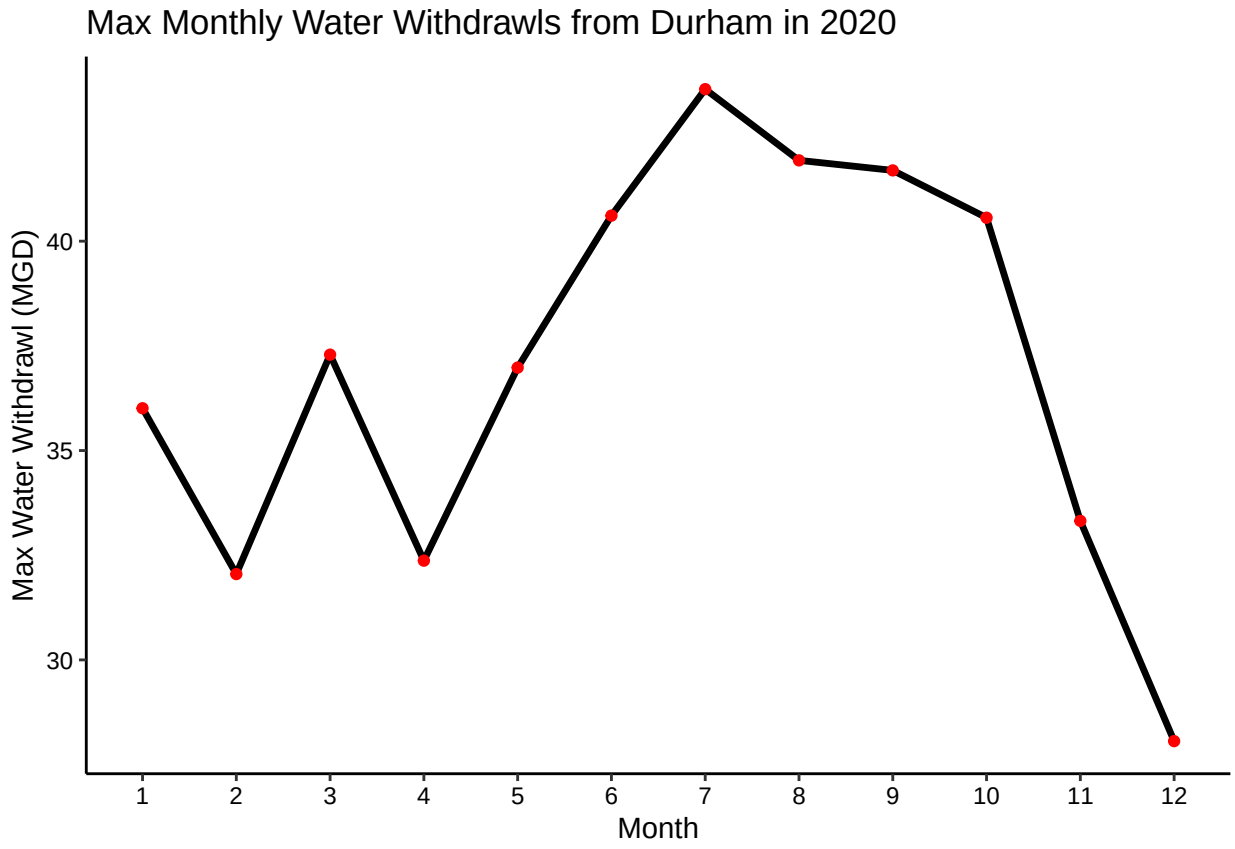
```
  "PSWID" = pswid,
   'Date' = my(paste(month,"-",year)))


maxuse.df <- arrange(maxuse.df, Month)

maxuse.df <- maxuse.df %>%
  mutate(
    MonthName = c(
      "Jan", "Fed", "Mar", "Apr", "May", "Jun", "Jul", "Aug", "Sept", "Oct", "Nov", "Dec"
  ))

#5

ggplot(maxuse.df, aes(x = Month, y = Max_Withdrawl, group = 1))+
  geom_line(size = 1.2)+
  geom_point(color = "red")+
  labs(title = "Max Monthly Water Withdrawls from Durham in 2020",
       y = "Max Water Withdrawl (MGD)")
```



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**.

```
#6.

maxuse.scrape <- function(PSWID, Year){
```

```
  #Fetch Website

  webpage <- read_html(paste0(
    'https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=',
    PSWID, '&year=',
    Year))

  #Scrape element data

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


  #Convert to df

  month <- c(1,5,9,2,6,10,3,7,11,4,8,12)
  maxuse <- data.frame(
  "Month" = as.factor(month),
  "Max_Withdrawl" = as.numeric(max.withdrawals.mgd),
  "System_Name" = water.system.name,
  "Ownership" = ownership,
  "PSWID" = pswid,
   'Date' = my(paste(month,"-",Year)))


  maxuse <- arrange(maxuse, Month)

  return(maxuse)

}

maxuse.scrape('03-32-010', 2019)
```

```
##    Month Max_Withdrawl System_Name    Ownership     PSWID       Date
## 1      1         29.62      Durham Municipality 03-32-010 2019-01-01
## 2      2         32.39      Durham Municipality 03-32-010 2019-02-01
## 3      3         36.43      Durham Municipality 03-32-010 2019-03-01
## 4      4         32.60      Durham Municipality 03-32-010 2019-04-01
## 5      5         35.73      Durham Municipality 03-32-010 2019-05-01
## 6      6         37.86      Durham Municipality 03-32-010 2019-06-01
## 7      7         46.02      Durham Municipality 03-32-010 2019-07-01
## 8      8         42.05      Durham Municipality 03-32-010 2019-08-01
## 9      9         54.07      Durham Municipality 03-32-010 2019-09-01
```

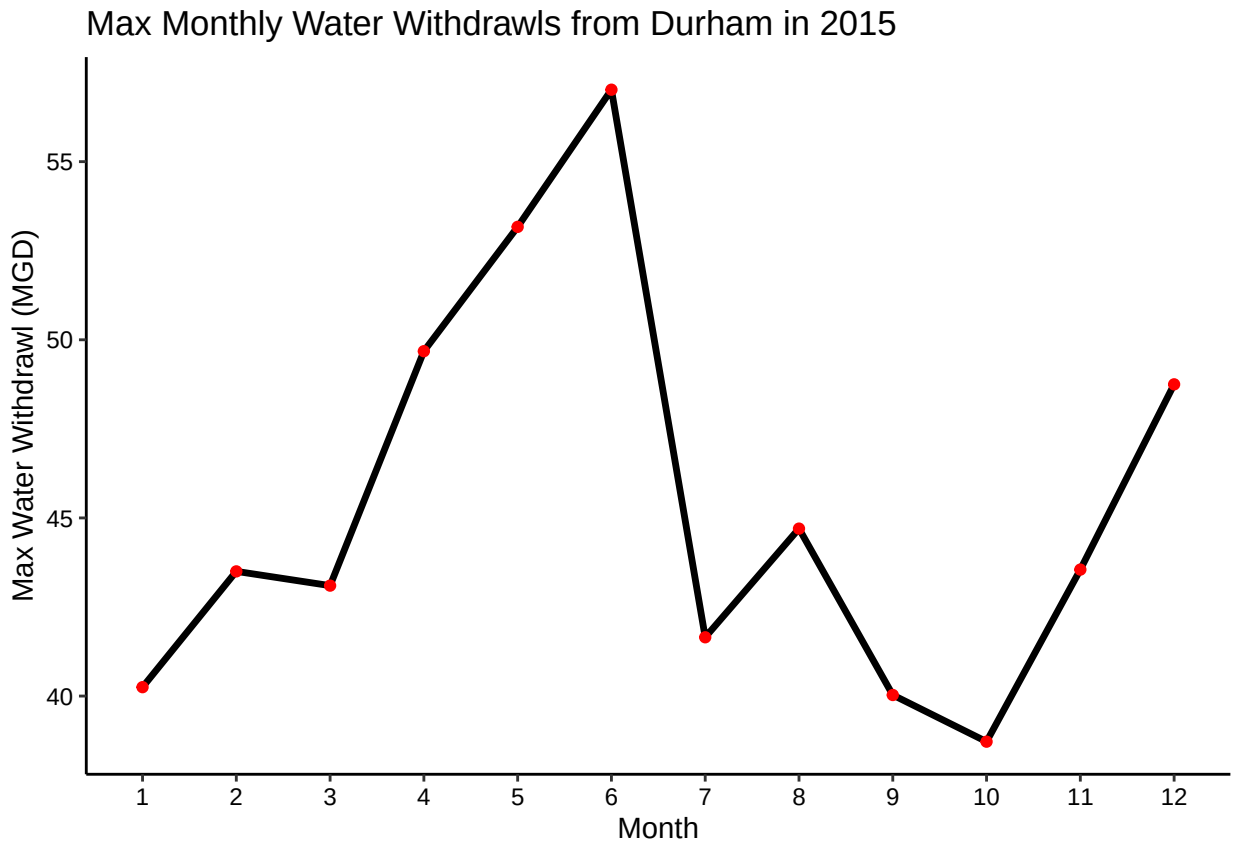
```
## 10    10         44.35      Durham Municipality 03-32-010 2019-10-01
## 11    11         36.06      Durham Municipality 03-32-010 2019-11-01
## 12    12         31.20      Durham Municipality 03-32-010 2019-12-01
```

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

```
#7

maxuseDurham.df <- maxuse.scrape("03-32-010", 2015)

ggplot(maxuseDurham.df, aes(x = Month, y=Max_Withdrawl, group = 1))+
   geom_line(size = 1.2)+
  geom_point(color = "red")+
    labs(title = "Max Monthly Water Withdrawls from Durham in 2015",
         y = "Max Water Withdrawl (MGD)")
```



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.

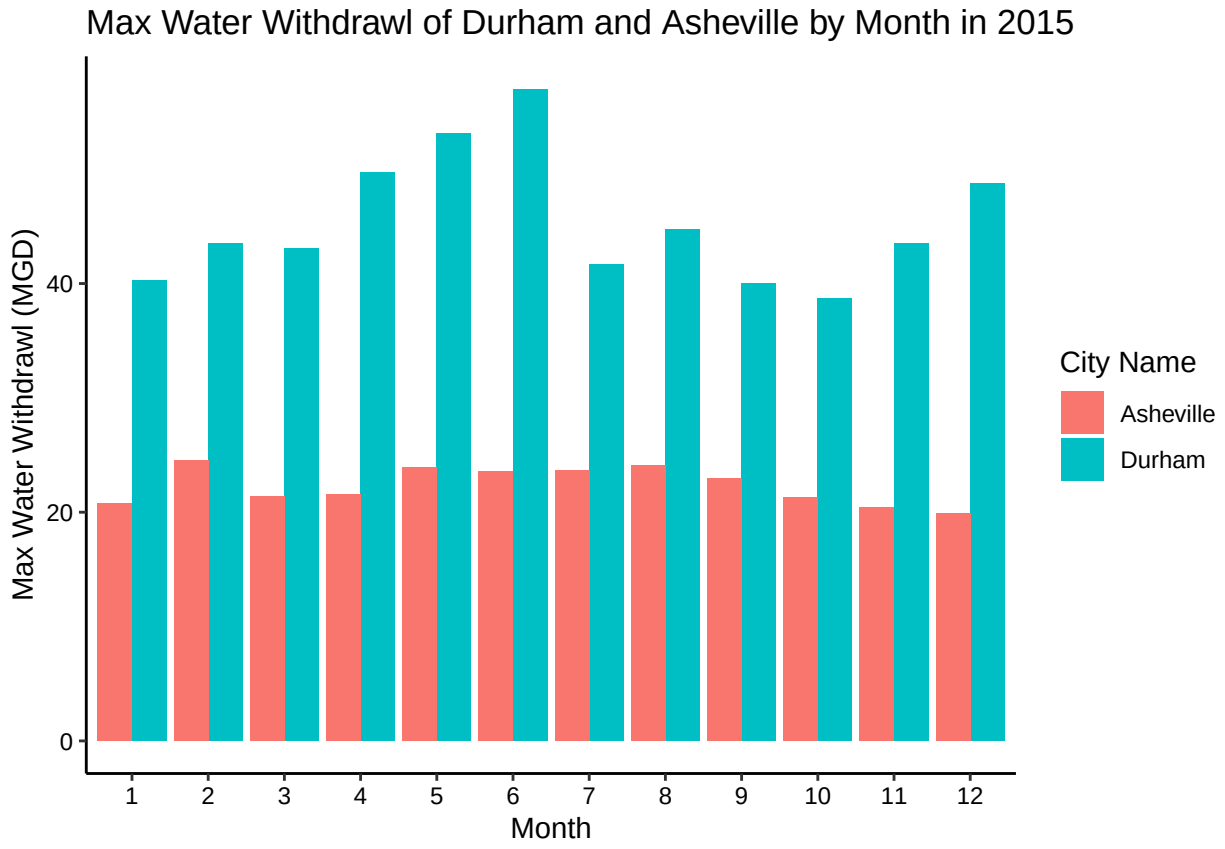
```
#8
maxuseAshville.df <- maxuse.scrape("01-11-010", 2015)
maxuseAshville.df
```

```
##    Month Max_Withdrawl System_Name    Ownership     PSWID       Date
## 1      1         20.81   Asheville Municipality 01-11-010 2015-01-01
## 2      2         24.54   Asheville Municipality 01-11-010 2015-02-01
## 3      3         21.42   Asheville Municipality 01-11-010 2015-03-01
```

```
## 4      4         21.60   Asheville Municipality 01-11-010 2015-04-01
## 5      5         23.95   Asheville Municipality 01-11-010 2015-05-01
## 6      6         23.53   Asheville Municipality 01-11-010 2015-06-01
## 7      7         23.68   Asheville Municipality 01-11-010 2015-07-01
## 8      8         24.11   Asheville Municipality 01-11-010 2015-08-01
## 9      9         22.97   Asheville Municipality 01-11-010 2015-09-01
## 10    10         21.32   Asheville Municipality 01-11-010 2015-10-01
## 11    11         20.45   Asheville Municipality 01-11-010 2015-11-01
## 12    12         19.88   Asheville Municipality 01-11-010 2015-12-01
```

```r
DurAsheMaxUSe.df <- bind_rows(maxuseDurham.df, maxuseAshville.df)

ggplot(DurAsheMaxUSe.df, aes(x = Month, y = Max_Withdrawl, fill = System_Name))+
  geom_bar(position = 'dodge', stat = "identity")+
  labs(
    title = "Max Water Withdrawl of Durham and Asheville by Month in 2015",
    y = "Max Water Withdrawl (MGD)",
    fill = "City Name")
```



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.

```r
#9

the_years <- rep(2010:2019)
the_pswid <- "01-11-010"
```

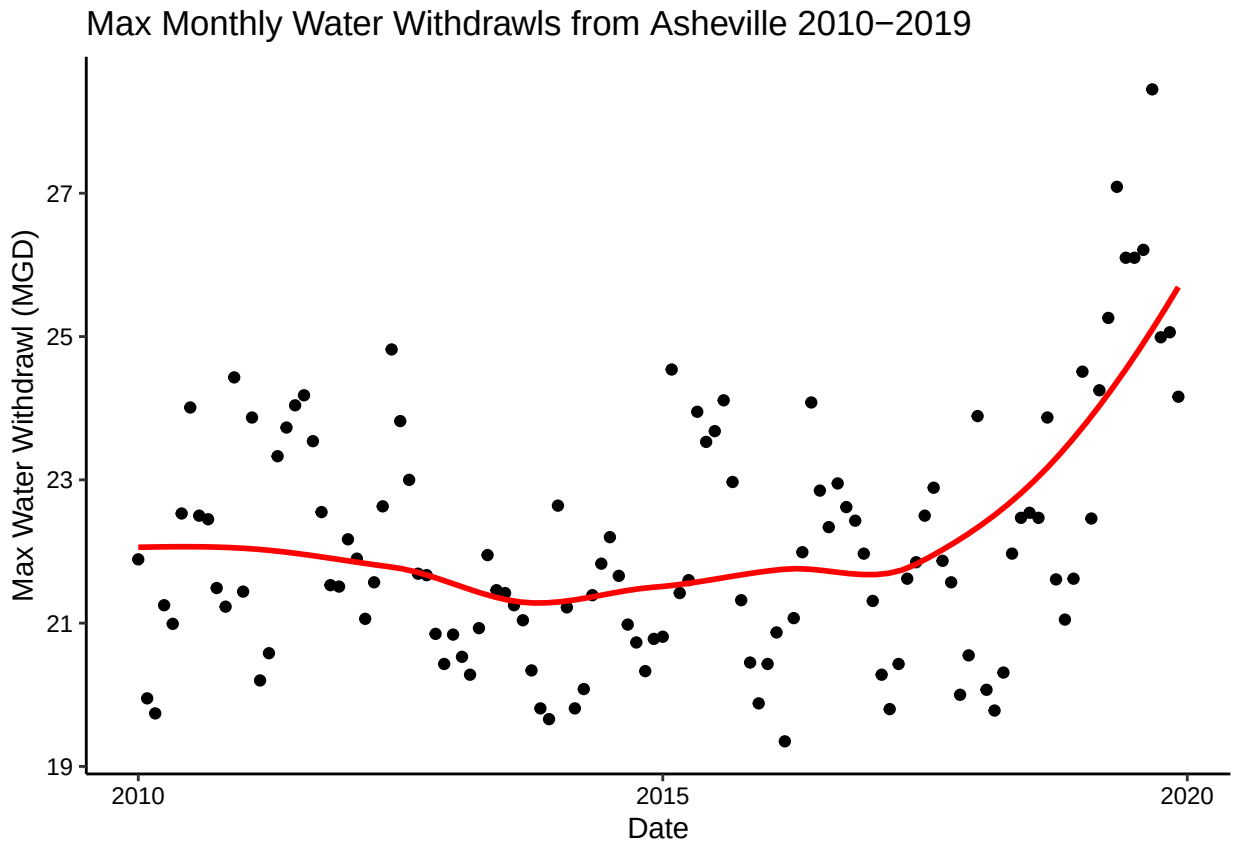
```
ashw_dfs <- map(the_years, maxuse.scrape, PSWID = the_pswid)

ashe_df <- bind_rows(ashw_dfs)

ashe_df$year <- as.factor(year(ydm(ashe_df$Date)))

ggplot(ashe_df, aes(x = Date, y = Max_Withdrawl))+
  geom_point()+
  geom_smooth(color = "red", se = F)+
  labs(title = "Max Monthly Water Withdrawls from Asheville 2010-2019",
       y = "Max Water Withdrawl (MGD)")
```

```
## `geom_smooth()` using method = 'loess' and 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?

It looks like there wasn't a clear trend in water usage from 2010 until 2017. In 2017 water usage started to rise and continued to do so through 2019.