Assignment 10: Data Scraping

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OVERVIEW

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

Directions

1. Rename this file `<FirstLast>_A10_DataScraping.Rmd` (replacing `<FirstLast>` with your first and last name).
2. Change "Student Name" on line 3 (above) with your name.
3. Work through the steps, **creating code and output** that fulfill each instruction.
4. Be sure your code is tidy; use line breaks to ensure your code fits in the knitted output.
5. Be sure to **answer the questions** in this assignment document.
6. When you have completed the assignment, **Knit** the text and code into a single PDF file.

Set up

1. Set up your session:

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

```
#1
library(tidyverse)
library(rvest)
library(lubridate)
library(viridis)
library(here)
library(dataRetrieval)
library(tidycensus)
library(dplyr)

here()
```

```
## [1] "/home/guest/EDA_Spring2024_SamanthaWM"
```

2. We will be scraping data from the NC DEQs Local Water Supply Planning website, specifically the Durham's 2022 Municipal Local Water Supply Plan (LWSP):

- Navigate to https://www.ncwater.org/WUDC/app/LWSP/search.php
- 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=2022

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

```
#2
Durham.LWSP <- read_html('https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid=03-32-010&year=2022')

Durham.LWSP
```

```
## {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:
- Maximum Day Use (MGD) - for each month

In the code chunk below scrape these values, assigning them to four 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 (represented as strings)".

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

```
## [1] "Durham"
```

```
PWSID <- Durham.LWSP %>%
  html_nodes("td tr:nth-child(1) td:nth-child(5)") %>%
  html_text()
PWSID
```

```
## [1] "03-32-010"
```

```
Ownership <- Durham.LWSP %>%
  html_nodes("div+ table tr:nth-child(2) td:nth-child(4)") %>%
  html_text()
Ownership
```

```
## [1] "Municipality"
```

```
MGD <- Durham.LWSP %>%
  html_nodes("th~ td+ td") %>%
  html_text()
MGD
```

```
##  [1] "36.1000" "43.4200" "52.4900" "30.5000" "42.5900" "34.8800" "39.9100"
##  [8] "43.3200" "32.5300" "34.6600" "41.8000" "37.5300"
```

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.

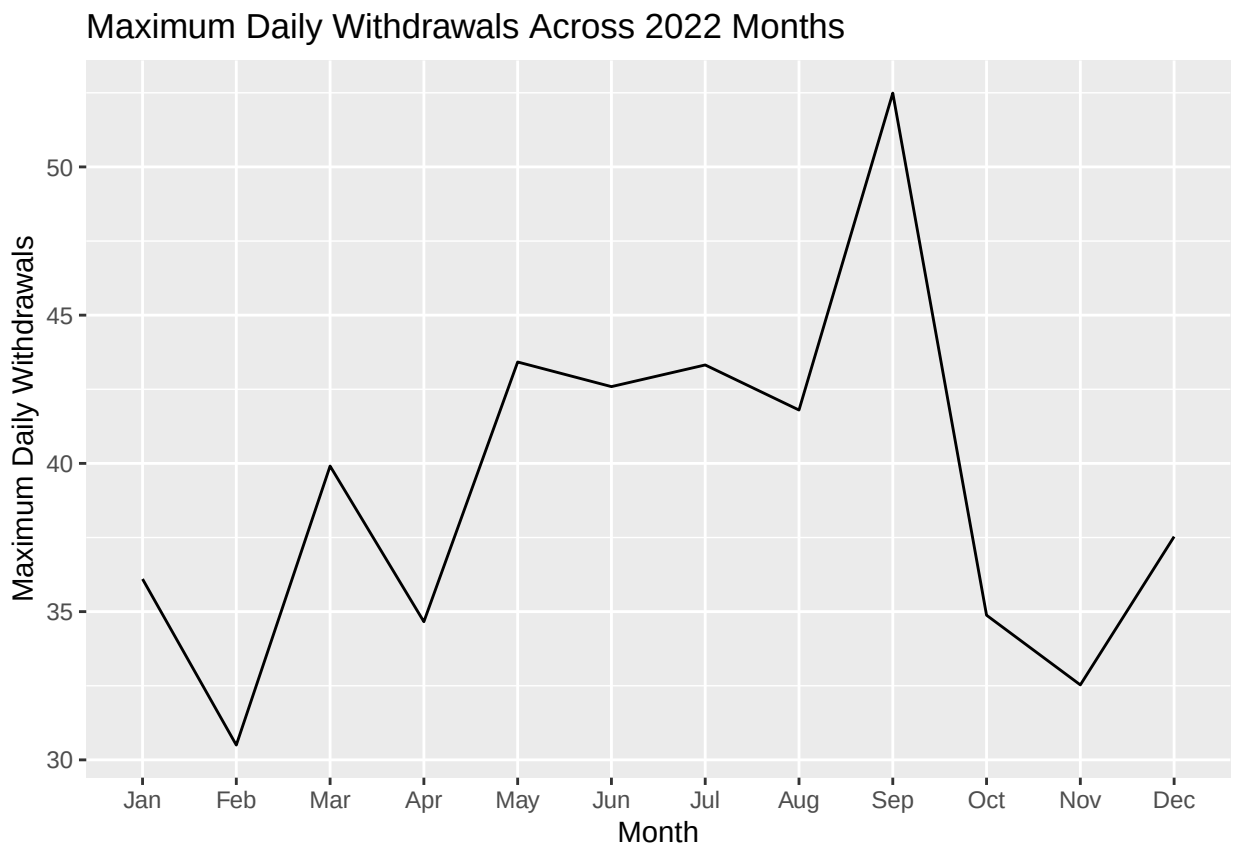
   NOTE: It's likely you won't be able to scrape the monthly widthrawal data in chronological order. You can overcome this by creating a month column manually assigning values in the order the data are scraped: "Jan", "May", "Sept", "Feb", etc... Or, you could scrape month values from the web page...

```
month.order <- c("Jan", "May", "Sep", "Feb", "Jun", "Oct", "Mar", "Jul", "Nov", "Apr", "Aug", "Dec")

Durham.LWSP.data <- data.frame("Month" = rep(1:12),
                               "Year" = rep(2022,12),
                               "Maximum.Day.Use" = as.numeric(MGD)) %>%
  mutate('Water System' = !!Water.system.name,
         Ownership = !!Ownership,
         PWSID = !!PWSID,
         Month = factor(Month,
                        levels = 1:12,
                        labels = month.order),
         Date = my(paste(Month,"-",Year)))


month.order.2 <- c("Jan", "Feb", "Mar", "Apr", "May", "Jun", "Jul", "Aug", "Sep", "Oct", "Nov", "Dec")

Durham.LWSP.data <- Durham.LWSP.data %>%
  mutate(Month = factor(Month, levels = month.order.2)) %>%
  arrange(Month)

view(Durham.LWSP.data)
```

5. Create a line plot of the maximum daily withdrawals across the months for 2022

```r
#5
ggplot(Durham.LWSP.data, aes(x = Month, y = `Maximum.Day.Use`)) +
  geom_line(aes(group = 1)) +
  geom_smooth(method="loess", se=FALSE) +
  labs(title = "Maximum Daily Withdrawals Across 2022 Months ",
       x = "Month",
       y = "Maximum Daily Withdrawals")
```

```
## `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 (pwsid) scraped**.

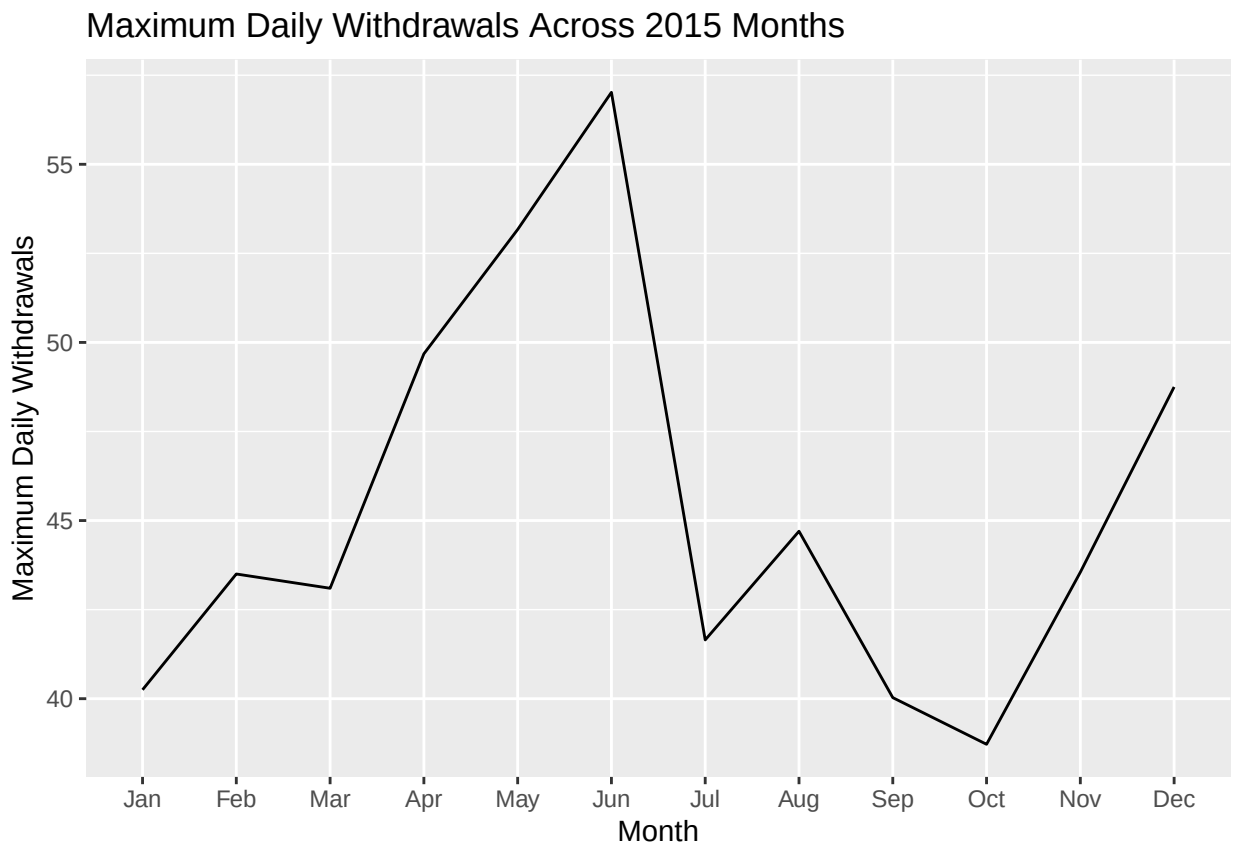
```r
#6.
Durham.LWSP.scraped <- function(PWSID, the_year){

  Durham.LWSP.website <- read_html(paste0('https://www.ncwater.org/WUDC/app/LWSP/report.php?',
'pwsid=',PWSID, '&year=',the_year))

  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)'
  MGD_tag <- 'th~ td+ td'
```

```
  Water.system.name_val <- Durham.LWSP.website %>% html_nodes(Water.system.name_tag) %>% html_text()
  PWSID_val <- Durham.LWSP.website %>%  html_nodes(PWSID_tag) %>%  html_text()
  Ownership_val <- Durham.LWSP.website %>% html_nodes(Ownership_tag) %>% html_text()
  MGD_val <- Durham.LWSP.website %>% html_nodes(MGD_tag) %>% html_text()

  month.order <- c("Jan", "May", "Sep", "Feb", "Jun", "Oct", "Mar", "Jul", "Nov", "Apr", "Aug", "Dec")

  S.Durham.LWSP.data <- data.frame("Month" = rep(1:12),
                                   "Year" = rep(the_year,12),
                                   "Maximum.Day.Use" = as.numeric(MGD_val)) %>%
    mutate('Water System' = Water.system.name_val,
           Ownership = Ownership_val,
           PWSID = PWSID_val,
           Month = factor(Month,
                          levels = 1:12,
                          labels = month.order),
           Date = paste(Month,"-",the_year, sep=""))

  month.order.2 <- c("Jan", "Feb", "Mar", "Apr", "May", "Jun", "Jul", "Aug", "Sep", "Oct", "Nov", "Dec")

  S.Durham.LWSP.data <- S.Durham.LWSP.data %>%
  mutate(Month = factor(Month, levels = month.order.2)) %>%
  arrange(Month)

  return(S.Durham.LWSP.data)
}
```

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

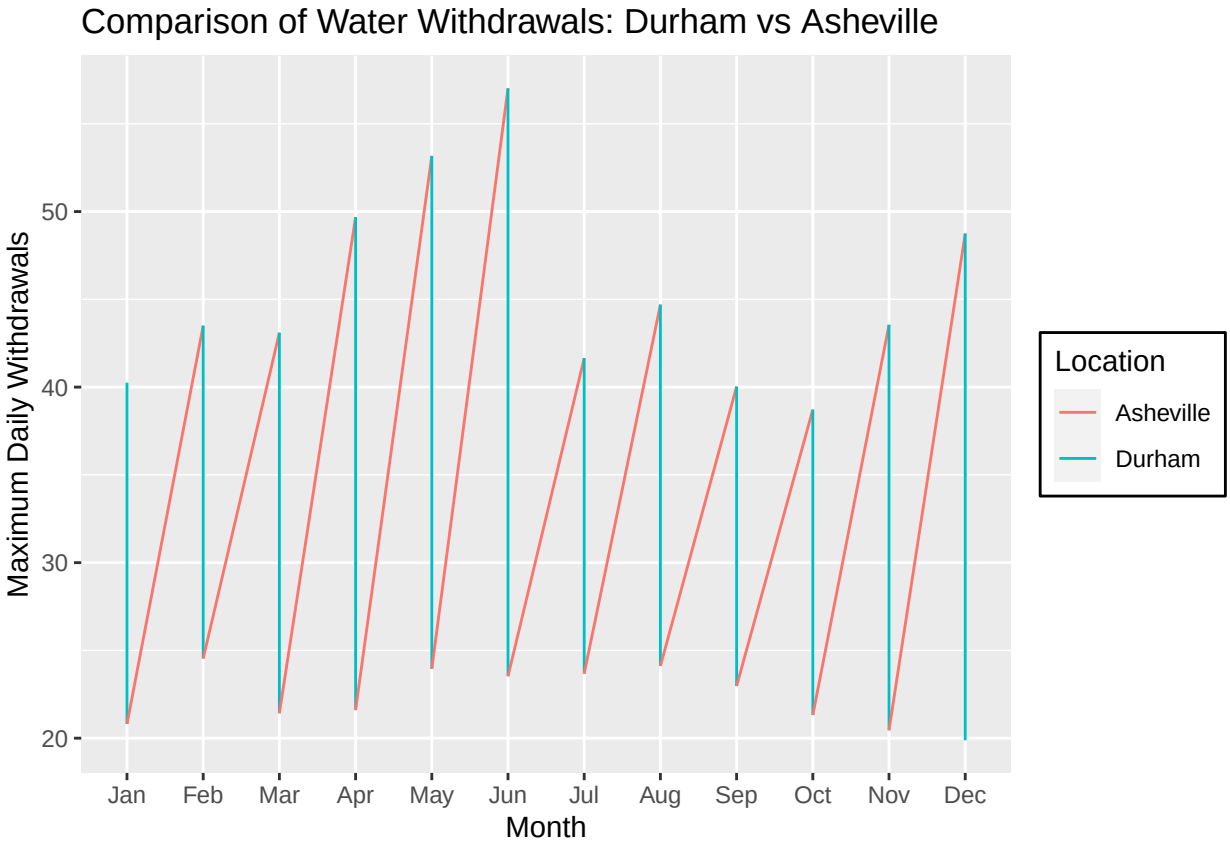
```
#7
Durham.LWSP.Data.2015 <- Durham.LWSP.scraped(PWSID = "03-32-010", the_year = 2015)

ggplot(Durham.LWSP.Data.2015, aes(x = Month, y = `Maximum.Day.Use`)) +
  geom_line(aes(group = 1)) +
  geom_smooth(method="loess", se=FALSE) +
  labs(title = paste("Maximum Daily Withdrawals Across 2015 Months"),
       x = "Month",
       y = "Maximum Daily Withdrawals")
```

```
## `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 Asheville's to Durham's water withdrawals.

```
#8
Ashville.LWSP.Data.2015 <- Durham.LWSP.scraped(PWSID = "01-11-010", the_year = 2015)

Combined <- rbind(Durham.LWSP.Data.2015, Ashville.LWSP.Data.2015)

ggplot(Combined, aes(x = Month, y = Maximum.Day.Use, color = `Water System`)) +
  geom_line(aes(group = 1)) +
  labs(title = "Comparison of Water Withdrawals: Durham vs Asheville",
       x = "Month",
       y = "Maximum Daily Withdrawals",
       color = "Location") +
  theme(legend.position = "right",
        legend.background = element_rect(fill = "white", colour = 1))
```

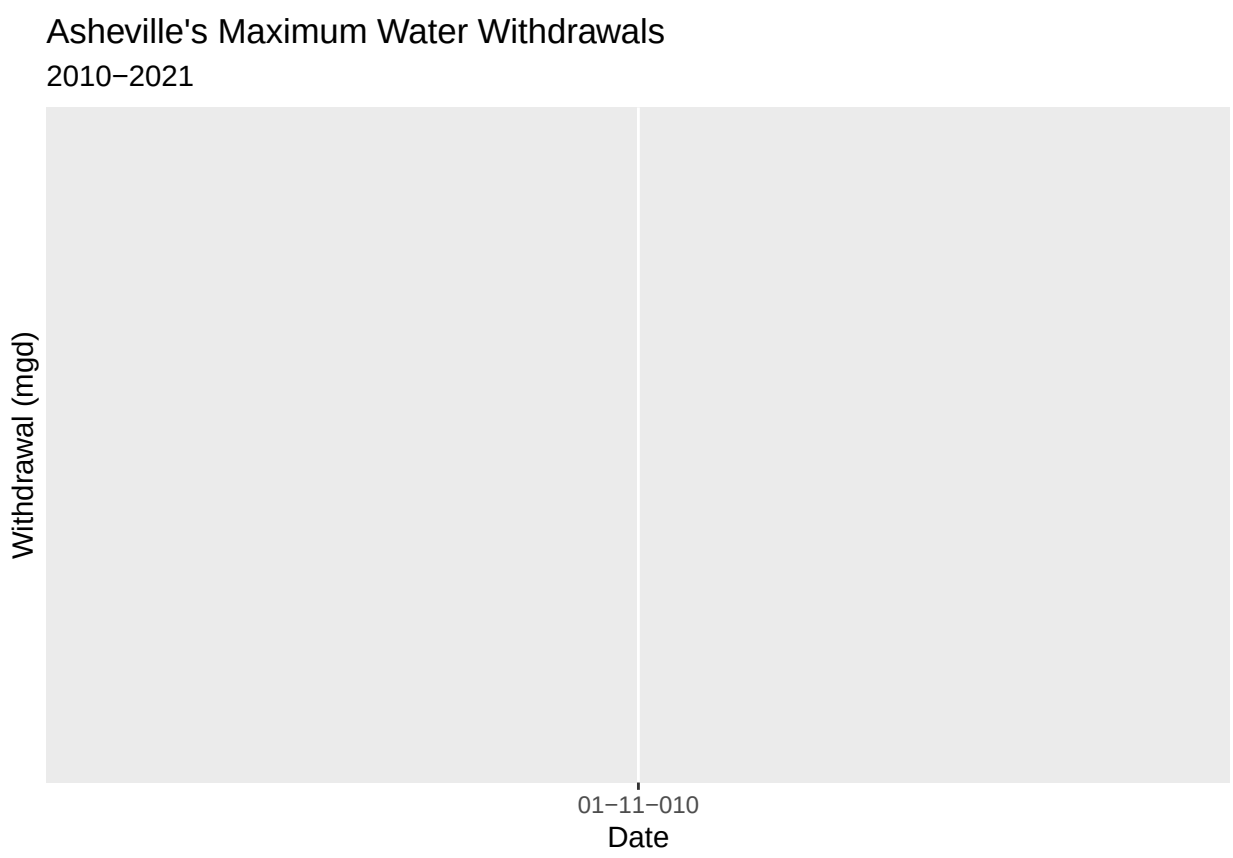


9. Use the code & function you created above to plot Asheville's max daily withdrawal by months for the years 2010 thru 2021.Add a smoothed line to the plot (method = 'loess').

   TIP: See Section 3.2 in the "10_Data_Scraping.Rmd" where we apply "map2()" to iteratively run a function over two inputs. Pipe the output of the map2() function to `bindrows()` to combine the dataframes into a single one.

```
#9
PWSID <- '01-11-010'
the_year <- rep(2010:2021)
the_months = rep(1:12)

the_dfs <- lapply(X = the_year, FUN = Durham.LWSP.scraped, PWSID = PWSID) %>%
  bind_rows()

MDW <-  map2(the_year, PWSID, Durham.LWSP.scraped) %>%
  bind_rows()

 ggplot(MDW, aes(x = Year, y = Maximum.Day.Use)) +
   geom_line() +
   geom_smooth(method = "loess", se = FALSE) +
   labs(title = paste("Asheville's Maximum Water Withdrawals"),
        subtitle = "2010-2021",
        y = "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? > Answer: > Yes, it there is a growth of water use since 2014-2015.