# Assignment 09: 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>_A09_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 to **answer the questions** in this assignment document.
5. When you have completed the assignment, **Knit** the text and code into a single PDF file.

### 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] "/home/guest/EDA_2022/EDA-Fall2022/Assignments"
```

```
library(tidyverse)
library(lubridate)
library(viridis)

install.packages("rvest")
library(rvest)

install.packages("dataRetrieval")
library(dataRetrieval)

install.packages("tidycensus")
library(tidycensus)

# Set theme
mytheme <- theme_classic() + theme(axis.text = element_text(color = "black"), legend.position = "top")
theme_set(mytheme)
```

2. We will be scraping data from the NC DEQs Local Water Supply Planning website, specifically the Durham's 2021 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=2021

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=2021")
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
- PSWID
- Ownership
- From the "3. Water Supply Sources" section:
- Maximum Daily 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), with the first value being "27.6400".

```
# 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 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...

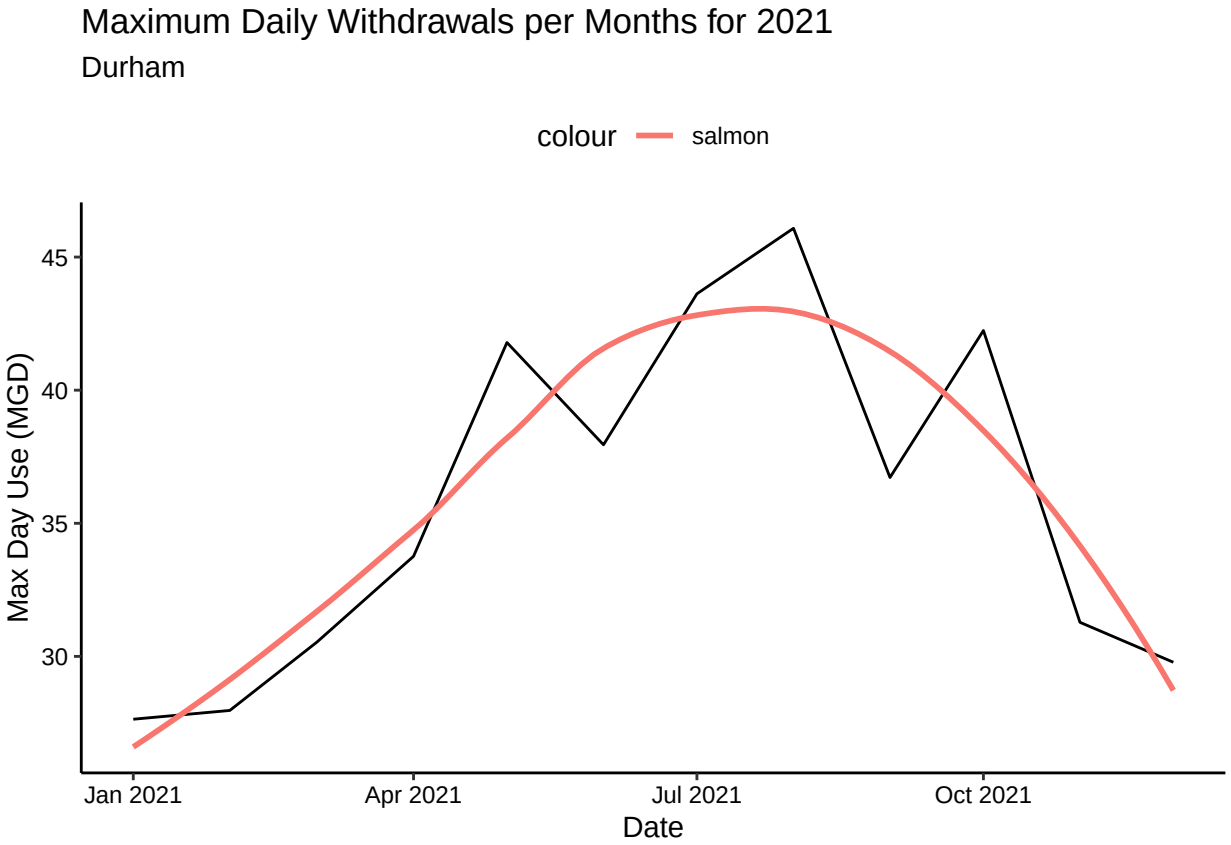
5. Create a line plot of the maximum daily withdrawals across the months for 2021

```
# 4

Month <- c(1, 5, 9, 2, 6, 10, 3, 7, 11, 4, 8, 12)
Year <- c(2021)

the_df <- data.frame(WaterSystem = water.system.name, PWSID = pwsid, Ownership = ownership,
    `Max Day Use` = as.numeric(max.withdrawals.mgd)) %>%
    mutate(Month = Month, Year = Year, Date = my(paste0(Month, "-", Year)), PWSID = !!pwsid,
        Ownership = !!ownership)

the_df
```

```
##    WaterSystem     PWSID    Ownership Max.Day.Use Month Year       Date
## 1       Durham 03-32-010 Municipality       27.64     1 2021 2021-01-01
## 2       Durham 03-32-010 Municipality       41.79     5 2021 2021-05-01
## 3       Durham 03-32-010 Municipality       36.72     9 2021 2021-09-01
## 4       Durham 03-32-010 Municipality       27.97     2 2021 2021-02-01
## 5       Durham 03-32-010 Municipality       37.95     6 2021 2021-06-01
## 6       Durham 03-32-010 Municipality       42.24    10 2021 2021-10-01
## 7       Durham 03-32-010 Municipality       30.54     3 2021 2021-03-01
## 8       Durham 03-32-010 Municipality       43.62     7 2021 2021-07-01
## 9       Durham 03-32-010 Municipality       31.28    11 2021 2021-11-01
## 10      Durham 03-32-010 Municipality       33.76     4 2021 2021-04-01
## 11      Durham 03-32-010 Municipality       46.08     8 2021 2021-08-01
## 12      Durham 03-32-010 Municipality       29.78    12 2021 2021-12-01
```

```
# 5
plot1 <- ggplot(the_df, aes(x = Date, y = Max.Day.Use)) + geom_line(aes(group = 1)) +
    geom_smooth(method = "loess", se = FALSE, aes(color = "salmon")) + labs(title = paste("Maximum Daily
    subtitle = "Durham", y = "Max Day Use (MGD)", x = "Date")

plot1
```

```
## `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**.

```
# 6.

base_url <- "https://www.ncwater.org/WUDC/app/LWSP/report.php?pwsid="
pwsid <- "03-32-010"
Year <- 2015
scrape_url <- paste0(base_url, pwsid, "&year=", Year)
website <- read_html(scrape_url)


scrape.it <- function(pwsid, Year) {

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

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

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

    ownership <- website %>%
```

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

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

    the_df2 <- data.frame(WaterSystem = water.system.name, PWSID = pwsid, Ownership = ownership,
        `Max Day Use` = as.numeric(max.withdrawals.mgd)) %>%
        mutate(Month = Month, Year = Year, Date = my(paste0(Month, "-", Year)), PWSID = !!pwsid,
            Ownership = !!ownership)

    return(the_df2)
}
```

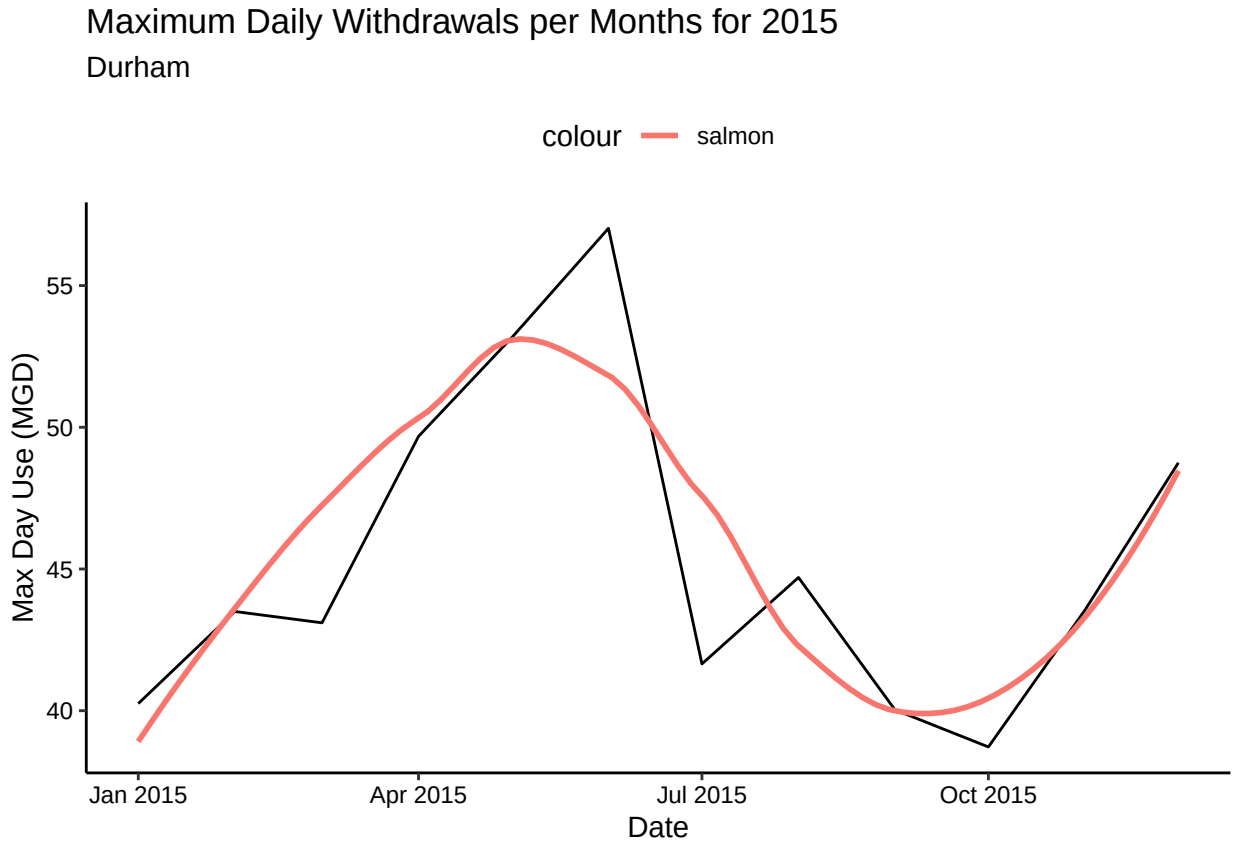
7. Use the function above to extract and plot max daily withdrawals for Durham (PWSID='03-32-010') for each month in 2015

```
# 7

Durham2015_df <- scrape.it("03-32-010", 2015)
print(Durham2015_df)
```

```
##    WaterSystem     PWSID    Ownership Max.Day.Use Month Year       Date
## 1       Durham 03-32-010 Municipality       40.25     1 2015 2015-01-01
## 2       Durham 03-32-010 Municipality       53.17     5 2015 2015-05-01
## 3       Durham 03-32-010 Municipality       40.03     9 2015 2015-09-01
## 4       Durham 03-32-010 Municipality       43.50     2 2015 2015-02-01
## 5       Durham 03-32-010 Municipality       57.02     6 2015 2015-06-01
## 6       Durham 03-32-010 Municipality       38.72    10 2015 2015-10-01
## 7       Durham 03-32-010 Municipality       43.10     3 2015 2015-03-01
## 8       Durham 03-32-010 Municipality       41.65     7 2015 2015-07-01
## 9       Durham 03-32-010 Municipality       43.55    11 2015 2015-11-01
## 10      Durham 03-32-010 Municipality       49.68     4 2015 2015-04-01
## 11      Durham 03-32-010 Municipality       44.70     8 2015 2015-08-01
## 12      Durham 03-32-010 Municipality       48.75    12 2015 2015-12-01
```

```
plot2 <- ggplot(Durham2015_df, aes(x = Date, y = Max.Day.Use)) + geom_line(aes(group = 1)) +
    geom_smooth(method = "loess", se = FALSE, aes(color = "salmon")) + labs(title = paste("Maximum Daily
    Year), subtitle = "Durham", y = "Max Day Use (MGD)", x = "Date")

plot2
```

```
## `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

Ashville2015 <- scrape.it("01-11-010", 2015)
print(Ashville2015)
```

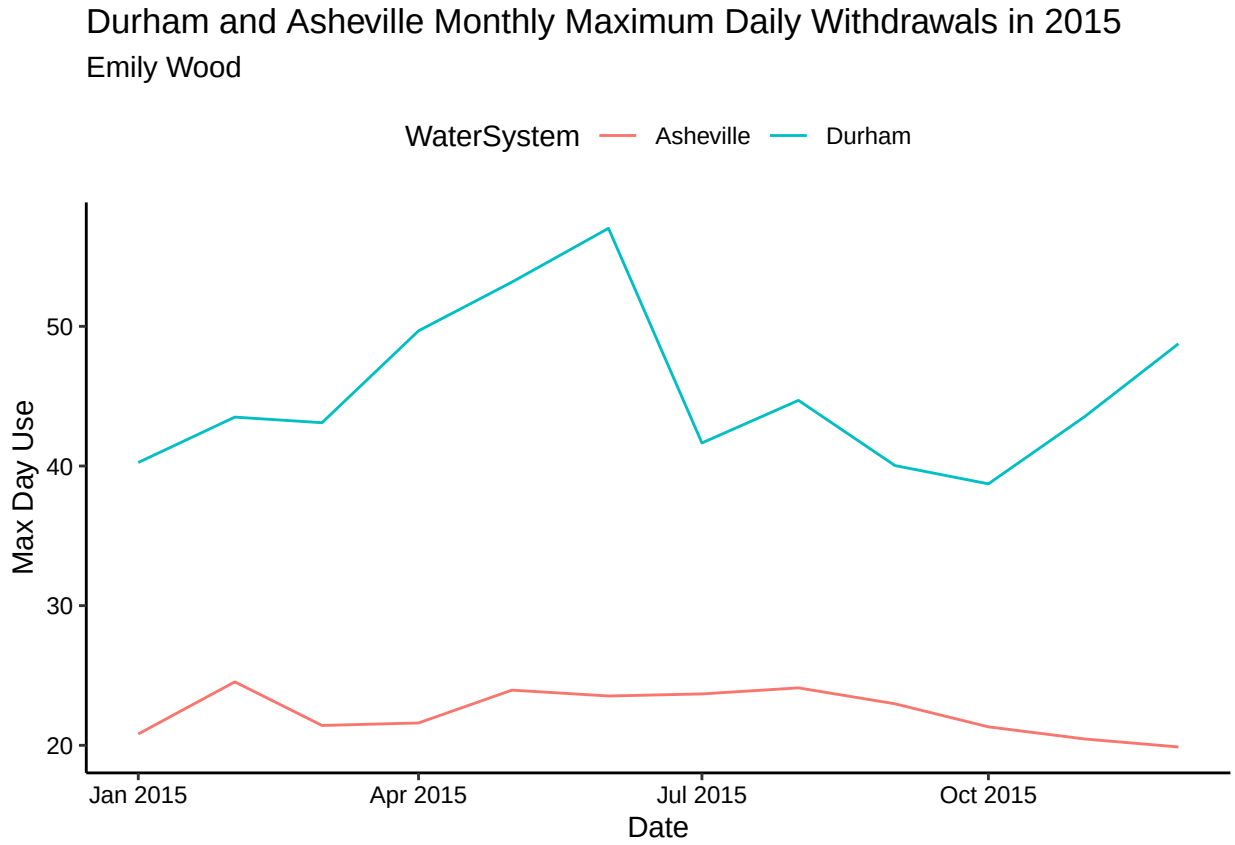
```
##    WaterSystem     PWSID    Ownership Max.Day.Use Month Year       Date
## 1    Asheville 01-11-010 Municipality       20.81     1 2015 2015-01-01
## 2    Asheville 01-11-010 Municipality       23.95     5 2015 2015-05-01
## 3    Asheville 01-11-010 Municipality       22.97     9 2015 2015-09-01
## 4    Asheville 01-11-010 Municipality       24.54     2 2015 2015-02-01
## 5    Asheville 01-11-010 Municipality       23.53     6 2015 2015-06-01
## 6    Asheville 01-11-010 Municipality       21.32    10 2015 2015-10-01
## 7    Asheville 01-11-010 Municipality       21.42     3 2015 2015-03-01
## 8    Asheville 01-11-010 Municipality       23.68     7 2015 2015-07-01
## 9    Asheville 01-11-010 Municipality       20.45    11 2015 2015-11-01
## 10   Asheville 01-11-010 Municipality       21.60     4 2015 2015-04-01
## 11   Asheville 01-11-010 Municipality       24.11     8 2015 2015-08-01
## 12   Asheville 01-11-010 Municipality       19.88    12 2015 2015-12-01
```

```
AshvilleDurham <- rbind(Durham2015_df, Ashville2015)
print(AshvilleDurham)
```

```
##    WaterSystem     PWSID    Ownership Max.Day.Use Month Year       Date
## 1       Durham 03-32-010 Municipality       40.25     1 2015 2015-01-01
```

```
## 2       Durham 03-32-010 Municipality       53.17     5 2015 2015-05-01
## 3       Durham 03-32-010 Municipality       40.03     9 2015 2015-09-01
## 4       Durham 03-32-010 Municipality       43.50     2 2015 2015-02-01
## 5       Durham 03-32-010 Municipality       57.02     6 2015 2015-06-01
## 6       Durham 03-32-010 Municipality       38.72    10 2015 2015-10-01
## 7       Durham 03-32-010 Municipality       43.10     3 2015 2015-03-01
## 8       Durham 03-32-010 Municipality       41.65     7 2015 2015-07-01
## 9       Durham 03-32-010 Municipality       43.55    11 2015 2015-11-01
## 10      Durham 03-32-010 Municipality       49.68     4 2015 2015-04-01
## 11      Durham 03-32-010 Municipality       44.70     8 2015 2015-08-01
## 12      Durham 03-32-010 Municipality       48.75    12 2015 2015-12-01
## 13   Asheville 01-11-010 Municipality       20.81     1 2015 2015-01-01
## 14   Asheville 01-11-010 Municipality       23.95     5 2015 2015-05-01
## 15   Asheville 01-11-010 Municipality       22.97     9 2015 2015-09-01
## 16   Asheville 01-11-010 Municipality       24.54     2 2015 2015-02-01
## 17   Asheville 01-11-010 Municipality       23.53     6 2015 2015-06-01
## 18   Asheville 01-11-010 Municipality       21.32    10 2015 2015-10-01
## 19   Asheville 01-11-010 Municipality       21.42     3 2015 2015-03-01
## 20   Asheville 01-11-010 Municipality       23.68     7 2015 2015-07-01
## 21   Asheville 01-11-010 Municipality       20.45    11 2015 2015-11-01
## 22   Asheville 01-11-010 Municipality       21.60     4 2015 2015-04-01
## 23   Asheville 01-11-010 Municipality       24.11     8 2015 2015-08-01
## 24   Asheville 01-11-010 Municipality       19.88    12 2015 2015-12-01
```

```
plot3 <- ggplot(AshvilleDurham) + geom_line(aes(x = Date, y = Max.Day.Use, color = WaterSystem)) +
    labs(title = paste("Durham and Asheville Monthly Maximum Daily Withdrawals in 2015"),
        subtitle = "Emily Wood", y = "Max Day Use", x = "Date")

plot3
```

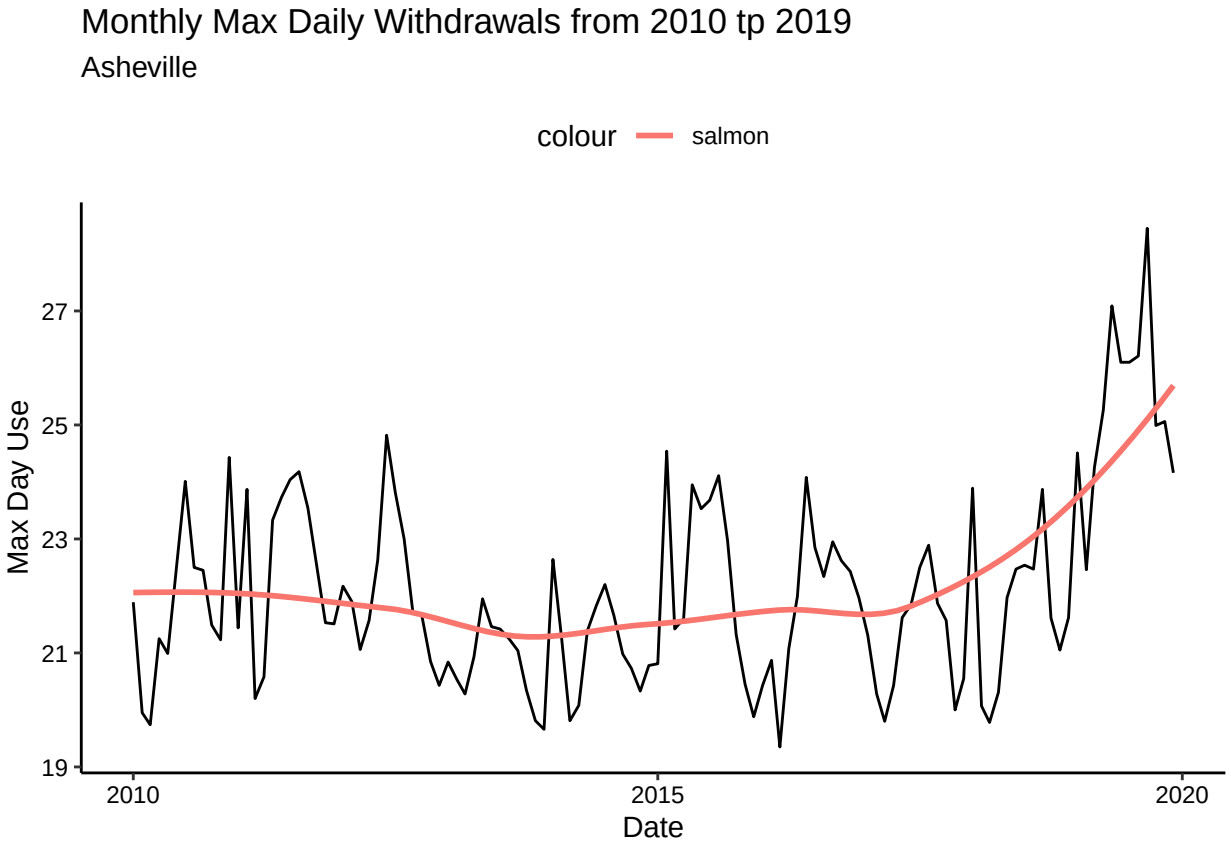



9. Use the code & function you created above to plot Asheville's max daily withdrawal by months for the years 2010 thru 2019.Add a smoothed line to the plot.

   TIP: See Section 3.2 in the "09_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

years = rep(2010:2019)
pwsidnew = "01-11-010"
df_10_19 <- years %>%
    map(scrape.it, pwsid = pwsidnew) %>%
    bind_rows()

plot4 <- ggplot(df_10_19, aes(y = Max.Day.Use, x = Date)) + geom_line() + geom_smooth(method = "loess",
    se = FALSE, aes(color = "salmon")) + labs(title = paste("Monthly Max Daily Withdrawals from 2010 tp
    subtitle = "Asheville", y = "Max Day Use", x = "Date")

plot4
```

```
## `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?

Just from looking at the plot I believe that Asheville has rising (positive) trend in max daily water usage overtime. This is depicted in the upward curve of the trend line.