

# Lab7\_submission

February 18, 2022

## 1 Lab 7

### 1.1 Brooke Hunter Submission

```
[1]: # Install package for obtaining USGS streamflow data  
!pip install -U dataretrieval
```

```
Requirement already satisfied: dataretrieval in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (0.7)  
Requirement already satisfied: requests in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from dataretrieval)  
(2.27.1)  
Requirement already satisfied: pandas in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from dataretrieval)  
(1.4.1)  
Requirement already satisfied: numpy>=1.21.0 in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from  
pandas->dataretrieval) (1.22.2)  
Requirement already satisfied: python-dateutil>=2.8.1 in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from  
pandas->dataretrieval) (2.8.2)  
Requirement already satisfied: pytz>=2020.1 in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from  
pandas->dataretrieval) (2021.3)  
Requirement already satisfied: urllib3<1.27,>=1.21.1 in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from  
requests->dataretrieval) (1.26.8)  
Requirement already satisfied: charset-normalizer~=2.0.0 in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from  
requests->dataretrieval) (2.0.12)  
Requirement already satisfied: certifi>=2017.4.17 in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from  
requests->dataretrieval) (2021.10.8)  
Requirement already satisfied: idna<4,>=2.5 in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from  
requests->dataretrieval) (3.3)  
Requirement already satisfied: six>=1.5 in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from python-  
dateutil>=2.8.1->pandas->dataretrieval) (1.16.0)
```

```
[2]: import ssl
ssl._create_default_https_context = ssl._create_unverified_context
```

```
[3]: # Import the functions for downloading data from NWIS
import dataretrieval.nwis as nwis
```

---

## Question 1 (10 points)  
 Make a new jupyter notebook called lab7\_submission.ipynb and complete the following tasks:  
 \* Download daily values (i.e. service='dv') for another station and time period of your choosing.  
 \* Plot one column  
 \* In a **markdown** cell below, describe what your plot shows  
 A map of station ID numbers can be found here:  
<https://maps.waterdata.usgs.gov/mapper/index.html>  
 A table of the parameter codes can be found here:  
[https://help.waterdata.usgs.gov/parameter\\_cd?group\\_cd=PHY](https://help.waterdata.usgs.gov/parameter_cd?group_cd=PHY)

---

```
[4]: # Specify the USGS site code
site = '05341550' #Station in Stillwater, Minnesota

# Get instantaneous values (iv)
df = nwis.get_record(sites=site, service='dv', start='2020-01-01',
    ↪end='2021-12-31')
df
```

```
[4]:
```

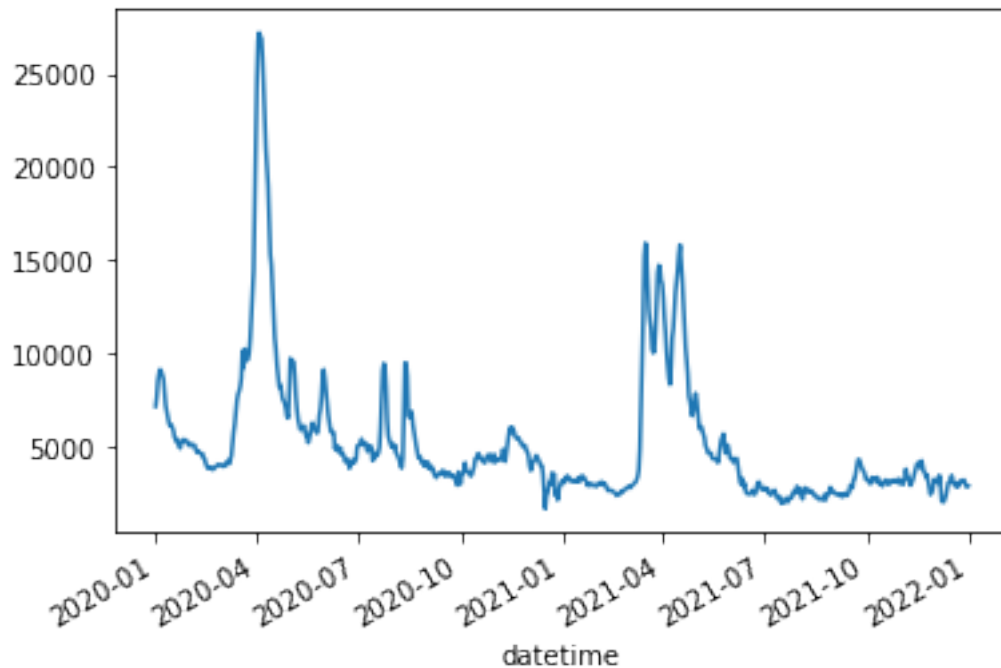
	00060_Mean	00060_Mean_cd	site_no
datetime			
2020-01-01 00:00:00+00:00	7120.0	A, e	05341550
2020-01-02 00:00:00+00:00	7630.0	A, e	05341550
2020-01-03 00:00:00+00:00	8490.0	A, e	05341550
2020-01-04 00:00:00+00:00	8870.0	A, e	05341550

2020-01-05 00:00:00+00:00	9100.0	A, e	05341550
...	...	...	...
2021-12-27 00:00:00+00:00	3170.0	P	05341550
2021-12-28 00:00:00+00:00	2980.0	P	05341550
2021-12-29 00:00:00+00:00	2810.0	P	05341550
2021-12-30 00:00:00+00:00	2790.0	P	05341550
2021-12-31 00:00:00+00:00	2850.0	P	05341550

[729 rows x 3 columns]

```
[5]: # plot one column
df['00060_Mean'].plot()
```

```
[5]: <AxesSubplot:xlabel='datetime'>
```



The plot above shows daily mean discharge (cfs - cubic feet per second) at a USGS station in Stillwater Minnesota along the St. Croix River. This is for the time period January 1st 2020 to December 31 2021, so two years of data.

---

## Question 2 (10 points)

---

\* Make an HTML table that contains the **site name**, **site number** and **mean daily discharge** between Oct 31, 2020 and Sep 30, 2021 (zero decimal places)\*\* for **three** rivers in the US. HINT: the discharge parameter is 00060\_Mean. If the data from your site does not contain this column, try another site.

---

```
[6]: # Specify the USGS site code
stillwater_site = '05341550' #Station in Stillwater, Minnesota (St. Croix)
minnehaha_site = '05289800' #Station in St Paul, Minnesota (Minnehaha Creek)
fall_site = '14151000' #Station in Fall Creek Oregon (Fall Creek)

# Get instantaneous values (iv)
still = nwis.get_record(sites=stillwater_site, service='dv',
    ↪start='2020-10-31', end='2021-09-30')
haha = nwis.get_record(sites=minnehaha_site, service='dv', start='2020-10-31',
    ↪end='2021-09-30')
fall = nwis.get_record(sites=fall_site, service='dv', start='2020-10-31',
    ↪end='2021-09-30')
```

```
[7]: still['00060_Mean'].mean()
```

```
[7]: 4542.537313432836
```

```
[8]: haha['00060_Mean'].mean()
```

```
[8]: 14.736210526315789
```

```
[9]: fall['00060_Mean'].mean()
```

```
[9]: 383.0268656716418
```

Site Name

Site Number

Mean Daily Discharge (cfs)

Stillwater, MN  
05341550  
4542  
Minnehaha, MN  
05289800  
15  
Fall Creek, OR  
14151000  
383

---

## Question 3 (10 points)  
\* Make a new map of the tallest mountains in Oregon but include a popup that displays the `Isolation` data as a **float**.

---

## 1.2 Extra credit/grad students

- Add a popup that includes the name of the mountain as a **string** (without any square brackets).

---

```
[10]: # Import packages
import numpy as np
import pandas as pd
import folium
```

```
[11]: # Read HTML table data
#mountains = pd.read_html('https://en.wikipedia.org/wiki/
↳List_of_mountain_peaks_of_Oregon')
mountains = pd.read_html('https://en.wikipedia.org/wiki/
↳List_of_mountain_peaks_of_Oregon')
#mountains
```

```
[12]: # Print number of tables on webpage
len(mountains)
```

```
[12]: 13
```

```
[13]: # We would like the table that contains the highest summits of Oregon which
      ↪ happens to be the second one
      mountain_stats = mountains[1]
      # Some wrangling
      mountain_stats['Location'] = mountain_stats['Location'].str.
      ↪ replace(mountain_stats['Location'].loc[0], "45°22 25 N 121°41 45 W\u00a0 /
      ↪ \u00a045.3735°N 121.6959°W", regex=True)
```

```
[14]: mountain_stats
```

```
[14]:      Rank      Mountain peak      Mountain range \
0      1      Mount Hood[6] [7] [8] [9] [a]      Cascade Range
1      2      Mount Jefferson[10] [11] [12] [13] [b]      Cascade Range
2      3      South Sister[14] [15] [16] [17]      Cascade Range
3      4      North Sister[18] [19] [20] [21] [c]      Cascade Range
4      5      Middle Sister[22] [23] [24] [25] [d]      Cascade Range
5      6      Sacajawea Peak[26] [27] [28] [e] [f]      Wallowa Mountains
6      7      Steens Mountain[29] [30] [31] [g]      Steens Mountain
7      8      Aneroid Mountain[32] [33] [34] [35]      Wallowa Mountains
8      9      Twin Peaks[36] [37] [38] [h]      Wallowa Mountains
9      10      Red Mountain[39] [40] [41] [42]      Wallowa Mountains
10     11      Mount McLoughlin[43] [44] [45] [46] [i] [j]      Cascade Range
11     12      Elkhorn Peak[47] [48] [49] [k]      Wallowa Mountains
12     13      Mount Thielsen[50] [51] [52] [53]      Cascade Range
13     14      Broken Top[54] [55] [56] [l]      Cascade Range
14     15      Rock Creek Butte[57] [58] [59] [m]      Elkhorn Mountains
15     16      Mount Bachelor[60] [61] [62] [63]      Cascade Range
16     17      Strawberry Mountain[64] [65] [66] [67] [n]      Strawberry Range
17     18      Mount Scott[68] [69] [70] [71]      Cascade Range
18     19      Diamond Peak[72] [73] [74] [75]      Cascade Range
19     20      Pueblo Mountain[76] [77] [78] [79] [o]      Pueblo Mountains
20     21      Crane Mountain[80] [81] [82] [83]      Warner Mountains
21     22      Drake Peak[84] [85] [86] [87] [p]      Warner Mountains
22     23      Mount Bailey[88] [89] [90] [91] [q]      Cascade Range
23     24      Gearhart Mountain[92] [93] [94] [95]      Gearhart Mountain
24     25      Aspen Butte[96] [97] [98] [99]      Cascade Range
25     26      Yamsay Mountain[100] [101] [102] [103]      Cascade Volcanic Arc
26     27      Vinegar Hill[104] [105] [106] [107] [r]      Greenhorn Mountains
27     28      Pelican Butte[108] [109] [110] [111]      Cascade Range
28     29      Lookout Mountain[112] [113] [114] [s]      Strawberry Range
29     30      Warner Peak[115] [116] [117] [118] [t]      Hart Mountain
30     31      Paulina Peak[119] [120] [121] [122] [u]      Paulina Mountains

      Elevation Prominence Isolation \
0      3428.8 m      2349 m      92.2 km
1      3201 m      1767 m      77.5 km
2      3158.5 m      1705 m      63.4 km
```

3	3075 m	837 m	7 km
4	3064 m	382 m	1.8 km
5	3000 m	1949 m	202 km
6	2968 m	1336 m	201 km
7	2958.7 m	647 m	9.48 km
8	2950 m	610 m	7.79 km
9	2913.8 m	610 m	11.84 km
10	2895 m	1364 m	111.8 km
11	2816 m	567 m	5.32 km
12	2799.4 m	1025 m	81.1 km
13	2798 m	669 m	5.52 km
14	2777 m	1364 m	69.9 km
15	2764 m	818 m	11.02 km
16	2756.1 m	1253 m	74.2 km
17	2722.9 m	920 m	25.9 km
18	2666.4 m	952 m	41.4 km
19	2633.3 m	927 m	45.5 km
20	2575.8 m	718 m	71.4 km
21	2564 m	779 m	28.1 km
22	2553.3 m	908 m	12.49 km
23	2550.6 m	1049 m	65.7 km
24	2503.83 m	947 m	23.7 km
25	2499.3 m	970 m	53.1 km
26	2482 m	884 m	23.5 km
27	2449.8 m	669 m	15.98 km
28	2450 m	650 m	10.73 km
29	2445.8 m	648 m	35.6 km
30	2435 m	981 m	46.5 km

#### Location

0	45°22 25 N	121°41 45 W	/	45.3735°N	121.6959°W
1	44°40 27 N	121°47 59 W	/	44.6743°N	121.7996°W
2	44°06 13 N	121°46 09 W	/	44.1035°N	121.7693°W
3	44°10 00 N	121°46 20 W	/	44.1666°N	121.7723°W
4	44°08 54 N	121°47 02 W	/	44.1483°N	121.7840°W
5	45°14 42 N	117°17 34 W	/	45.2450°N	117.2929°W
6	42°38 11 N	118°34 36 W	/	42.6364°N	118.5767°W
7	45°12 11 N	117°10 30 W	/	45.2030°N	117.1750°W
8	45°18 17 N	117°20 43 W	/	45.3046°N	117.3452°W
9	45°03 52 N	117°14 46 W	/	45.0644°N	117.2460°W
10	42°26 40 N	122°18 56 W	/	42.4445°N	122.3156°W
11	45°13 20 N	117°23 48 W	/	45.2223°N	117.3968°W
12	43°09 10 N	122°03 59 W	/	43.1528°N	122.0665°W
13	44°04 59 N	121°41 58 W	/	44.0830°N	121.6994°W
14	44°49 00 N	118°06 14 W	/	44.8168°N	118.1039°W
15	43°58 46 N	121°41 19 W	/	43.9794°N	121.6885°W
16	44°18 44 N	118°43 00 W	/	44.3123°N	118.7166°W

```

17 42°55 22 N 122°00 58 W / 42.9229°N 122.0162°W
18 43°31 15 N 122°08 59 W / 43.5207°N 122.1496°W
19 42°05 58 N 118°39 02 W / 42.0995°N 118.6506°W
20 42°03 46 N 120°14 27 W / 42.0628°N 120.2408°W
21 42°18 00 N 120°07 26 W / 42.3001°N 120.1238°W
22 43°09 18 N 122°13 12 W / 43.1551°N 122.2200°W
23 42°29 46 N 120°52 38 W / 42.4960°N 120.8773°W
24 42°18 56 N 122°05 15 W / 42.3155°N 122.0876°W
25 42°55 50 N 121°21 39 W / 42.9306°N 121.3607°W
26 44°42 50 N 118°33 42 W / 44.7138°N 118.5617°W
27 42°30 48 N 122°08 43 W / 42.5134°N 122.1453°W
28 44°17 20 N 118°29 43 W / 44.2889°N 118.4954°W
29 42°27 35 N 119°44 29 W / 42.4597°N 119.7414°W
30 43°41 21 N 121°15 18 W / 43.6892°N 121.2549°W

```

```
[15]: mountain_stats.dtypes
```

```

[15]: Rank                int64
Mountain peak            object
Mountain range           object
Elevation                object
Prominence               object
Isolation                object
Location                 object
dtype: object

```

### 1.2.1 Convert coordinates to float

As can be seen from above, our `Location` column is an `object` datatype which is not very useful. But web scraping is all about data wrangling. So we will convert it to a `float` so we can plot these mountains on a map.

```

[16]: # Have a look at the location object
mountain_stats['Location'].iloc[0]

# The latitude is string position 27 to 34
lat1 = mountain_stats['Location'].iloc[0][27:34]

# The longitude is string position 37 to 45
lon1 = mountain_stats['Location'].iloc[0][37:45]

```

```

[17]: # To get these data from every row, we can write a quick for loop
coords = []
for i in range(len(mountain_stats)):
    lat = float(mountain_stats['Location'].iloc[i][27:34])
    lon = float(mountain_stats['Location'].iloc[i][37:45]) * -1
    coords.append((lat, lon))
#coords

```



### 1.3 Convert Elevation and Isolation to float

It would also be useful to convert other columns to float so we can analyze the data. To do this we'll have to drop the `m` from the data.

Remember when we index a string, a `:` used on the **right** side of the index will get everything **after** that particular index as an output. Alternatively, a `:` used on the **left** side of the index will get everything **before** that particular index as an output.

Also remember that we can pass **negative numbers** to index from the **end** of the string (instead of from the start).

```
[18]: # To get these data from every row, we can write another quick for loop
elevation = []
isolation = []
names = []
for i in range(len(mountain_stats)):
    elev = float(mountain_stats['Elevation'].iloc[i][:-2])
    elevation.append(elev)

    iso = float(mountain_stats['Isolation'].iloc[i][:-2])
    isolation.append(iso)

    name = str(mountain_stats['Mountain peak'].iloc[i][:-2]).split("[")[0]
    names.append(name)

#elevation
```

```
[19]: #isolation
```

```
[20]: #names
```

### 1.4 Plot map with isolation pop up

```
[21]: map = folium.Map(location=[44, -121], zoom_start=6)
for i in range(0, len(coords)):
    folium.Marker(coords[i], popup=isolation[i]).add_to(map)
map
```

```
[21]: <folium.folium.Map at 0x1c4984f9b40>
```

### 1.5 Plot map with name pop up

```
[22]: map = folium.Map(location=[44, -121], zoom_start=6)
for i in range(0, len(coords)):
    folium.Marker(coords[i], popup=names[i]).add_to(map)
map
```

```
[22]: <folium.folium.Map at 0x1c4984f87c0>
```

---

## Question 4 (10 points)  
\* Write a script to automatically derive the geographic coordinates for the following addresses:  
\* 1844 SW Morrison St, Portland, OR 97205  
\* 800 Occidental Ave S, Seattle, WA 98134  
\* 1001 Stadium Dr, Inglewood, CA 90301  
\* 2700 Martin Luther King Jr Blvd, Eugene, OR 97401  
You can **either** find each one individually **or** make a list of the addresses and use a for loop.  
\* Plot the coordinates of these addresses on an interactive map using folium

---

```
[23]: # Install webdriver_manager: https://github.com/SergeyPirogov/webdriver\_manager  
!pip3 install webdriver_manager
```

```
Requirement already satisfied: webdriver_manager in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (3.5.3)  
Requirement already satisfied: crayons in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from webdriver_manager)  
(0.4.0)  
Requirement already satisfied: requests in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from webdriver_manager)  
(2.27.1)  
Requirement already satisfied: configparser in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from webdriver_manager)  
(5.2.0)  
Requirement already satisfied: colorama in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from  
crayons->webdriver_manager) (0.4.4)  
Requirement already satisfied: charset-normalizer~=2.0.0 in  
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from
```

```
requests->webdriver_manager) (2.0.12)
Requirement already satisfied: idna<4,>=2.5 in
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from
requests->webdriver_manager) (3.3)
Requirement already satisfied: certifi>=2017.4.17 in
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from
requests->webdriver_manager) (2021.10.8)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
c:\users\brdeh\anaconda3\envs\lab7\lib\site-packages (from
requests->webdriver_manager) (1.26.8)
```

```
[24]: # Import packages
from selenium import webdriver
from selenium.webdriver.chrome.service import Service
from selenium.webdriver.common.by import By
from selenium.webdriver.support.ui import WebDriverWait
from selenium.webdriver.support import expected_conditions as EC
from webdriver_manager.chrome import ChromeDriverManager
```

```
[25]: # Install Chrome webdriver
driver = webdriver.Chrome(service=Service(ChromeDriverManager().install()))

# Open a web browser at the following page
driver.get("https://en.wikipedia.org/wiki/Category:
↳Ski_areas_and_resorts_in_Oregon")
```

```
===== WebDriver manager =====
Could not get version for google-chrome with the command: powershell
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion ; if (-not $? -or
$? -match $error) { (Get-Item -Path "$env:PROGRAMFILES(x86)\Google\Chrome\Applc
ation\chrome.exe").VersionInfo.FileVersion } if (-not $? -or $? -match $error) {
(Get-Item -Path "$env:LOCALAPPDATA\Google\Chrome\Application\chrome.exe").Versio
nInfo.FileVersion } if (-not $? -or $? -match $error) { reg query
"HKCU\SOFTWARE\Google\Chrome\BLBeacon" /v version } if (-not $? -or $? -match
$error) { reg query
"HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\Google
Chrome" /v version }"
Current google-chrome version is UNKNOWN
Get LATEST chromedriver version for UNKNOWN google-chrome
Trying to download new driver from
https://chromedriver.storage.googleapis.com/98.0.4758.102/chromedriver_win32.zip
Driver has been saved in cache
[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]
```

```
[26]: # Retrieve ski resort names
html_list = driver.find_element(By.ID, "mw-pages")
items = html_list.find_elements(By.TAG_NAME, "li")

[27]: address_list = ['1844 SW Morrison St, Portland, OR 97205', '800 Occidental Ave S,
↳Seattle, WA 98134', '1001 Stadium Dr, Inglewood, CA 90301', '2700 Martin
↳Luther King Jr Blvd, Eugene, OR 97401']
address_list

[27]: ['1844 SW Morrison St, Portland, OR 97205',
'800 Occidental Ave S, Seattle, WA 98134',
'1001 Stadium Dr, Inglewood, CA 90301',
'2700 Martin Luther King Jr Blvd, Eugene, OR 97401']
```

## 1.6 Geocoding

Geocoding is the process of transforming an address (e.g. “1600 Amphitheatre Parkway, Mountain View, CA”) into geographic coordinates (e.g. 37.423021, -122.083739). This is a hugely important part of mapping services like Google Maps and OpenStreetMap since it allows these services to place markers on a map, provide directions etc. There are many geocoding services but often they have a limit the number of free calls we can make. But if we’re clever, we can geocode **unlimitedly** for **free** using Google Maps (<https://www.google.com/maps>) and automated web browsing.

```
[28]: # Define test URL
url = 'https://www.google.com/maps/place/Hoodoo+Ski+Area+Oregon/'

# Install Chrome webdriver
driver = webdriver.Chrome(service=Service(ChromeDriverManager().install()))

# Open URL
driver.get(url)
```

===== WebDriver manager =====

```
Could not get version for google-chrome with the command: powershell
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion ; if (-not $? -or
$? -match $error) { (Get-Item -Path "$env:PROGRAMFILES(x86)\Google\Chrome\Applc
ation\chrome.exe").VersionInfo.FileVersion } if (-not $? -or $? -match $error) {
(Get-Item -Path "$env:LOCALAPPDATA\Google\Chrome\Application\chrome.exe").Versio
nInfo.FileVersion } if (-not $? -or $? -match $error) { reg query
"HKCU\SOFTWARE\Google\Chrome\BLBeacon" /v version } if (-not $? -or $? -match
$error) { reg query
"HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\Google
Chrome" /v version }"
Current google-chrome version is UNKNOWN
Get LATEST chromedriver version for UNKNOWN google-chrome
```

Trying to download new driver from  
https://chromedriver.storage.googleapis.com/98.0.4758.102/chromedriver\_win32.zip  
Driver has been saved in cache  
[C:\Users\brdeh\.wdm\drivers\chromedriver\win32\98.0.4758.102]

```
[29]: addres_coords = []
# Loop through every ski resort to find it's coordinates
for add in addres_list:

    # Define URL to search in Google Maps and add 'Oregon' in for good measure
    url = 'https://www.google.com/maps/place/'+ add + '/'
    print(url)
    # Import web driver and search for ski resorts
    driver = webdriver.Chrome(service=Service(ChromeDriverManager().install()))
    driver.get(url)

    # Click search
    element = WebDriverWait(driver, 20).until(EC.element_to_be_clickable((By.
↪ID, "searchbox-searchbutton")))
    element.click()

    # Make the web driver wait until the URL updates (i.e. contains the @ sign
↪we're looking for)
    WebDriverWait(driver, 20).until(EC.url_contains("@"))

    # Retrieve the URL
    link = driver.current_url

    # Split string
    lat, lon = link.rsplit('@', 1)[1].rsplit(',', 1)[0].rsplit('.', 1)

    # Append to list
    addres_coords.append((lat, lon))

    # Close driver
    driver.close()
```

===== WebDriver manager =====

https://www.google.com/maps/place/1844 SW Morrison St, Portland, OR 97205/

Could not get version for google-chrome with the command: powershell  
"\$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "\$env:PROGRAMFILES\  
Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion ; if (-not \$? -or  
\$? -match \$error) { (Get-Item -Path "\$env:PROGRAMFILES(x86)\Google\Chrome\Applic  
ation\chrome.exe").VersionInfo.FileVersion } if (-not \$? -or \$? -match \$error) {  
(Get-Item -Path "\$env:LOCALAPPDATA\Google\Chrome\Application\chrome.exe").Versio

```
nInfo.FileVersion } if (-not $? -or $? -match $error) { reg query
"HKCU\SOFTWARE\Google\Chrome\BLBeacon" /v version } if (-not $? -or $? -match
$error) { reg query
"HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\Google
Chrome" /v version }"
Current google-chrome version is UNKNOWN
Get LATEST chromedriver version for UNKNOWN google-chrome
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https://chromedriver.storage.googleapis.com/98.0.4758.102/chromedriver_win32.zip
Driver has been saved in cache
[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]
```

===== WebDriver manager =====

<https://www.google.com/maps/place/800 Occidental Ave S, Seattle, WA 98134/>

```
Could not get version for google-chrome with the command: powershell
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion ; if (-not $? -or
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Driver has been saved in cache
[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]
```

===== WebDriver manager =====

<https://www.google.com/maps/place/1001 Stadium Dr, Inglewood, CA 90301/>

```
Could not get version for google-chrome with the command: powershell
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion ; if (-not $? -or
$? -match $error) { (Get-Item -Path "$env:PROGRAMFILES(x86)\Google\Chrome\Applic
ation\chrome.exe").VersionInfo.FileVersion } if (-not $? -or $? -match $error) {
(Get-Item -Path "$env:LOCALAPPDATA\Google\Chrome\Application\chrome.exe").Versio
nInfo.FileVersion } if (-not $? -or $? -match $error) { reg query
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$error) { reg query
"HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\Google
```

```

Chrome" /v version }"
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[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]

```

===== WebDriver manager =====

```

https://www.google.com/maps/place/2700 Martin Luther King Jr Blvd, Eugene, OR
97401/

```

```

Could not get version for google-chrome with the command: powershell
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion ; if (-not $? -or
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Driver has been saved in cache
[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]

```

[30]: `adres_coords`

```

[30]: [('45.5216776', '-122.693017'),
       ('47.5933101', '-122.3344609'),
       ('33.9530049', '-118.3407129'),
       ('44.0594287', '-123.0710918')]

```

```

[31]: map = folium.Map(location=[42, -121], zoom_start=5)
      for i in range(0, len(adres_coords)):
          folium.Marker(adres_coords[i], popup=adres_list[i]).add_to(map)
      map

```

[31]: <folium.folium.Map at 0x1c498812f20>

---

## Question 5 (10  
points)

---

\* Which ski resort  
received **more**  
snowfall in 2020,  
Mount Ashland,  
Willamette Pass or  
Hoodoo?

---

```
[32]: ski_resort_names = ['Hoodoo', 'Willamette Pass', 'Mount Ashland']
      ski_resort_names
```

```
[32]: ['Hoodoo', 'Willamette Pass', 'Mount Ashland']
```

```
[33]: ski_resort_coords = [('42.081689', '-122.7069373'), ('44.4086477', '-121.
      ↪8735991'), ('43.6000579', '-122.0387233')]
      ski_resort_coords
```

```
[33]: [('42.081689', '-122.7069373'),
      ('44.4086477', '-121.8735991'),
      ('43.6000579', '-122.0387233')]
```

```
[34]: map = folium.Map(location=[44, -121], zoom_start=6)
      for i in range(0, len(ski_resort_names)):
          folium.Marker(ski_resort_coords[i], popup=ski_resort_names[i]).add_to(map)
      map
```

```
[34]: <folium.folium.Map at 0x1c498813d60>
```

```
[35]: # Import package
      import xarray as xr
```

```
[36]: # Define filepath
      fp = 'E:\GitHub\GeospatialDataAnalysis\geospatial-data-science\labs\lab7'
      # Read data
      xds = xr.open_dataset(fp + '/era_monthly_snowfall_2020.nc', decode_coords='all')
      #xds
```

```
[37]: df = pd.DataFrame()
      df['name'] = ski_resort_names
      df['coords'] = ski_resort_coords
      sf_test = []
      for i in range(0, len(ski_resort_coords)):
          val_sf = xds['sf'].sel(latitude = ski_resort_coords[i][0], longitude = ↵
          ↪ski_resort_coords[i][1], method = 'nearest').sum().values
          sf_test.append(val_sf)
      df['sf_t'] = sf_test
      df.sort_values(["sf_t"], ascending=False)
```



[37]:	name	coords	sf_t
2	Mount Ashland	(43.6000579, -122.0387233)	0.019636936
1	Willamette Pass	(44.4086477, -121.8735991)	0.018596929
0	Hoodoo	(42.081689, -122.7069373)	0.009228621

## 1.7 Question 5 Answer

Most - Willamette Pass with 0.0196 meters of water equivalent

Middle - Hoodoo (ski area) with 0.0186 meters of water equivalent

Least - Mount Ashland Ski Area with 0.0092 meters of water equivalent

## 1.8 Extra credit/grad students

Download era\_monthly\_snowfall\_1979\_2020.nc from the lab7 folder on Dropbox.

- Rank the ski resorts by:
  - Average snowfall in **November**
  - Average snowfall in **Spring** (i.e. March, April, and May)
  - **Interannual variability** in snowfall

```
[38]: # Install Chrome webdriver
driver = webdriver.Chrome(service=Service(ChromeDriverManager().install()))

# Open a web browser at the following page
driver.get("https://en.wikipedia.org/wiki/Category:
↳Ski_areas_and_resorts_in_Oregon")

# Retrieve ski resort names
html_list = driver.find_element(By.ID, "mw-pages")
items = html_list.find_elements(By.TAG_NAME, "li")

ski_resort_names = []
for item in items:
    text = item.text
    print(text)
    ski_resort_names.append(text)
driver.close()
```

===== WebDriver manager =====

Could not get version for google-chrome with the command: powershell

```
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion ; if (-not $? -or
$? -match $error) { (Get-Item -Path "$env:PROGRAMFILES(x86)\Google\Chrome\Applc
ation\chrome.exe").VersionInfo.FileVersion } if (-not $? -or $? -match $error) {
```

```
(Get-Item -Path "$env:LOCALAPPDATA\Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion } if (-not $? -or $? -match $error) { reg query "HKCU\SOFTWARE\Google\Chrome\BLBeacon" /v version } if (-not $? -or $? -match $error) { reg query "HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\Google Chrome" /v version }"
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https://chromedriver.storage.googleapis.com/98.0.4758.102/chromedriver_win32.zip
Driver has been saved in cache
[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]
```

Anthony Lakes (ski area)  
 Mount Ashland Ski Area  
 Cooper Spur ski area  
 Ferguson Ridge Ski Area  
 Hoodoo (ski area)  
 Mount Ashland Ski Area Expansion  
 Mount Bachelor ski area  
 Mount Hood Meadows  
 Mount Hood Skibowl  
 Snow Bunny  
 Spout Springs Ski Area  
 Summit Pass (Oregon)  
 Timberline Lodge ski area  
 Warner Canyon  
 Willamette Pass Resort

```
[39]: import time
ski_resort_coords = []
# Loop through every ski resort to find it's coordinates
for resort in ski_resort_names:
    # Define URL to search in Google Maps and add 'Oregon' in for good measure
    url = 'https://www.google.com/maps/place/' + resort + ' Oregon/'

    # Import web driver and search for ski resorts
    driver = webdriver.Chrome(service=Service(ChromeDriverManager().install()))
    driver.get(url)

    # Click search
    element = WebDriverWait(driver, 20).until(EC.element_to_be_clickable((By.ID, "searchbox-searchbutton")))
    element.click()
    time.sleep(3)
    # Make the web driver wait until the URL updates (i.e. contains the @ sign we're looking for)
    WebDriverWait(driver, 20).until(EC.url_contains("@"))
```

```

# Retrieve the URL
link = driver.current_url

# Split string
lat, lon = link.rsplit('@', 1)[1].rsplit(',', 1)[0].rsplit(',', 1)

# Append to list
ski_resort_coords.append((lat, lon))

# Close driver
driver.close()

```

===== WebDriver manager =====

```

Could not get version for google-chrome with the command: powershell
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
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```

===== WebDriver manager =====

```

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$error) { reg query
"HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\Google
Chrome" /v version }"
Current google-chrome version is UNKNOWN

```

```
Get LATEST chromedriver version for UNKNOWN google-chrome
Trying to download new driver from
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[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]
```

===== WebDriver manager =====

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===== WebDriver manager =====

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```

===== WebDriver manager =====

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===== WebDriver manager =====

```

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```

```

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===== WebDriver manager =====

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===== WebDriver manager =====

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```

[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]

===== WebDriver manager =====

```
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```

===== WebDriver manager =====

```
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===== WebDriver manager =====

```
Could not get version for google-chrome with the command: powershell
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion ; if (-not $? -or
$? -match $error) { (Get-Item -Path "$env:PROGRAMFILES(x86)\Google\Chrome\Appl
```

```

ation\chrome.exe").VersionInfo.FileVersion } if (-not $? -or $? -match $error) {
(Get-Item -Path "$env:LOCALAPPDATA\Google\Chrome\Application\chrome.exe").Versio
nInfo.FileVersion } if (-not $? -or $? -match $error) { reg query
"HKCU\SOFTWARE\Google\Chrome\BLBeacon" /v version } if (-not $? -or $? -match
$error) { reg query
"HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\Google
Chrome" /v version }"
Current google-chrome version is UNKNOWN
Get LATEST chromedriver version for UNKNOWN google-chrome
Trying to download new driver from
https://chromedriver.storage.googleapis.com/98.0.4758.102/chromedriver_win32.zip
Driver has been saved in cache
[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]

```

===== WebDriver manager =====

```

Could not get version for google-chrome with the command: powershell
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
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```

===== WebDriver manager =====

```

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ation\chrome.exe").VersionInfo.FileVersion } if (-not $? -or $? -match $error) {
(Get-Item -Path "$env:LOCALAPPDATA\Google\Chrome\Application\chrome.exe").Versio
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"HKCU\SOFTWARE\Google\Chrome\BLBeacon" /v version } if (-not $? -or $? -match
$error) { reg query
"HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\Google
Chrome" /v version }"
Current google-chrome version is UNKNOWN

```



```

Get LATEST chromedriver version for UNKNOWN google-chrome
Trying to download new driver from
https://chromedriver.storage.googleapis.com/98.0.4758.102/chromedriver_win32.zip
Driver has been saved in cache
[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]

```

```

===== WebDriver manager =====

```

```

Could not get version for google-chrome with the command: powershell
"$ErrorActionPreference='silentlycontinue' ; (Get-Item -Path "$env:PROGRAMFILES\
Google\Chrome\Application\chrome.exe").VersionInfo.FileVersion ; if (-not $? -or
$? -match $error) { (Get-Item -Path "$env:PROGRAMFILES(x86)\Google\Chrome\Applc
ation\chrome.exe").VersionInfo.FileVersion } if (-not $? -or $? -match $error) {
(Get-Item -Path "$env:LOCALAPPDATA\Google\Chrome\Application\chrome.exe").Versio
nInfo.FileVersion } if (-not $? -or $? -match $error) { reg query
"HKCU\SOFTWARE\Google\Chrome\BLBeacon" /v version } if (-not $? -or $? -match
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"HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\Google
Chrome" /v version }"
Current google-chrome version is UNKNOWN
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Trying to download new driver from
https://chromedriver.storage.googleapis.com/98.0.4758.102/chromedriver_win32.zip
Driver has been saved in cache
[C:\Users\brdeh\wdm\drivers\chromedriver\win32\98.0.4758.102]

```

```
[40]: ski_resort_coords
```

```

[40]: [('44.9629273', '-118.2357129'),
 ('42.081689', '-122.7069427'),
 ('45.4188609', '-121.6064525'),
 ('45.2816889', '-117.1148305'),
 ('44.4086477', '-121.8736045'),
 ('44.0294504', '-123.0520456'),
 ('44.0028975', '-121.6812601'),
 ('44.0294504', '-123.0520456'),
 ('45.2943644', '-121.7896261'),
 ('45.2871456', '-121.7312302'),
 ('45.7552462', '-118.0536097'),
 ('44.0304639', '-123.4892662'),
 ('45.3311319', '-121.7131951'),
 ('42.237378', '-120.2968271'),
 ('43.6000579', '-122.0387287')]

```

```

[41]: # Read data
xds2 = xr.open_dataset(fp + '/era_monthly_snowfall_1979_2020.nc',
↳ decode_coords='all')

```

```
[42]: nov = xds2.isel(time = xds2.time.dt.month == 11)
      nov["time.month"]
```

```
[42]: <xarray.DataArray 'month' (time: 42)>
      array([11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11,
             11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11,
             11, 11, 11, 11, 11, 11, 11], dtype=int64)
      Coordinates:
        * time      (time) datetime64[ns] 1979-11-01 1980-11-01 ... 2020-11-01
```

```
[43]: spring = xds2.sel(time = xds2.time.dt.season == "MAM")
      spring["time.month"]
```

```
[43]: <xarray.DataArray 'month' (time: 126)>
      array([3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3,
             4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4,
             5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5,
             3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3,
             4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4,
             5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5, 3, 4, 5], dtype=int64)
      Coordinates:
        * time      (time) datetime64[ns] 1979-03-01 1979-04-01 ... 2020-05-01
```

```
[44]: year = xds2.resample(time='1Y').mean()
      year
```

```
[44]: <xarray.Dataset>
      Dimensions:      (time: 42, longitude: 49, latitude: 25)
      Coordinates:
        * time          (time) datetime64[ns] 1979-12-31 1980-12-31 ... 2020-12-31
        * longitude      (longitude) float32 -128.0 -127.8 -127.5 ... -116.5 -116.2 -116.0
        * latitude       (latitude) float32 47.0 46.75 46.5 46.25 ... 41.5 41.25 41.0
      Data variables:
        sf              (time, latitude, longitude) float32 -9.313e-10 ... 0.0003046
```

```
[45]: df2 = pd.DataFrame()
      df2['name'] = ski_resort_names
      df2['coords'] = ski_resort_coords
      Nov_sf = []
      Spring_sf = []
      intvar = []

      for i in range(0, len(ski_resort_coords)):
          nov_val_sf = nov['sf'].sel(latitude = ski_resort_coords[i][0], longitude =
          ↪ ski_resort_coords[i][1], method = 'nearest').mean().values
          Nov_sf.append(nov_val_sf)
```

```

    spring_val_sf = spring['sf'].sel(latitude = ski_resort_coords[i][0],
    ↪ longitude = ski_resort_coords[i][1], method = 'nearest').mean().values
    Spring_sf.append(spring_val_sf)
    intvar_val_sf = year['sf'].sel(latitude = ski_resort_coords[i][0],
    ↪ longitude = ski_resort_coords[i][1], method = 'nearest').std().values
    intvar.append(intvar_val_sf)
df2['Average Nov Snowfall'] = Nov_sf
df2['Average Spring Snowfall'] = Spring_sf
df2['Interannual Variability (standard dev of annual means)'] = intvar

```

```
[46]: df2.sort_values(["Average Nov Snowfall"], ascending=False)
```

```
[46]:
```

	name	coords \
6	Mount Bachelor ski area	(44.0028975, -121.6812601)
14	Willamette Pass Resort	(43.6000579, -122.0387287)
4	Hoodoo (ski area)	(44.4086477, -121.8736045)
3	Ferguson Ridge Ski Area	(45.2816889, -117.1148305)
8	Mount Hood Skibowl	(45.2943644, -121.7896261)
9	Snow Bunny	(45.2871456, -121.7312302)
12	Timberline Lodge ski area	(45.3311319, -121.7131951)
0	Anthony Lakes (ski area)	(44.9629273, -118.2357129)
2	Cooper Spur ski area	(45.4188609, -121.6064525)
1	Mount Ashland Ski Area	(42.081689, -122.7069427)
10	Spout Springs Ski Area	(45.7552462, -118.0536097)
13	Warner Canyon	(42.237378, -120.2968271)
5	Mount Ashland Ski Area Expansion	(44.0294504, -123.0520456)
7	Mount Hood Meadows	(44.0294504, -123.0520456)
11	Summit Pass (Oregon)	(44.0304639, -123.4892662)

	Average Nov Snowfall	Average Spring Snowfall \
6	0.0032581266	0.0020057987
14	0.002860935	0.0017587584
4	0.0025108436	0.0015250901
3	0.0022443563	0.0015363443
8	0.002203377	0.001485502
9	0.002203377	0.001485502
12	0.002203377	0.001485502
0	0.0018615923	0.0011098591
2	0.0016262013	0.00081358914
1	0.0016191967	0.0010225766
10	0.001565914	0.00070195703
13	0.0013031556	0.0008413863
5	7.82503e-05	6.956184e-05
7	7.82503e-05	6.956184e-05
11	5.0190392e-05	6.345044e-05

Interannual Variability (standard dev of annual means)

6	0.00040021454
14	0.00036251967
4	0.00034544914
3	0.00026299493
8	0.00032707243
9	0.00032707243
12	0.00032707243
0	0.00019159571
2	0.00024317137
1	0.00031316077
10	0.00018419641
13	0.00019654837
5	9.195319e-05
7	9.195319e-05
11	7.835622e-05

```
[47]: df2.sort_values(["Average Spring Snowfall"], ascending=False)
```

```
[47]:
```

	name	coords \
6	Mount Bachelor ski area	(44.0028975, -121.6812601)
14	Willamette Pass Resort	(43.6000579, -122.0387287)
3	Ferguson Ridge Ski Area	(45.2816889, -117.1148305)
4	Hoodoo (ski area)	(44.4086477, -121.8736045)
8	Mount Hood Skibowl	(45.2943644, -121.7896261)
9	Snow Bunny	(45.2871456, -121.7312302)
12	Timberline Lodge ski area	(45.3311319, -121.7131951)
0	Anthony Lakes (ski area)	(44.9629273, -118.2357129)
1	Mount Ashland Ski Area	(42.081689, -122.7069427)
13	Warner Canyon	(42.237378, -120.2968271)
2	Cooper Spur ski area	(45.4188609, -121.6064525)
10	Spout Springs Ski Area	(45.7552462, -118.0536097)
5	Mount Ashland Ski Area Expansion	(44.0294504, -123.0520456)
7	Mount Hood Meadows	(44.0294504, -123.0520456)
11	Summit Pass (Oregon)	(44.0304639, -123.4892662)

	Average Nov Snowfall	Average Spring Snowfall \
6	0.0032581266	0.0020057987
14	0.002860935	0.0017587584
3	0.0022443563	0.0015363443
4	0.0025108436	0.0015250901
8	0.002203377	0.001485502
9	0.002203377	0.001485502
12	0.002203377	0.001485502
0	0.0018615923	0.0011098591
1	0.0016191967	0.0010225766
13	0.0013031556	0.0008413863
2	0.0016262013	0.00081358914

10	0.001565914	0.00070195703
5	7.82503e-05	6.956184e-05
7	7.82503e-05	6.956184e-05
11	5.0190392e-05	6.345044e-05

	Interannual Variability (standard dev of annual means)
6	0.00040021454
14	0.00036251967
3	0.00026299493
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8	0.00032707243
9	0.00032707243
12	0.00032707243
0	0.00019159571
1	0.00031316077
13	0.00019654837
2	0.00024317137
10	0.00018419641
5	9.195319e-05
7	9.195319e-05
11	7.835622e-05

```
[48]: df2.sort_values(["Interannual Variability (standard dev of annual means)"],
↪ascending=False)
```

```
[48]:
```

	name	coords \
6	Mount Bachelor ski area	(44.0028975, -121.6812601)
14	Willamette Pass Resort	(43.6000579, -122.0387287)
4	Hoodoo (ski area)	(44.4086477, -121.8736045)
8	Mount Hood Skibowl	(45.2943644, -121.7896261)
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2	Cooper Spur ski area	(45.4188609, -121.6064525)
13	Warner Canyon	(42.237378, -120.2968271)
0	Anthony Lakes (ski area)	(44.9629273, -118.2357129)
10	Spout Springs Ski Area	(45.7552462, -118.0536097)
5	Mount Ashland Ski Area Expansion	(44.0294504, -123.0520456)
7	Mount Hood Meadows	(44.0294504, -123.0520456)
11	Summit Pass (Oregon)	(44.0304639, -123.4892662)

	Average Nov Snowfall	Average Spring Snowfall \
6	0.0032581266	0.0020057987
14	0.002860935	0.0017587584
4	0.0025108436	0.0015250901
8	0.002203377	0.001485502

9	0.002203377	0.001485502
12	0.002203377	0.001485502
1	0.0016191967	0.0010225766
3	0.0022443563	0.0015363443
2	0.0016262013	0.00081358914
13	0.0013031556	0.0008413863
0	0.0018615923	0.0011098591
10	0.001565914	0.00070195703
5	7.82503e-05	6.956184e-05
7	7.82503e-05	6.956184e-05
11	5.0190392e-05	6.345044e-05

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0	0.00019159571
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5	9.195319e-05
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11	7.835622e-05