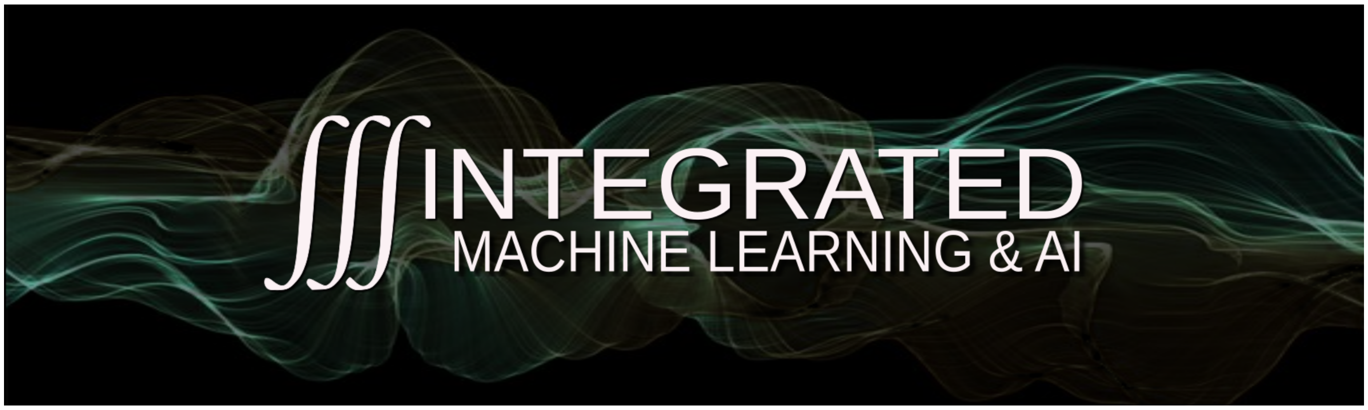
A Beginning To Advanced Web Scraping

by Thom Ives, Ph.D.



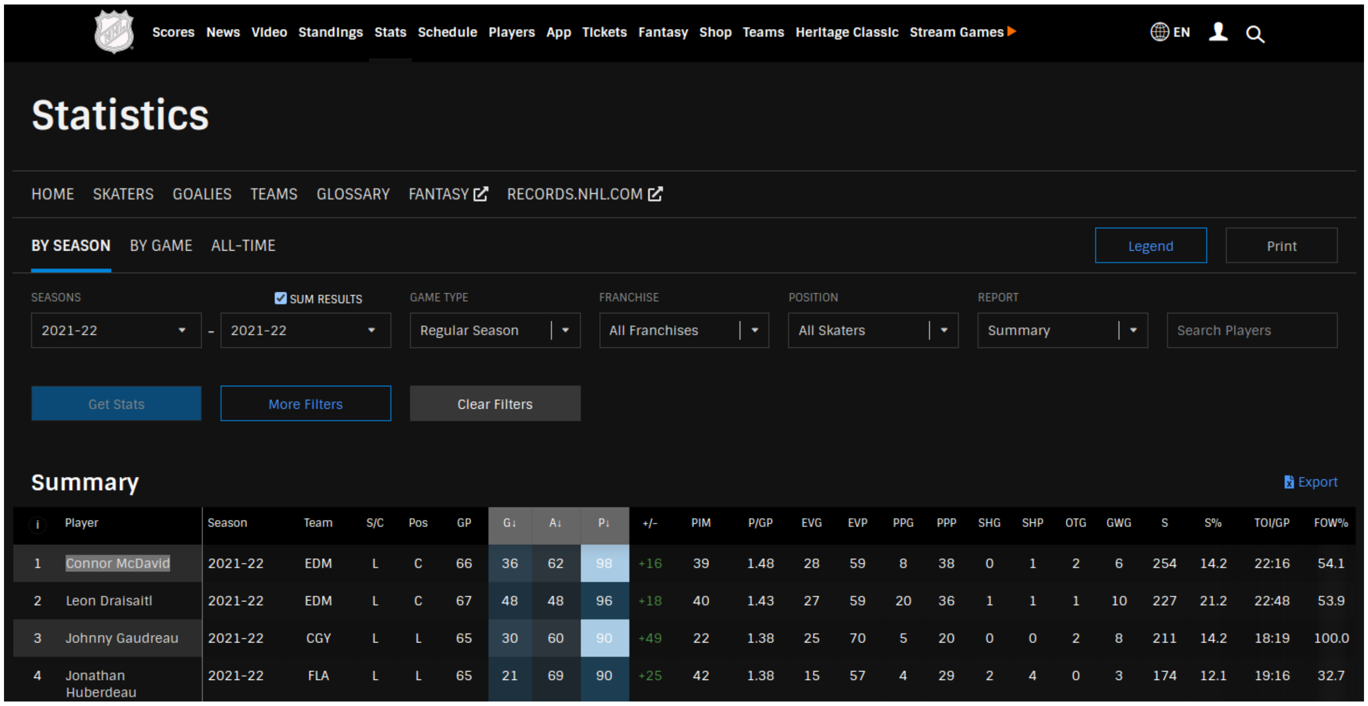
Why this work? Sometimes, to automate data collection from websites, we must actually operate those web pages on that site to reach a page that has the data we need. These types of data collections cannot be done using simple Python `requests`. However, learning to automate web pages is a great skill for both testing web site operations AND for collecting data that could not be collected otherwise. This is an initial tutorial on how to setup advanced web scraping with selenium through Python.

All of the code shown in this `ReadMe.md` markdown file is in Thom's Web_Scraping Repo on DagsHub, and this file is also stored as a PDF in that repo. I will be updating the code AND this document with additional and refactored tools and other examples as frequently as possible.

This initial work is for Linux, but I do have routines that work just as well on Windows, and I will share them soon. Mac users, I think the linux routines will be a good starting point for you, and I don't own a Mac, so you are on your own - sorry.

What Will NOT Work More And More Often

Consider that we are in a fantasy hockey league, and we want to automate capturing skater statistics from National Hockey League's statistics on skaters. Why? The data on our skater pool changes frequently, and we need updated data to make the best decisions about which skaters to place on our team. We would even hope to use some cool math machines from machine learning techniques or more to create the best fantasy team so that our team can win in this fantasy league. But we need to scrape the data from one of the pages on the NHL Skaters page first. Oh! There are many pages of these skaters. Hmmm. Let's start with at least one page first. Here's what the NHL Skaters site looks like in dark mode when we go there.



Statistics

SEASONS: 2021-22 - 2021-22 | SUM RESULTS ✓ | GAME TYPE: Regular Season | FRANCHISE: All Franchises | POSITION: All Skaters | REPORT: Summary

Summary

i	Player	Season	Team	S/C	Pos	GP	G↓	A↓	P↓	+/-	PIM	P/GP	EVG	EVP	PPG	PPP	SHG	SHP	OTG	GWG	S	S%	TOI/GP	FOW%
1	Connor McDavid	2021-22	EDM	L	C	66	36	62	98	+16	39	1.48	28	59	8	38	0	1	2	6	254	14.2	22:16	54.1
2	Leon Draisaitl	2021-22	EDM	L	C	67	48	48	96	+18	40	1.43	27	59	20	36	1	1	1	10	227	21.2	22:48	53.9
3	Johnny Gaudreau	2021-22	CGY	L	L	65	30	60	90	+49	22	1.38	25	70	5	20	0	0	2	8	211	14.2	18:19	100.0
4	Jonathan Huberdeau	2021-22	FLA	L	L	65	21	69	90	+25	42	1.38	15	57	4	29	2	4	0	3	174	12.1	19:16	32.7

Those skilled in such arts of web scraping of data already know some cool tricks! Assuming you are in Python3, we can use the code below on some sites.

```
import requests
import pandas as pd


page_url = "https://www.nhl.com/stats/skaters"
page = requests.get(page_url)

# This didn't work!
# dfs = pd.read_html(page.text)
# print(dfs[0])

print("Connor McDavid" in page.text)
```

The Pandas `read_html` class is VERY smart. It will look through the text of page contents captured from the `page = requests.get(page_url)` line and then give us all the tables found in `page.text` as a list of Pandas DataFrames.

Well, as you likely guessed, due to foreshadowing of the language in the previous text, and the commented out lines, this did NOT work. Bummer! Note what we tried. Also, just to further investigate the extent of the issue, we checked to see if the first players name from the table appeared anywhere in `page.text`, and that last `print("Connor McDavid" in page.text)` did return `False`.

Why is this happening? If you do an inspection on this page (right click on the NHL Skaters page, and then click `Inspect` in the context sensitive menu), you will see that the html code for this page loads a ton of scripts! Basically, the table that we see won't get loaded when we try to capture it using a `requests.get(page_url)` type command.

Is there hope? Yes, but it becomes a bit more complicated. Let's take that increased complication and break it into small and manageable steps. We hope that this document makes it much easier for you to get started than if you had to start learning this from the point where we did.

What You Need More And More Often

We need Selenium. Seleni-what? Haha! The language used to automate the testing and (as it turns out) the collection of data from highly dynamic websites. We basically use it to help us programmatically operate web browswers like we would, but with a program. Now, if you are spoiled Python users like us (yes, we went there, because after so many other languages, we feel completely spoiled using Python), you want to be able to use Selenium through Python, and that is how we will use Selenium - thru Python.

Setting Linux Up For Selenium Thru Python With Chrome

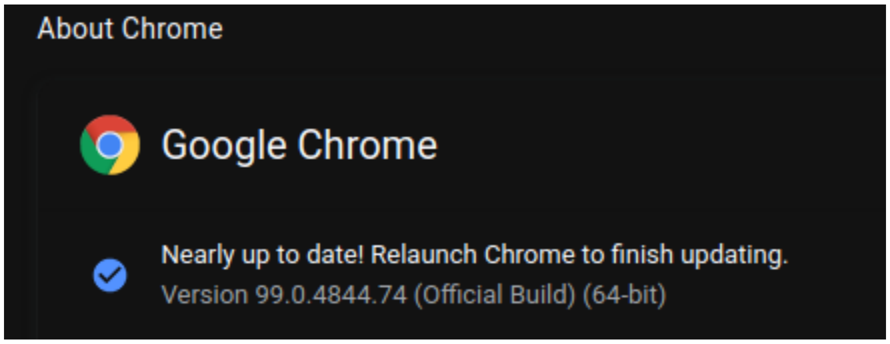
(Windows OS And Other Browsers Coming Soon)

First, we will need a driver that allows us to control an instance of the Chrome browser from our local host using selenium. Thankfully, the major browser companies create such drivers knowing that dynamic web pages need to be tested locally before they are released into the wild wild web. This driver for Chrome is simply called the `chromedriver`. As we grow this repo, we will add setup guides for other browsers.

The chromedriver you need for your system is dependent on the following.

1. Your version of chrome.
2. Your OS and OS's bit size.

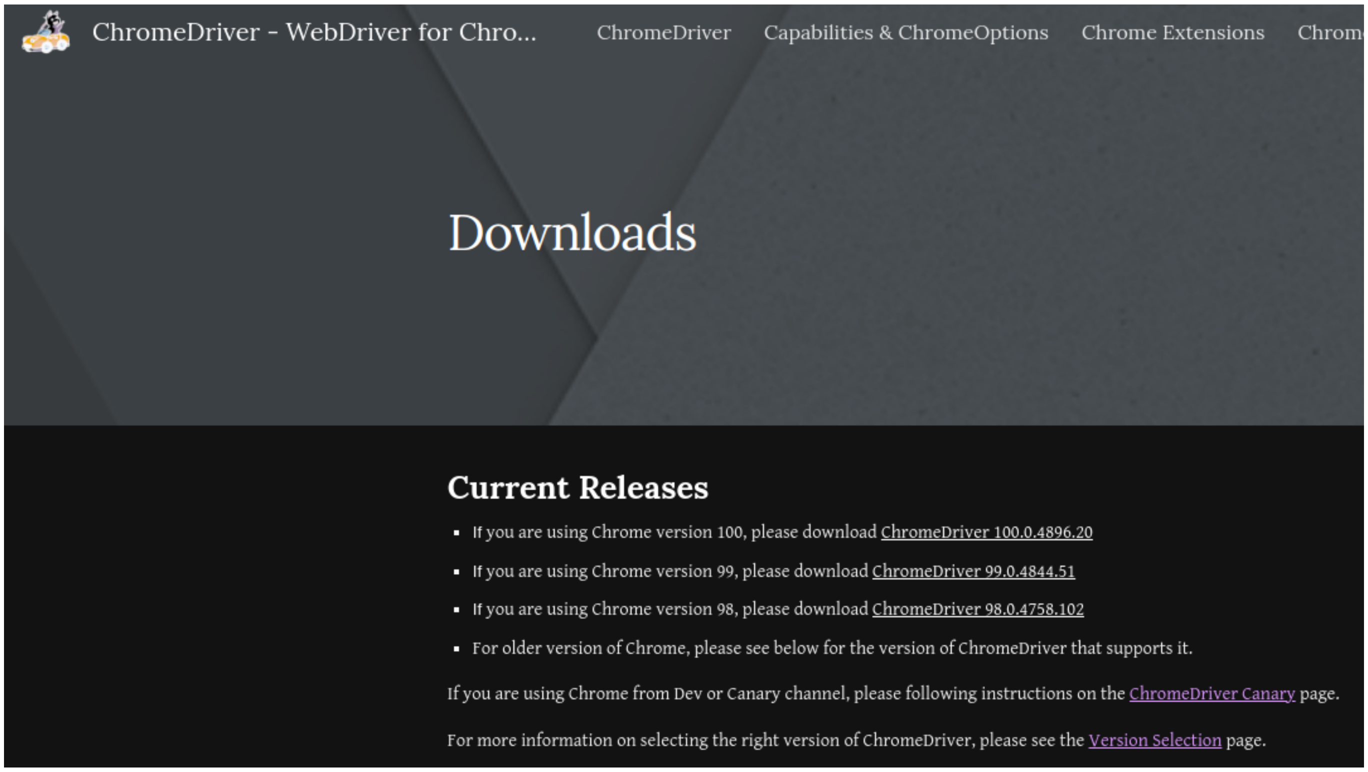
To find your Chrome version, go to your chrome settings, and find your current version of Chrome as shown in the image below.


About Chrome

Google Chrome

Nearly up to date! Relaunch Chrome to finish updating.
Version 99.0.4844.74 (Official Build) (64-bit)

Once you know that, we can go to https://chromedriver.chromium.org/downloads to find the version of chromedriver that will match our chrome version as shown in the image below.


ChromeDriver - WebDriver for Chro...
ChromeDriver
Capabilities & ChromeOptions
Chrome Extensions
Chrom

Downloads

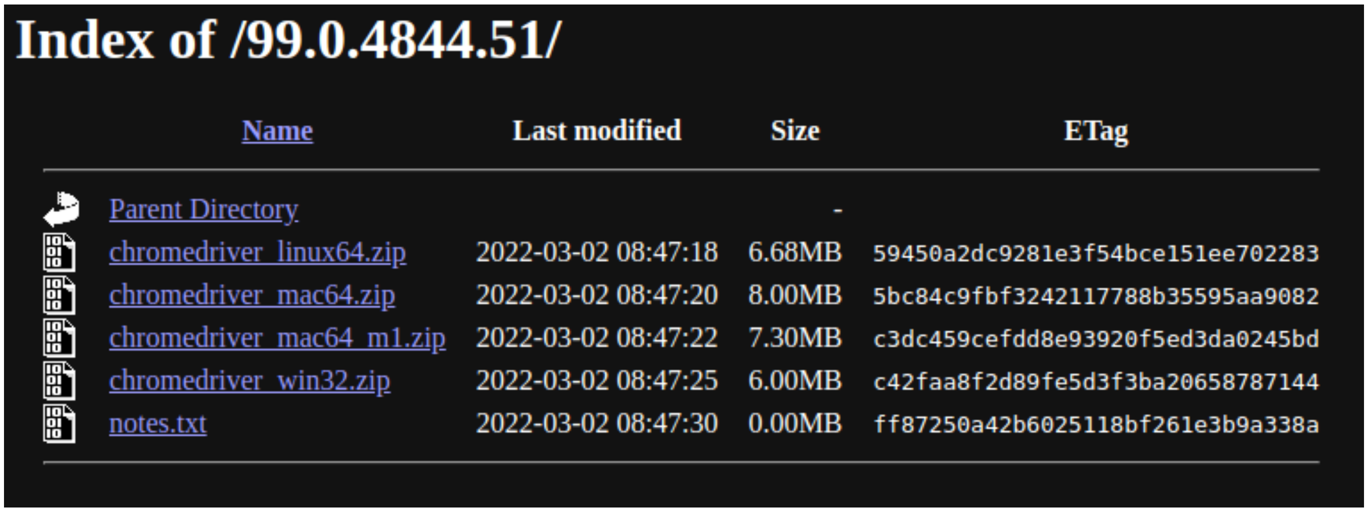
Current Releases

- If you are using Chrome version 100, please download ChromeDriver 100.0.4896.20
- If you are using Chrome version 99, please download ChromeDriver 99.0.4844.51
- If you are using Chrome version 98, please download ChromeDriver 98.0.4758.102
- For older version of Chrome, please see below for the version of ChromeDriver that supports it.

If you are using Chrome from Dev or Canary channel, please following instructions on the ChromeDriver Canary page.

For more information on selecting the right version of ChromeDriver, please see the Version Selection page.

For Thom, currently, I'd click on the version 99 link unless I decided to upgrade to version 100 of Chrome. How to automate capturing a new `chromedriver` 🤔? We want to do this, but let's get these basics learned first.



Index of /99.0.4844.51/

Name	Last modified	Size	ETag
Parent Directory		-	
chromedriver_linux64.zip	2022-03-02 08:47:18	6.68MB	59450a2dc9281e3f54bce151ee702283
chromedriver_mac64.zip	2022-03-02 08:47:20	8.00MB	5bc84c9fbf3242117788b35595aa9082
chromedriver_mac64_m1.zip	2022-03-02 08:47:22	7.30MB	c3dc459cefdd8e93920f5ed3da0245bd
chromedriver_win32.zip	2022-03-02 08:47:25	6.00MB	c42faa8f2d89fe5d3f3ba20658787144
notes.txt	2022-03-02 08:47:30	0.00MB	ff87250a42b6025118bf261e3b9a338a

Location Of chromedriver On Linux

Once we have our chromedriver, OR an upgraded version of it, we prefer to put that chromedriver into the `/usr/bin/` directory, or replace the current version. You can put it elsewhere, but you will just need to point to it as we will show you.

`/usr/bin/chromedriver`

A Dedicated ChromeProfile For Our Web Scraper

Last, we want to create a copy of our current Chrome profile and put the profile into a dedicated directory for web scraping work. Thom even creates a separate profile for each web scraper. This may be overkill, and I may change this in the future, but right now, I just do it to keep things separated. So, find your current Chrome Profile, and copy it to a new directory that you can point to with our new routines later.

Operating Web Browser Ops With Selenium Through Python

Creating And Covering Convenience Functions

Rather than start from scratch, we want to show you some tools that we've developed that you can use over and over (trying to stay DRY - don't repeat yourself, or in our case - ourselves). As we always encourage, take our code as a starting point, and PLEASE refactor it to your specific needs and/or liking. If this helps you to make a great start, we'd appreciate you mentioning us in your code comments or any posts you write about the same with a link back to this repo. But if you don't, we won't take any action against you either - all of this is free to use.

Let's start in the `Basic_Tools.py` file. First, the imports.

```
import time
import subprocess
import selenium
import os
import pprint

from selenium.webdriver.chrome.options import Options

pp = pprint.PrettyPrinter(indent=2)
```

Next, the `send_Bot_to_sleep` function. What?!?! We want to put the Bot to sleep already? Well, this is just a convenience function. While developing a new web scraper that is specific to some new web scraping on a specific site, we often times need an automated way to simply `kill` the process that was running our web instance. In summary, the specific `lsof` command in the parentheses of `kill $(lsof -t -i:{port})` finds the process id (pid) for our port (we check to see if it is running before we call this function) and then kills that pid after setting the found pid to a system variable. Killing the bot sounds so violent, but then the process isn't sentient, so we should be OK with this.

```
def send_bot_to_sleep(host_port):
    port = host_port.split(':')[-1]
    print("Seeing if Bot is awake.")
    subprocess.run(f"kill $(lsof -t -i:{port})")

    pid = bot_is_running(host_port)

    if pid:
        print('Failed to put bot down.')
    else:
        print('Bot put down successfully.')
```

Depending on where we are at in our web scraping development, we may or may not call the above function. As always, play with this. Take it line by line and study what each line has accomplished. You'll be glad that you did.

This next function, `bot_is_running`, similar in nature to the above, simply returns a pid if the bot is running, or it returns an empty string if it's not. I prefer to call this function as a conditional before deciding to run the above function.

```
def bot_is_running(host_port):
    port = host_port.split(':')[-1]
    ops = subprocess.run(f"lsof -i:{port}", shell=True,
capture_output=True)
    time.sleep(2)
    pid = [r for r in ops.stdout.decode("utf-8").split('\n') if port in r]

    if pid:
        pid = pid[0].split()[1]
    else:
        pid = ''

    if pid:
        return pid
    else:
        return ''
```

And finally, at least for this intro to automatic web ops, we need a function that literally opens a browser, so that we can start to operate it and collect data from it. That function is named `prepare_bot`. Note that `prepare_bot` calls `bot_is_running` so that we don't needlessly try to relaunch another browser, which the code in the `if` block will do if it's ran. This really helps with developing our specific web scraper routines. We can start at a certain place in our website operations and continue from there to test one new little thing at a time by using an existing running instance of a selenium controlled browser rather than operate through all the operations up to the point of our current development. This saves a TON of development time!

For the `cmd_str`, we build it up to call a linux terminal that will stay open, and run the command `google-chrome-stable --remote-debugging-port=8223 --user-data-dir ="home/thom/NHS/ChromeProfile"`, but we escape our `"`s where needed to build the string and send it properly to the opened terminal. Take note of how we use our dedicated chrome profile in the `cmd_str` - `--user-data-dir ="/home/thom/NHS/ChromeProfile"`.

The code below the `if` block will give us the `driver` to connect to the instance that we started, if it wasn't yet running, or connect to an existing instance. The line, `options.add_experimental_option("debuggerAddress", host_port)` is key to what we are doing here. It makes reusing instances for our specific test profile and browser possible.

Also, note how we tell our selenium routines where to find our `chromedriver` with `driver = selenium.webdriver.Chrome(ChromeDriverPath, options=options)`.

```
def prepare_bot(host_port):
    port = host_port.split(':')[-1]
    ChromeDriverPath = "/usr/bin/chromedriver"

    if not bot_is_running(host_port):
        cmd_str = "gnome-terminal -- 'bash -c \"google-chrome-stable "
        cmd_str += f"--remote-debugging-port={port} --user-data-dir"
        cmd_str += "=\"/home/thom/NHS/ChromeProfile\"; exec bash\"'"
        os.system(cmd_str)
        time.sleep(3)

    options = Options()
    options.headless = False
    options.add_experimental_option("debuggerAddress", host_port)
    driver = selenium.webdriver.Chrome(ChromeDriverPath, options=options)
    time.sleep(3)

    return driver
```

Using Convenience Functions And More To Operate Our Website

Let's now explain the lines in the `Basic_Dev_1.py` script that is used to control our browser. First, `import` needed modules. Obviously, for your Python environment, `pip install <needed_packages>` also. Please note that the `Basic_Tools` module is the Python script `Basic_Tools.py` that we previously covered.

```
import Basic_Tools as bt
import numpy as np
import pandas as pd
import time
```

The next block of code is tasked with obtaining a `driver` that we can use to perform web operations on our website's pages.

```
host_port = "127.0.0.1:8223"
```

```
''' The intents of this commented out code is replaced with Manage_Bot.py.
# if bt.bot_is_running(host_port):
#     bt.send_bot_to_sleep(host_port)
#     time.sleep(1)

driver = bt.prepare_bot(host_port)
```

This next block is KEY to maintaining our sanity during the development of a new web scraper. If we are already where we want to go, don't reload the page to go there! And the `if` block could be changed to allow for many more page titles. This allows us to pull data and operate the page from where we were last doing operations on our website. This is a BIG time saver and sanity maintainer as we refactor and add more and more functionality.

```
page_title = "NHL Stats | NHL.com"
if page_title not in driver.title:
    print(f"Going To {page_title}.\n")
    driver.get("https://www.nhl.com/stats/skaters")
    time.sleep(4)
else:
    print(f"Already on {page_title}\n")
```

We encourage you to comment out the code after the above block of code in the file and watch your terminal and test browser open. Pretty cool - right? Well, we are only just starting. Let the coolness continue. If the previous code has not yet seemed super cool, prepare your inner geek to be thrilled.

In the next block, we first use the `driver` to obtain the page source. Then we use the `driver` to `find_elements_by_class_name` that have the class name of `"rt-header-cell"` so that we can find the table header names / column names. How did we know to use `"rt-header-cell"`?

Once your inspection window is open for the NHL Skaters site, you can right click on various elements in the web page again, and the highlighter in the html code window will highlight the code that controls that. We kept doing this until we saw the table header code highlighted for this first page of Skater Stats. Then we double clicked on the class name, which highlighted it, and then copied it, and then pasted copied class name into our find elements statement.

Next, we cycle through `col_elements` elements to collect the text to capture the text from each element of `col_elements`.

Next, we repeat a similar process for the `"rt-tbody"` class element(s). Now usually, we can take magical steps with Pandas' `read_html` method to capture this table data by giving it some form of the `page_source` data. On our NHL page, this did not work - DARN! So, we get creative!

```
page_source = driver.page_source
```

```
col_elements = driver.find_elements_by_class_name("rt-header-cell")
col_names = [e.text for e in col_elements]
```

```
table_sel = driver.find_elements_by_class_name("rt-tbody")[0]
table_list = np.array(table_sel.text.split('\n'))
table_array = np.reshape(table_list, (50, 25))
```

```
df = pd.DataFrame(data=table_array, columns=col_names).set_index('i')
print(df)
```

Creative step 1 is `table_list = np.array(table_sel.text.split('\n'))`, where we take what we got from table_sel, which was a long string of table data, split it into an array delimited by new line characters, and changed it into a numpy array. Then, we reshape that array to be a table (or a matrix). Finally, we put the array data into a Pandas DataFrame, and set the column names with the column names that we found previously, and then finally let the index values of the DataFrame be the ones from the web page's skater table data.

The next code block is just showing an alternative way to build the dataframe. We prefer the method above, but we wanted you to be aware of this other option too.

```
'''Another Method that is commented out in the actual file'''
table_data = {}
for i in range(25):
    table_data[col_names[i]] = table_array[:, i].tolist()

df = pd.DataFrame(data=table_data).set_index('i')
```

Once we are done with our automation operations, it's a great practice to quit the driver.

```
driver.quit()
```

Intermediate Summary

We couldn't get to our table data in a web page unless we operated that web page, and we wanted to automate these actions so that we could repeat this data gathering at will. So we used Selenium through Python to operate the web page and collect our data.

A New Bot Manager Script

A new script was created to manage the bot. It is in `Manage_Bot.py`.

```
import Basic_Tools as bt


host_port = "127.0.0.1:8223"
put_bot_to_sleep = False

pid = bt.bot_is_running(host_port)
if pid:
    print(f'Bot is running on pid "{pid}"')
    if put_bot_to_sleep:
        bt.send_bot_to_sleep(host_port)
else:
    print(f'Bot is NOT running.')
```

Automating Movement To Other Skater Stats Pages

Our next steps are the following.

1. We need to move to the other skater pages and put their table data into dataframes.
2. We want to concatenate these dataframes into one.

Then, we can begin exploring the data and create routines with the intention of creating the best fantasy hockey team possible.

Hopefully we will use these new found skills in other ways too!

The Updated Code For Gathering Data From All Skater Pages

We've only added one new import below - `from selenium.webdriver.common.action_chains import ActionChains as ACs`. This class is not always needed, but we've found it's just easier to apply it than find out later we didn't need it.

```
import Basic_Tools as bt
import numpy as np
import pandas as pd
import time

from selenium.webdriver.common.action_chains import ActionChains as ACs
```

The next block is the same as before.

```
host_port = "127.0.0.1:8223"
```

```
driver = bt.prepare_bot(host_port)

page_title = "NHL Stats | NHL.com"
if page_title not in driver.title:
    print(f"Going To {page_title}.\n")
    driver.get("https://www.nhl.com/stats/skaters")
    time.sleep(4)
else:
    print(f"Already on {page_title}\n")
```

In this next block, we now have a way to find the total number of pages. The way we find the column names is the same as before. We also create an empty list to store dataframes for the tables from each page of skaters.

```
# We don't need the next line yet. It will be useful later.
page_source = driver.page_source

num_pages_list = driver.find_elements_by_class_name("-totalPages")
num_pages = int(num_pages_list[0].text)

col_elements = driver.find_elements_by_class_name("rt-header-cell")
col_names = [e.text for e in col_elements]

dfs = []
```

Now we have a for loop to cycle through each of the pages. The operations that we previously did for the first page are now replicated for each page.

We ran into a WEIRD issue. Note the lines with comments at the end. We only had to add / modify these lines to handle the last page of skaters.

The first commented line was added to determine the number of rows. We had to use `int`, because it came out as a float. There was an extra character added to the end of `table_list` due to the splitting method, so we sliced that table down to the integer value of `rows*25`, and this allowed the `reshape` to work properly. Yay!

Next, we find the next page button, make sure we have the button with the right text, and then create an `action` so that we can move to the `next_page_button[0]` and `click` it. Then we pause. May not need to pause or to even pause for 2 seconds, but we were being conservative. We don't want to outrun the automation.

```
for page in range(num_pages):
    print(f'Working on page {page+1} of {num_pages}.')
    table_sel = driver.find_elements_by_class_name("rt-tbody")[0]
    table_list = np.array(table_sel.text.split('\n'))
    rows = int(len(table_list)/25)  # new line to determine rows
    table_list = table_list[:rows*25]  # new line to slice the 1D table
list
    table_array = np.reshape(table_list, (rows, 25))  # reshape using rows
```

```
    dfs.append(pd.DataFrame(
        data=table_array, columns=col_names).set_index('i'))
```

```
    next_page_button = driver.find_elements_by_class_name("-btn")
    next_page_button = [b for b in next_page_button if b.text == ">"]
```

```
    action = ACs(driver)
    action.move_to_element(next_page_button[0]).click().perform()
    time.sleep(2)
```

Once all the dataframes are in the list, we can then `concat`enate them and save the new dataframe `df` to a json file. Finally, we `quit` our `driver`.

```
df = pd.concat(dfs)
df.to_json("dataframe.json")

driver.quit()
```

The code above is ONLY for collecting the data from this site on the skaters. Now, we'd like a script that can retrieve the saved dataframe and begin using it.

A Script To Open The Saved DataFrame

Now, in a separate file, we can open our data frame, and start doing some analyses with the data to *hopefully* help us pick our best possible fantasy team.

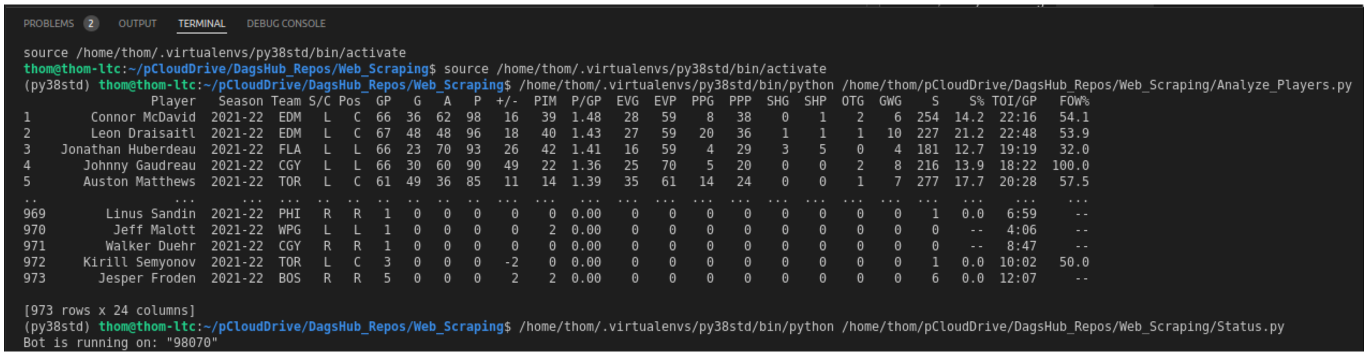
```
import pandas as pd
```

```
df = pd.read_json("dataframe.json")
```

```
print(df)
```

```
'''
Then do some ultra cool analysis to hopefully create the best fantasy team!
'''
```

The output of the above script is shown below followed by output from `Manage_Bot.py`.



```
source /home/thom/.virtualenvs/py38std/bin/activate
thom@thom-ltc:~/pCloudDrive/DagsHub_Repos/Web_Scraping$ source /home/thom/.virtualenvs/py38std/bin/activate
(py38std) thom@thom-ltc:~/pCloudDrive/DagsHub_Repos/Web_Scraping$ /home/thom/.virtualenvs/py38std/bin/python /home/thom/pCloudDrive/DagsHub_Repos/Web_Scraping/Analyze_Players.py
                Player   Season Team S/C Pos  GP   G   A   P  +/-  PIM  P/GP  EVG  EVP  PPG  PPP  SHG  SHP  OTG  GWG    S    S% TOI/GP   FOW%
1        Connor McDavid  2021-22  EDM   L   C  66  36  62  98   16   39  1.48   28   59    8   38    0    1    2    6  254  14.2  22:16   54.1
2        Leon Draisaitl  2021-22  EDM   L   C  67  48  48  96   18   40  1.43   27   59   20   36    1    1    1   10  227  21.2  22:48   53.9
3    Jonathan Huberdeau  2021-22  FLA   L   L  66  23  70  93   26   42  1.41   16   59    4   29    3    5    0    4  181  12.7  19:19   32.0
4       Johnny Gaudreau  2021-22  CGY   L   L  66  30  60  90   49   22  1.36   25   70    5   20    0    0    2    8  216  13.9  18:22  100.0
5        Auston Matthews  2021-22  TOR   L   C  61  49  36  85   11   14  1.39   35   61   14   24    0    0    1    7  277  17.7  20:28   57.5
..                  ...      ...  ...  ..  ..  ..  ..  ..  ..  ...  ...   ...  ...  ...  ...  ...  ...  ...  ...  ...  ...   ...    ...    ...
969        Linus Sandin  2021-22  PHI   R   R   1   0   0   0    0    0  0.00    0    0    0    0    0    0    0    0    1   0.0   6:59     --
970         Jeff Malott  2021-22  WPG   L   L   1   0   0   0    0    2  0.00    0    0    0    0    0    0    0    0    0    --   4:06     --
971        Walker Duehr  2021-22  CGY   R   R   1   0   0   0    0    0  0.00    0    0    0    0    0    0    0    0    0    --   8:47     --
972     Kirill Semyonov  2021-22  TOR   L   C   3   0   0   0   -2    0  0.00    0    0    0    0    0    0    0    0    1   0.0  10:02   50.0
973       Jesper Froden  2021-22  BOS   R   R   5   0   0   0    2    2  0.00    0    0    0    0    0    0    0    0    6   0.0  12:07     --

[973 rows x 24 columns]
(py38std) thom@thom-ltc:~/pCloudDrive/DagsHub_Repos/Web_Scraping$ /home/thom/.virtualenvs/py38std/bin/python /home/thom/pCloudDrive/DagsHub_Repos/Web_Scraping/Status.py
Bot is running on: "98070"
```

Obviously, we have many more details to develop! Are you ready to compete with us? We've at least helped you to collect the data. 😎