Lecture 4

Data Collection II: Web-scrapping Primer; Scrapping Data with `selenium`

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Premier on Web-scrapping

🎣📥 Data Collection via Web-scraping

- Web pages can be a rich data source, but **web scraping is powerful**.
    - Careless scraping can **harm websites, violate rules, or compromise privacy**.
- Our goal in this module:
    - Learn the **web fundamentals** (client/server, HTTPS, URL, HTML/DOM),
    - Understand **ethical, responsible scraping**

⚖️🤔 "Legal" Is Not the Same as "Ethical"

> *"If you can see things in your web browser, you can scrape them."*

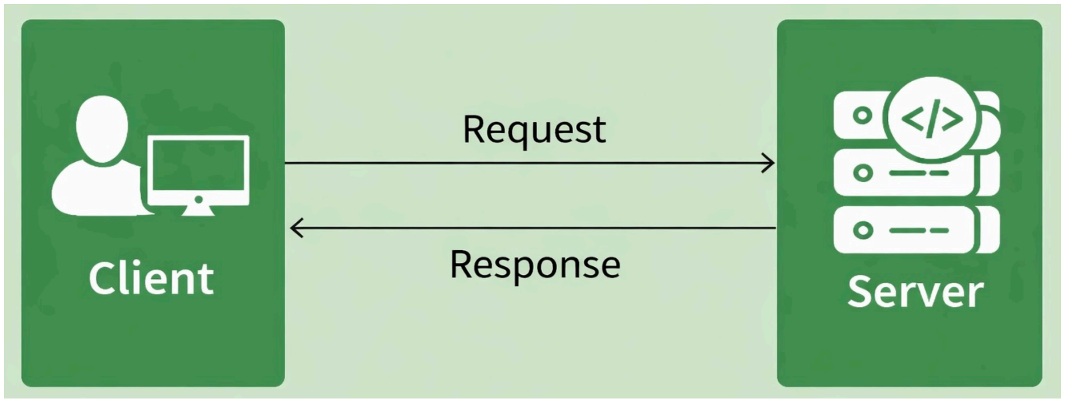
- *Legally (U.S.)*: **publicly available** data may sometimes be scraped using automated tools in US (e.g., **hiQ Labs vs. LinkedIn Corp.**)
- *But legality ≠ permission or responsibility*:
  - *Technically*: it may be possible.
  - *Ethically*: you still must consider terms or service (ToS), **robots.txt**, privacy, and data minimization.
  - *Practically*: you can trigger blocks or harm service quality (e.g., overloading servers, ToS/privacy issues).

Warning

Legal ≠ ethical. Even if data is "public," ToS, privacy expectations, and platform blocks still matter.

🌐 Web Basics: Clients and Servers

💻↔🗄️ Clients and Servers



- Devices on the web act as **clients** and **servers**.
- Your browser is a **client**; websites and data live on **servers**.
  - **Client**: your computer/phone + a browser (Chrome/Firefox/Safari).
  - **Server**: a computer that stores webpages/data and sends them when requested.
- When you load a page, your browser sends a **request** and the server sends back a **response** (the page content).

🔒🛡️ Hypertext Transfer Protocol Secure (HTTPS)

- **HTTP** is how clients and servers communicate.
- **HTTPS** is encrypted HTTP (safer).

When we type a URL starting with `https://`:

1. Browser finds the server.
2. Browser and server establish a secure connection.
3. Browser sends a request for content.
4. Server responds (e.g., **200 OK**) and sends data.
5. Browser decrypts and displays the page.

🚦🔢 HTTP Status Codes

```python
# library for making HTTPS requests in Python
import requests
```

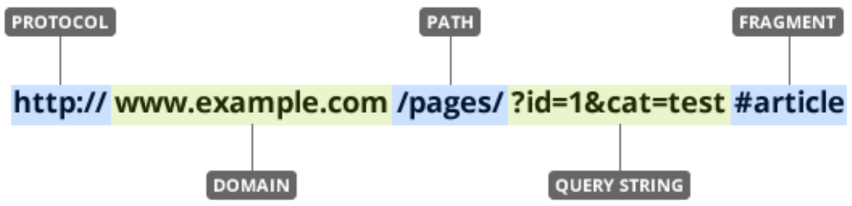
```python
p = 'https://bcdanl.github.io/210'
response = requests.get(p)
print(response.status_code)
print(response.reason)
```

- **200 OK** → success; content returned.

```python
p = 'https://bcdanl.github.io/2100'
response = requests.get(p)
print(response.status_code)
print(response.reason)
```

- **404 Not Found** → URL/page doesn't exist (typo, removed page, broken link).

🔗📍 URL (what you're actually requesting)



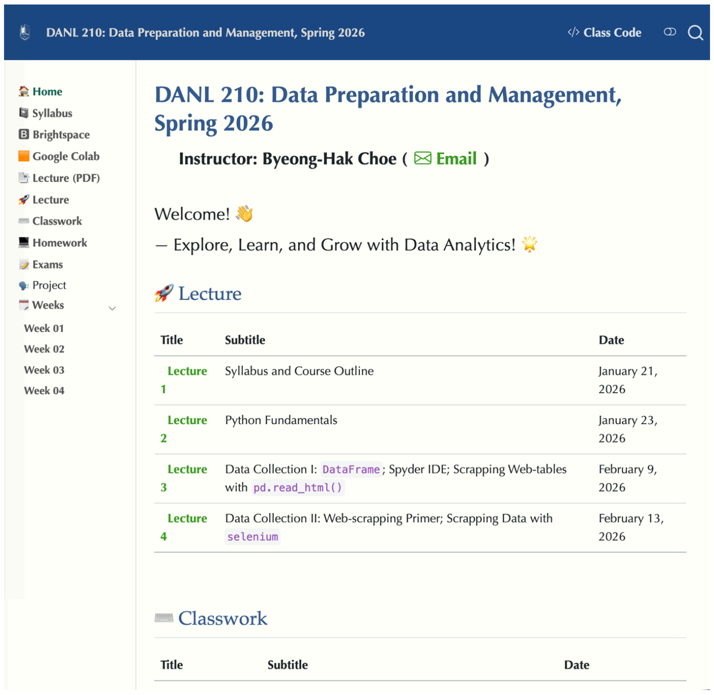
- A **URL** is a location for a resource on the internet.
- Often includes:
  - Protocol (`https`)
  - Domain (`example.com`)
  - Path (`/products`)
  - **Query string** (`?id=...&cat=...`) ← common in data pages
  - Fragment (`#section`) ← in-page reference

🏗 HTML Basics

🎯🤏 The Big Idea: Scraping = Selecting from HTML

- **HTML** (HyperText Markup Language) is the markup that defines the **structure** of a web page (headings, paragraphs, links, tables, etc.).
- When you "scrape," you usually:
  1. Load a page
  2. Examine the **HTML**
  3. Extract specific elements (title, price, table, links, etc.)
- **If you don't understand HTML, you can't reliably target the right data.**
- Selenium is not "magic"—it automates a browser, but you still need to:
  - Inspect the HTML to identify and target the right elements

🖼️🆚📝 HTML in Browser vs. HTML Source Code



DANL 210: Data Preparation and Management, Spring 2026

Instructor: Byeong-Hak Choe (✉ Email)

Welcome! 👋

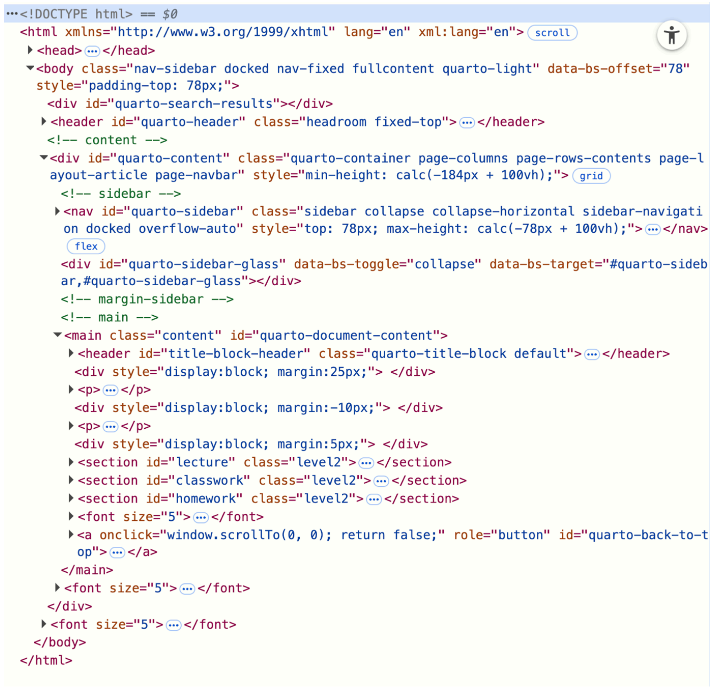
— Explore, Learn, and Grow with Data Analytics! 🌟

🚀 Lecture

Title	Subtitle	Date
Lecture 1	Syllabus and Course Outline	January 21, 2026
Lecture 2	Python Fundamentals	January 23, 2026
Lecture 3	Data Collection I: `DataFrame`; Spyder IDE; Scrapping Web-tables with `pd.read_html()`	February 9, 2026
Lecture 4	Data Collection II: Web-scrapping Primer; Scrapping Data with `selenium`	February 13, 2026

⌨️ Classwork

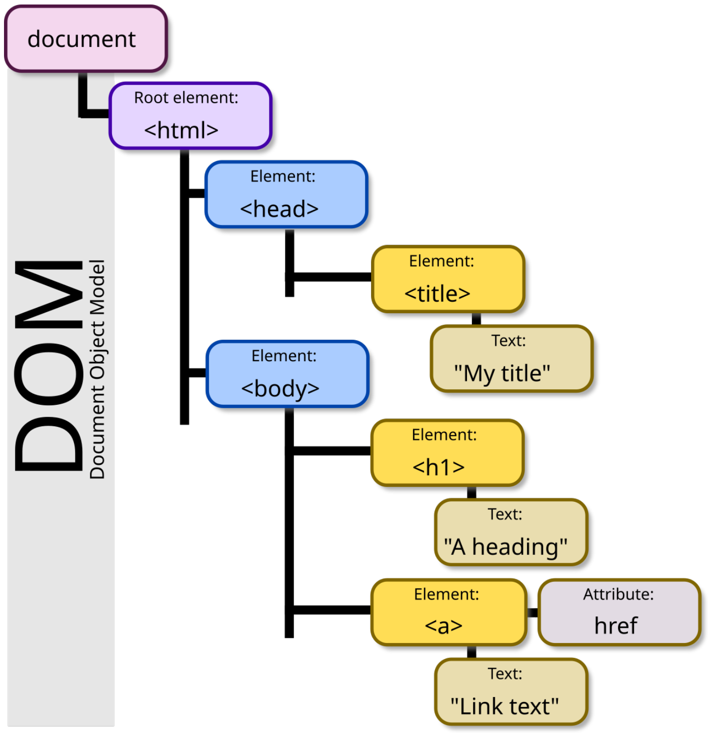
Title	Subtitle	Date



```
⋯<!DOCTYPE html> == $0
<html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en"> scroll
 ▶<head>⋯</head>
 ▼<body class="nav-sidebar docked nav-fixed fullcontent quarto-light" data-bs-offset="78"
  style="padding-top: 78px;">
    <div id="quarto-search-results"></div>
   ▶<header id="quarto-header" class="headroom fixed-top">⋯</header>
    <!-- content -->
   ▼<div id="quarto-content" class="quarto-container page-columns page-rows-contents page-l
    ayout-article page-navbar" style="min-height: calc(-184px + 100vh);"> grid
      <!-- sidebar -->
     ▶<nav id="quarto-sidebar" class="sidebar collapse collapse-horizontal sidebar-navigati
      on docked overflow-auto" style="top: 78px; max-height: calc(-78px + 100vh);">⋯</nav>
       flex
      <div id="quarto-sidebar-glass" data-bs-toggle="collapse" data-bs-target="#quarto-sideb
      ar,#quarto-sidebar-glass"></div>
      <!-- margin-sidebar -->
      <!-- main -->
     ▼<main class="content" id="quarto-document-content">
       ▶<header id="title-block-header" class="quarto-title-block default">⋯</header>
        <div style="display:block; margin:25px;"> </div>
       ▶<p>⋯</p>
        <div style="display:block; margin:-10px;"> </div>
       ▶<p>⋯</p>
        <div style="display:block; margin:5px;"> </div>
       ▶<section id="lecture" class="level2">⋯</section>
       ▶<section id="classwork" class="level2">⋯</section>
       ▶<section id="homework" class="level2">⋯</section>
       ▶<font size="5">⋯</font>
       ▶<a onclick="window.scrollTo(0, 0); return false;" role="button" id="quarto-back-to-t
        op">⋯</a>
      </main>
     ▶<font size="5">⋯</font>
    </div>
   ▶<font size="5">⋯</font>
  </body>
</html>
```

🌳📄 Document Object Model (DOM)

The Browser's "Tree" of the Page



- The browser represents HTML as the **DOM** (Document Object Model).
- Selenium interacts with the **DOM**.
- Scraping often becomes:
  - "Find the node"
  - "Extract its text/attribute"

🔍🕵️ Inspecting HTML (your #1 web-scrapping skill)

- Open a **Chrome** browser.
- Open DevTools:
    - **F12**, or right-click → **Inspect**
- Use it to find:
    - Element text
    - `id` / `class`
    - Attributes (like `href`, `data-*`)

🧱🧩 HTML Elements (what you actually scrape)

- Most HTML is built from **elements** like:

```
<tagname>Content goes here...</tagname>
```

- Common ones you'll extract:
  - Headings: `<h1> ... </h1>`
  - Text blocks: `<p> ... </p>`
  - Links: `<a href="..."> ... </a>`
  - Tables: `<table> ... </table>`
  - Containers: `<div> ... </div>`
  - Inline text: `<span> ... </span>`

🔗🖼️ HTML Body: Links and Images

`<a>` (Link)

```
<a href="https://www.w3schools.com">This is a link</a>
```

- The `href` attribute is often what you scrape.

`<img>` (Image)

```
<img src="w3schools.jpg" alt="W3Schools.com" width="104" height="142">
```

- You may scrape `src` (image URL) or `alt` (description).

HTML Tables

```html
<table style="width:100%">
  <tr>
    <th>Firstname</th>
    <th>Lastname</th>
    <th>Age</th>
  </tr>
  <tr>
    <td>Eve</td>
    <td>Jackson</td>
    <td>94</td>
  </tr>
</table>
```

- Table structure:
  - `<table>` table container
  - `<tr>` row
  - `<th>` header cell
  - `<td>` data cell

📋 Lists you’ll see in the wild

⚫ Unordered List (`<ul>`)

```html
<ul>
  <li>Coffee</li>
  <li>Tea</li>
  <li>Milk</li>
</ul>
```

- Coffee
- Tea
- Milk

🔢 Ordered List (`<ol>`)

```html
<ol>
  <li>Coffee</li>
  <li>Tea</li>
  <li>Milk</li>
</ol>
```

1. Coffee
2. Tea
3. Milk

🎯📦 Containers you’ll target a lot: `<div>` and `<span>`

`<div>` – block-level container

```html
<div style="background-color:black;color:white;padding:20px;">
  <h2>Seoul</h2>
  <p>Seoul is the capital city of South Korea...</p>
</div>
```

Seoul

Seoul is the capital city of South Korea…

- Often used to group major page sections.

`<span>` – inline container

```html
<p>My mother has <span style="color:blue;font-weight:bold">blue</span> eyes...</p>
```

My mother has **blue** eyes…

⚙️🕸️ Web-scrapping with Python `selenium`

❓ What is Selenium?

- **Selenium** is a tool that lets Python **control a real web browser** (like Chrome or Firefox) automatically.
- It is used for:
  - **Web automation** (click buttons, fill forms, scroll pages)
  - **Web scraping** when a website is **dynamic** (JavaScript loads content after the page opens)
- Selenium works by interacting with the page's **DOM** (Document Object Model):
  - It finds elements in HTML
  - Then reads **text/attributes** or performs actions (click, type, scroll)

WebDriver

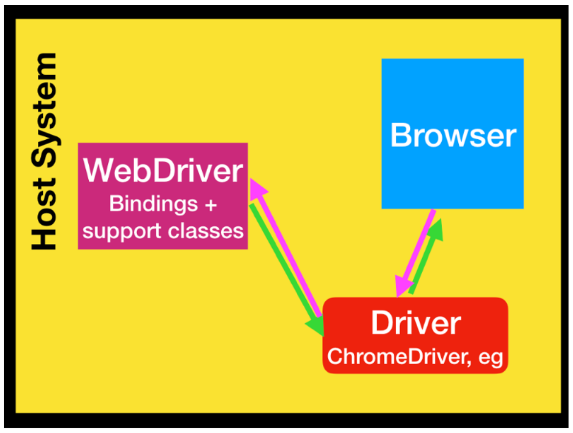
- **WebDriver** is an wire protocol that defines a language-neutral interface for controlling the behavior of web browsers.
- The purpose of WebDriver is to **control the behavior of web browsers programmatically**, allowing automated interactions such as:
    - Extracting webpage content
    - Opening a webpage
    - Clicking buttons
    - Filling out forms
    - Running automated tests on web applications
- **Selenium WebDriver** refers to both the language bindings and the implementations of browser-controlling code.

Driver

- Each browser requires a specific **WebDriver** implementation, called a **driver**.
    - Web browsers (e.g., Chrome, Firefox, Edge) do not natively understand Selenium WebDriver commands.
    - To bridge this gap, each browser has its own **WebDriver implementation**, known as a **driver**.
- The **driver** handles communication between Selenium WebDriver and the browser.
    - This **driver** acts as a middleman between **Selenium WebDriver** and the actual browser.
- Different browsers have specific drivers:
    - **ChromeDriver** for Chrome
    - **GeckoDriver** for Firefox

🔁 WebDriver-Browser Interaction

- A simplified diagram of how **WebDriver** interacts with **browser** might look like this:



- WebDriver interacts with the browser via the **driver** in a two-way communication process:
  1. **Sends commands** (e.g., open a page, click a button) to the browser.
  2. **Receives responses** from the browser.

🔧 Setting up

- Install the Chrome or FireFox web-browser if you do not have either of them.
    - I will use the Chrome.
- Install Selenium using `pip`:
    - On the Spyder Console, run the following:
    - `pip install selenium`
- **Selenium with Python** is a well-documented reference.

🧩 Setting up - `webdriver.Chrome()`

- To begin with, we import (1) `webdriver` from `selenium` and (2) the `By` and `Options` classes.
  - `webdriver.Chrome()` opens the Chrome browser that is being controlled by automated test software, `selenium`.

```python
import pandas as pd
import os, time, random
from io import StringIO

# Import the necessary modules from the Selenium library
from selenium import webdriver  # Main module to control the browser
from selenium.webdriver.common.by import By  # Helps locate elements on the webpage
from selenium.webdriver.chrome.options import Options  # Allows setting browser opt
from selenium.webdriver.support.ui import WebDriverWait
from selenium.webdriver.support import expected_conditions as EC
from selenium.common.exceptions import NoSuchElementException
from selenium.common.exceptions import TimeoutException
from selenium.common.exceptions import StaleElementReferenceException

# Create an instance of Chrome options
options = Options()

```

🌐 `get()` Method in WebDriver

- `get(url)` from `webdriver` opens the specified URL in a web browser.
- When using `webdriver` in Google Chrome, you may see the message:
  - *"Chrome is being controlled by automated test software."*

```python
form_url = "https://qavbox.github.io/demo/webtable/"
driver.[?](form_url)
driver.close()
driver.quit()
```

- `close()` terminates the current browser window.
- `quit()` completely exits the `webdriver` session, closing a browser window.

🔎 Inspecting a Web Element with `find_element()`

- Once the Google Chrome window loads with the provided URL, we need to **find specific elements** to interact with.
    - The easiest way to identify elements is by using **Developer Tools** to inspect the webpage structure.
- To inspect an element:
    1. **Right-click** anywhere on the webpage.
    2. **Select** the **Inspect** option from the pop-up menu.
    3. In the `Elements` panel, **hover over** the DOM structure to locate the desired element.

🔍 Inspecting a Web Element with `find_element()`

- When inspecting an element, look for:
  - **HTML tag** (e.g., `<input>`, `<button>`, `<div>`) used for the element.
  - **Attributes** (e.g., `id`, `class`, `name`) that define the element.
  - **Attribute values** that help uniquely identify the element.
  - **Page structure** to understand how elements are nested within each other.

📍 Locating Web Elements by `find_element()` & `find_elements()`

📍 Locating Web Elements by `find_element()`

- There are various strategies to locate elements in a page.

```
find_element(By.ID, "id")
find_element(By.CLASS_NAME, "class name")
find_element(By.NAME, "name")
find_element(By.CSS_SELECTOR, "css selector")
find_element(By.TAG_NAME, "tag name")
find_element(By.LINK_TEXT, "link text")
find_element(By.PARTIAL_LINK_TEXT, "partial link text")
find_element(By.XPATH, "xpath")
```

- Selenium provides the `find_element()` method to locate elements in a page.
- To find multiple elements (these methods will return a **list**):
  - `find_elements()`

`find_element(By.ID, "")`

- `find_element(By.ID, "")` & `find_elements(By.ID, "")`:
    - Return element(s) that match a given **ID** attribute value.
- Example HTML code where an element has an ID attribute `form1`:

```
<form id="form1">...</form>
```

- Example of locating the form using `find_element(By.ID, "")`:

```
form = driver.find_element(By.ID, "form1")
form.text  # Retrieves text content if available
```

`find_element(By.CLASS_NAME, "")`

- `find_element(By.CLASS_NAME, "")` & `find_elements(By.CLASS_NAME, "")`:
  - Return element(s) matching a specific **class attribute**.
- Example HTML code with a `homebtn` class:

```html
<div class="homebtn" align="center">...</div>
```

```python
home_button = driver.find_element(By.CLASS_NAME, "homebtn")
home_button.click()  # Clicks the home button
driver.back()  # Navigates back to the previous page
```

`find_element(By.NAME, "")`

- `find_element(By.NAME, "")` & `find_elements(By.NAME, "")`:
  - Return element(s) with a matching **name attribute**.
- Example HTML code with a name attribute `home`:

```html
<input type="button" class="btn" name="home" value="Home" />
```

```python
home_button2 = driver.find_element(By.NAME, "home")
home_button2.click()
driver.back()
```

`find_element(By.CSS_SELECTOR, "")`

- `find_element(By.CSS_SELECTOR, "")` & `find_elements(By.CSS_SELECTOR, "")`:
    - Locate element(s) using a **CSS selector**.
- Inspect the webpage using browser Developer Tools.
- Locate the desired element in the Elements panel.
- Right-click and select **Copy selector**
    - Let's find out CSS selector for the Home button.

```python
home_button3 = driver.find_element(By.CSS_SELECTOR, "body > div > a > input")
home_button3.click()
driver.back()
```

`find_element(By.TAG_NAME, "")`

- `find_element(By.TAG_NAME, "")` & `find_elements(By.TAG_NAME, "")`:
  - Locate element(s) by a specific **HTML tag**.

```python
table01 = driver.find_element(By.ID, "table01")
thead = table01.find_element(By.TAG_NAME, "thead")
thead.text
```

`find_element(By.LINK_TEXT, "")`

- `find_element(By.LINK_TEXT, "")` & `find_elements(By.LINK_TEXT, "")`:
  - Locate link(s) using the exact **text displayed**.
- Example HTML for a Selenium link:

```html
<a href="http://www.selenium.dev/">Selenium</a>
```

```python
selenium_link = driver.find_element(By.LINK_TEXT, "Selenium")
selenium_link.click()
driver.back()
```

`find_element(By.PARTIAL_LINK_TEXT, "")`

- Finds link(s) containing **partial** text.

```python
Selen_links = driver.find_elements(By.PARTIAL_LINK_TEXT, "qav")
print(len(Selen_links))
Selen_links[0].click()
driver.back()
```

`find_element(By.XPATH, "")`

- `find_element(By.XPATH, "…")` and `find_elements(By.XPATH, "…")`:
  - Find element(s) that match the given **XPath** expression.
  - `find_element(...)` returns **one** matching element (the first match).
  - `find_elements(...)` returns a **list** of all matching elements.
- **XPath** is a query language for locating nodes in a tree structure.
  - Web pages are written in **HTML**, and the browser represents them as a **DOM tree**, which XPath can query.
  - Selenium supports XPath in all major browsers.
  - XPath is useful when **id/name/class** selectors are missing, duplicated, or unstable.
  - It's powerful for navigating **nested or complex** HTML structures.

Basic XPath Pattern

```
//tag_name[@attribute='value']
```

- `//` → search **anywhere** in the document
- `tag_name` → HTML tag name (`input`, `div`, `span`, `table`, etc.)
- `@attribute` → attribute name (`id`, `class`, `aria-label`, `role`, `data-*`, etc.)
- `'value'` → the attribute's value (quoted)

XPath vs. Full XPath

When you right-click an element in **Chrome DevTools → Copy**, you often see:

- **Copy XPath** (often a *relative-style* XPath)
  - Typically starts with `//...`
  - Tries to find the element using attributes and structure
  - Usually **more flexible** if the page layout changes
- **Copy Full XPath**
  - Typically starts with `/html/body/...`
  - A complete path from the root of the document tree
  - Often **fragile**: if the page structure changes, it can break easily

> In practice: prefer **XPath** (the shorter one) over **Full XPath** when possible.

Example: Finding the 2nd Table with XPath

- Suppose we want the **second** `<table>` on a page, but the tables have no unique `id` or `class`.
- Using `find_element(By.TAG_NAME, "table")` is **too vague** because it returns only the **first** table.
- XPath can target the second one:

```python
# second table on the page:
second_table = driver.find_element(By.XPATH, "(//table)[2]")
```

🛠️ Extracting XPath from Developer Tools

- **Inspect** the webpage using browser Developer Tools.
- Locate the desired element in the **Elements** panel.
- **Right-click** and select **Copy XPath**.
- Example extracted XPath:

```
//*[@id="table02"]/tbody/tr[1]/td[1]
/html/body/form/fieldset/div/div/table/tbody/tr[1]/td[1]
```

🎯 Example: Finding an Element Using XPath

- Locate **"Tiger Nixon"** in the second table:

```python
elt = driver.find_element(By.XPATH, '//*[@id="table02"]/tbody/tr[1]/td[1]')
print(elt.text)  # Output the extracted text
```

When to Use XPath

- **Use XPath when:**
  - The element lacks a unique **ID** or **class**.
  - Other locator methods (`By.ID`, `By.CLASS_NAME`, etc.) **don’t work**.
- **Limitations:**
  - XPath can be **less efficient** than ID-based locators.
  - Page structure changes may break XPath-based automation.
- **For our tasks, however, XPath remains a reliable and effective method!**

Web-scrapping with Python `selenium`

Let's do **Classwork 4**!

🧾 Retrieving Attribute Values with `get_attribute()`

HTML Example

- `get_attribute()` extracts an element's **attribute value**.
- Useful for retrieving **hidden** properties not visible on the page.

```html
<a href="https://www.selenium.dev/">Selenium</a>
<input id="btn" class="btn" type="button" onclick="change_text(this)" value="Delete
```

Python Example

```python
driver.find_element(By.XPATH, '//*[@id="table01"]/tbody/tr[2]/td[3]/a').get_attribu
driver.find_element(By.XPATH, '//*[@id="btn"]').get_attribute('value')
```

🚫🔎 `NoSuchElementException` and `try-except` blocks

```python
try:
    elem = driver.find_element(By.XPATH, "element_xpath")
    elem.click()
except:
    pass
```

- When a web element is not found, it throws the `NoSuchElementException`.
    - `try-except` can be used to avoid the termination of the selenium code.
- This solution is to address the **inconsistency** in the DOM among the seemingly same pages.

⌛ WebDriverWait

🆚⏱️ Two different “waits”

- **Pause to respect servers** (politeness):
  - Use `time.sleep(random.uniform(a, b))` as a small *human-like* delay **between actions/pages**.
  - This helps avoid hammering a website with rapid-fire requests.
  - **Use** `time.sleep(random.uniform())` for *politeness* (respect servers).
- **Wait for the page to be ready** (robustness):
  - Use `WebDriverWait()` + a condition (presence/clickable).
  - This prevents flaky failures on slow networks or busy sites.
  - **Use** `WebDriverWait()` for *robustness* (wait for conditions).

> Best practice: **Use both**—`WebDriverWait` for robustness, and small randomized sleeps for politeness.

🤝🎲 Polite Scraping: Randomized Pauses with `time.sleep(random.uniform())`

```python
import time, random

# Example: polite delay between actions/pages
time.sleep(random.uniform(0.5, 1.5))  # small jitter (adjust as needed)
```

- After each page load, click, or data extraction, add a **small randomized pause**.
- This is not about “waiting for the DOM”—it is about **respecting servers** and reducing bursty traffic.

⚠️😴 Why `time.sleep()` Alone is Not Robust

```python
import time

url = "https://qavbox.github.io/demo/delay/"
driver.get(url)

driver.find_element(By.XPATH, '//*[@id="one"]/input').click()

time.sleep(2)  # blind wait: always 2 seconds

element = driver.find_element(By.XPATH, '//*[@id="two"]')
element.text
```

- `time.sleep()` is a **blind wait**:
  - If content loads **faster**, you waste time.
  - If content loads **slower**, your code may crash (element not found).
- For reliable automation/scraping, use **condition-based waits**.

✅👀 Robust Wait for Presence (exists in DOM) with `WebDriverWait()` + `expected_conditions`

```python
driver.get("https://qavbox.github.io/demo/delay/")
driver.find_element(By.XPATH, '//*[@id="one"]/input').click()

try:
    element = WebDriverWait(driver, 10).until(
        EC.presence_of_element_located((By.XPATH, '//*[@id="two"]'))
    )
    print(element.text)
except TimeoutException:
    print("Timed out: element did not appear within 10 seconds.")
```

- Good when the element is added to the DOM but might not be visible yet.

✅🖱️ Robust Wait for Clickable (Visible + Enabled) with `WebDriverWait()` + `expected_conditions`

```
btn = WebDriverWait(driver, 10).until(
    EC.element_to_be_clickable((By.XPATH, '//*[@id="one"]/input'))
)
btn.click()
```

- Best when you want to click reliably.

🤝 A Common Pattern (Robust + Polite)

```python
# Robust: wait until the table is present
table = WebDriverWait(driver, 10).until(
    EC.presence_of_element_located((By.TAG_NAME, "table"))
)

# Extract something...
html = table.get_attribute("outerHTML")

# Polite: pause before the next request/action
time.sleep(random.uniform(1, 3))
```

📋🔎 Selenium with `pd.read_html()` for Table Scrapping

Selenium with `pd.read_html()` for Table Scrapping

- Yahoo! Finance has probably renewed its database system, so that `yfinance` does not work now.
- **Yahoo! Finance** uses web table to display historical data about a company's stock.
- Let's use Selenium with `pd.read_html()` to collect stock price data!

💹📈 Selenium with `pd.read_html()` for Yahoo! Finance Data

```python
# Load content page
url = 'https://finance.yahoo.com/quote/MSFT/history/?p=MSFT&period1=1672531200&peri
driver.get(url)
time.sleep(random.uniform(3, 5))  # wait for table to load
```

- `period1` and `period2` values for Yahoo Finance URLs uses **Unix timestamps** (number of seconds since January 1, 1970),
    - 1672531200 ➝ 2023-01-01
    - 1772323200 ➝ 2026-03-01

🧾🔍 `get_attribute("outerHTML")`

```python
# Extract the <table> HTML element
table_html = driver.find_element(By.TAG_NAME, 'table').get_attribute("outerHTML")

# Parse the HTML table into a pandas DataFrame
df = pd.read_html(StringIO(table_html))[0]
```

- `StringIO` turns that string into a file-like object, which is what `pd.read_json()` expects moving forward.
- `.get_attribute("outerHTML")`: gets the entire HTML from the WebElement.