Mandatory Assignment 5

Regular Expressions & Web Scraping (30 + 15 Points/40 + 5 Points)

University of Oslo - IN3110/IN4110

Fall 2021

Your solution to this mandatory assignment needs to be placed in the directory `assignment5` in your GitHub repository. The repository has to contain a `README.md` file with information on how to run your scripts, required dependencies and packages (versions the code ran with and operating system) as well as how to install them. Documentation on how to run your examples is required. Furthermore, your code needs to be well commented and documented. **All** functions need to have docstrings explaining what the function does, how it should be used, an explanation of the parameters and return value(s) (including types). We **highly** recommend you use a well-established docstring style such as the Google style docstrings[1]. However, you are free to choose your own docstring style. We expect your code to be well-formatted and readable. Black is useful tool for automatically formatting Python code [2]. Coding style and documentation will be part of the point evaluation for **all tasks** in this assignment. This assignment will be followed by a peer-review. Delivery of the assignment is required for participation in the peer review.

A Note on Your Solutions There is no such thing as the "one right solution" to the assignments. As a response to the survey, we wanted to mention here that the assignment text is kept relatively open as we want to give you enough freedom to implement the solution in a way that you feel works best. In real software development, you will not have a step-by-step exact guide on how to implement a certain feature. You will likely know, what the product is supposed to look like in the end and will have to figure out a way, how to best create a product with certain features. With these assignments, we want to give you a chance on learning how to tackle a problem, how to structure a project and realizing that there is not necessarily one perfect solution.

Files to Deliver for this Task

All `.py`-files will be delivered in the same `assignment5` folder. Each subtask will create an output folder with all outputs as stated in the subtask.

- `README.md` including dependencies and their installation and commands you used for running your examples and creating your output files

[1] `https://sphinxcontrib-napoleon.readthedocs.io/en/latest/example_google.html`

[2] `https://black.readthedocs.io`

Note: Regular expressions can be tricky to write, and they can get hairy very quickly. In addition to being difficult to write, regular expressions are even harder to read. Documentation for your regular expressions should also be given. You are also required to supply files that can be used to demonstrate your solutions.

- You are required to supply everything necessary to demonstrate your code, i.e. you should include the code examples you use when testing your work, or something equivalent. Writing tests to run with `pytest` is a great way to check your code as you write it, and give us a clear idea of how you expect your code to work.
- `regex101.com` is a great resource for testing and understanding your regular expressions, as illustrated in our lecture on 6. October.

5.1 Sending HTTP requests (2 Points)

In order to parse html and become the regex master of the year, you need to access the html body first. This can be done using the python `requests` module [3].

The module can be installed as follows:

```
python3 -m pip install requests
```

To retrieve data from any destination, the most common approach is the **GET** Request. This is the most-used HTTP method. In our example, we will use the get request to fetch data from the website of choice. The result will be printed out as html data. The request module can be imported and used as shown below.

```
#import the module
import requests as req

# grabbing the content of https://en.wikipedia.org/wiki/URL
resp = req.get("https://en.wikipedia.org/wiki/URL")

#get() method returns a response object
print(resp.text)

<!DOCTYPE html>
<html class="client-nojs" lang="en" dir="ltr">
<head>
<meta charset="UTF-8"/>
<title>URL - Wikipedia</title>
...
#shortened for the purpose of viewing
```

Fantastic, now we can actually display the data in html!

Often you are interested in a specific type of data. With GET requests, you can send parameters in the form of query strings. How does that work?

[3] https://requests.readthedocs.io/en/master/user/install/

If you were to construct the URL by hand, the data you are interested in would be given as key/value pairs in the URL after a question mark, e.g. `https://httpbin.org/get?key=val`. Using get requests, you can provide these arguments as a dictionary of strings, using the params keyword argument. That means, if you wanted to pass key1=value1 and key2=value2 to httpbin.org/get the code would in theory look like this:

```
import requests as req

params = {'key1': 'value1', 'key2': 'value2'}
r = req.get('https://httpbin.org/get', params=params)

# the url would be encoded accordingly
print(r.url)
https://httpbin.org/get?key2=value2&key1=value1
```

For a real example you can look at the following snippet:

```
import requests as req


params = {'user_name': 'admin', 'password': 'password'}
r = req.get('http://httpbin.org/get', params=params)

print(r.url)
http://httpbin.org/get?user_name=admin&password=password

# print the.text content of the request
print(r.text)

{
  "args": {
    "password": "password",
    "user_name": "admin"
  },
  "headers": {
    "Accept": "*/*",
    "Accept-Encoding": "gzip, deflate",
    "Host": "httpbin.org",
    "User-Agent": "python-requests/2.22.0",
    "X-Amzn-Trace-Id": "Root=1-5f841066-0c0ea5084573be8a230feaea"
  },
  "origin": "51.175.234.27",
  "url": "http://httpbin.org/get?user_name=admin&password=password
    "
}
```

Your task will be to create the function `get_html` which makes a request for a url from a given website. The function should be able to optionally take in parameters that are passed to the get function.

There should be an optional argument allowing to specify that the response url and text will be saved to a text file with a specified name `optionalargument.txt`. If the optional argument is not set, the html text is returned.

An outline of the function is shown below.

```

```

```python
# import what you need
import requests as req


def get_html(url, params=None, output=None):
        """Your detailed Docstring Here
        """

        # passing the optional paramters argument to the get function
        response = req.get(url, params=params)

        #YOUR CODE
        # if output is specified, the response txt and url get printed to a
        # txt file with the name in ‘output‘

        return html_str

html_str = get_html(url)
html_str = get_html(url, params={"key": "value"})
html_str = get_html(url, params={"key": "value"}, output="output.txt")

# if ‘output‘ is specified, the response txt and url get printed to a file
# with the name given in output.
# For example:

url: https://en.wikipedia.org/w/index.php?key=value
<html>
...
</html>
```

You should test your function on the following websites:

- `https://en.wikipedia.org/wiki/Studio_Ghibli`
- `https://en.wikipedia.org/wiki/Star_Wars`

The extended function with parameters should be tested for these websites:

- `https://en.wikipedia.org/w/index.php`
  - with parameters title=Main_Page and action=info

Files to deliver in this Subtask

Create a folder `requesting_urls` where you put all output files from your test runs created for solving this subtask.

- `requesting_urls.py`
- Three files inside the `requesting_urls` folder containing the function output for the example websites.

5.2 Regex for filtering URLs (5 Points)

In this task, you will be making functions for finding urls in a body of html using regex. Create a script named `filter_urls.py` that includes a function `find_urls` that receives a string of html and returns a list of all urls found in the text.

```
list_of_urls = find_urls(html_str)
```

You will be using the `re.findall` method taught in the lecture. This will give us a list of all the strings matching your regular expression. To be strict, we only consider urls that are anchor[4] hyperlinks with the `<a>` HTML tag. The function should ignore fragment identifiers. That is, links that start with a hash (#) symbol. If the url points to a different page, but a specific fragment/section using the hash symbol, the fragment part of the url should be stripped before it is returned by the function.

Example: The string `https://www.example.com/somepage#someidentifier` becomes `https://www.example.com/somepage` after stripping.

In order to handle relative urls, the function should have an optional parameter to receive a base url.

What is a relative url and what is a base url? The url you see when searching for Giannis Antetokounmpo in your browser is the full or absolute url `https://en.wikipedia.org/wiki/Giannis_Antetokounmpo`. An absolute URL is the entire address from the protocol (https), to the domain name including the location within your website (path). A relative url does not use the full web address but only contains the path followed by the domain. Therefore it assumes the link is on the same site and should be retrieved from the same host. The relative url linking to Giannis Antetokounmpos wiki page looks like this:

```
        <a href="/wiki/Giannis_Antetokounmpo" ...

```

The base url is represented by `https://en.wikipedia.org/` in our example.

For getting started, here is an example test to verify finding links in an HTML snippet:

```
def test_find_urls():
    html = """
    <a href="#fragment-only">anchor link</a>
    <a id="some-id" href="/relative/path#fragment">relative link</
    a>
    <a href="//other.host/same-protocol">same-protocol link</a>
    <a href="https://example.com">absolute URL</a>
    """
    urls = find_urls(html, base_url="https://en.wikipedia.org")
    assert urls == [
        "https://en.wikipedia.org/relative/path",
        "https://other.host/same-protocol",
        "https://example.com",
    ]
```

[4]name of the HTML-element, with the HTML-tag "a"

Further, make a function `find_articles` that calls `find_urls` and returns only urls to Wikipedia articles. This function should also use regex and **be able to handle any chosen language** (`no.wikipedia.org`, `en.wikipedia.org` etc).

Note: Non-wikipedia pages can be ignored.

Combine these functions with your functions from previous tasks in order to test them on the following websites, by showing all linked URLs and all linked wikipedia pages for the following pages:

- `https://en.wikipedia.org/wiki/Nobel_Prize`
- `https://en.wikipedia.org/wiki/Bundesliga`
- `https://en.wikipedia.org/wiki/2019%E2%80%9320_FIS_Alpine_Ski_World_Cup`

Note 1: You should only return normal Wikipedia articles, so no special namespace article (or files). While you could exclude just the specific reserved namespaces [5], **it is sufficient to exclude all articles with a colon**. This will exclude some actual articles (for example `https://en.wikipedia.org/wiki/Avengers:_Endgame`, but we won't deduct points for it.

Note 2: You should only find urls that are in the `href` attribute of a tag. It is *not always* the first attribute which means matching just `<a href=` is not enough, but you can assume some things about the use of special html characters since regex cannot parse html alone.

Note 3: You need to handle partial urls, which should be combined with the base url. Examples of relative urls: `/wiki/Executive_director` and `//en.wikipedia.org/wiki/Wikipedia:Contact_us`

Note 4: The outputs for both `find_urls` and `find_articles` should be added to your outputs.

The found urls should be saved to a .txt file, which name can be defined by an optional argument. Feel free to create helper functions, if you feel that would improve your implementation.

Shown below is a possible general outline of the functions to be created in this task

```
1
2  def find_urls(html_string, base_url=<your choice of a default or
       None here>, output=None):
3      """Your Descriptive Docstring Here
4      """
5      # YOUR CODE HERE
6
7      # Remove duplicate urls
8
9      # write list of urls to file if output not None
10
11     return url_list
```

[5] i.e. look here `https://en.wikipedia.org/wiki/Wikipedia:Namespace`

```
12
13
14 def find_articles(html_string, output=None):
15     """Your Descriptive Docstring Here
16     """
17     urls = find_urls(text)
18
19     # write list of articles found to file if output not None
20
21     return article_url_list
```

For reference, here is an example of using regex to find the `src` attribute of all `img` tags:

```
1  def find_img_src(html):
2      """Find all src attributes of img tags in an HTML string
3
4      Args:
5
6          html (str): A string containing some HTML.
7
8      Returns:
9
10         list: A list of strings
11
12         The list contains every found src attibute
13         of an img tag in the given HTML.
14     """
15     # img_pat finds all the <img alt="..." src="..."> snippets
16     # this finds <img and collects everything up to the closing
       '>'
17     img_pat = re.compile(r"<img[^>]+>", flags=re.IGNORECASE)
18     # src finds the text between quotes of the 'src' attribute
19     src_pat = re.compile(r'src="([^"]+)"')
20     src_list = []
21     # first, find all the img tags
22     for img_tag in img_pat.findall(html):
23         # then, find the src attribute of the img, if any
24         src = src_pat.find(html)
25         for src in src_pat.findall(html):
26             src_list.append(src)
27     return src_list
```

You will need to adapt this to find the `href` attribute of `a` tags, and handle the additional processing of evaluating URLs relative to the page.

Files to Deliver in this Subtask

Create a folder `filter_urls` where you put all output files from the test runs created for solving this subtask.

Files Required in this Subtask

- `filter_urls.py` containing the `find_urls` and `find_articles` functions
- Six files inside the `filter_urls` folder containing a list of the urls and articles returned for each of the three example websites.

You should not use Beautiful Soup or any HTML parser in this task, only regex.

5.3 Regular Expressions for finding Dates (IN3110 OPTIONAL & IN4110 REQUIRED 10 Points)

In this task, you will be making functions for finding "dates" in a body of html using regex. Create a script named `collect_dates.py` that includes a function `find_dates` that receives a string of html and returns a list of all dates found in the text in the following year/month/day format:

```
1998/10/31
1998/11/04
1999/01/13
```

Which date formats do we need to consider? You need to consider the wikipedia standardized formats [6]. These are the four formats:

```
DMY: 13 October 2020
MDY: October 13, 2020
YMD: 2020 October 13
ISO: 2020-10-13
```

Note: You also need to include the case, where the month is abbreviated, e.g. Oct for October, which adds these date types to consider.

```
DMY: 13 Oct 2020
MDY: Oct 13, 2020
YMD: 2020 Oct 13
```

We are aware, that Wikipedia should not support the abbreviated month, but we would like to allow your code to be flexible, in case you are handling other websites in the future.

For a list of dates found which have two dates with `year/month/day` the returned list could look like this:

```
1998/10/31
1998/11/18
1999/01/13
```

The dates **returned** should be formatted as `year/month/day`.

Moreover, there should be an optional argument `output` allowing to specify that the resulting list will be saved to a text file with a specified name `optionalargument.txt`.

You are supposed to use regex in this task. One strategy could be using the `re.findall` and `re.sub` method taught in the lecture. This will give us a list of all the strings matching your regular expression and allow to change the formatting.

Here is the list of websites, you need to deliver a report in form of a text-file for:

- visit the following websites
- `https://en.wikipedia.org/wiki/J._K._Rowling`

[6] `https://en.wikipedia.org/wiki/Template:Date`

- `https://en.wikipedia.org/wiki/Richard_Feynman`
- `https://en.wikipedia.org/wiki/Hans_Rosling`

Below you can find an example outline of the function

```
def find_dates(html_string, output=None):
    """
    Finds all dates in a html string.

    The returned list is in the following format:
    - 1998/10/12
    - 1998/11/04
    - 1999/01/13

    The following formats are considered when searching:
    DMY: 13 Oct(ober) 2020
    MDY: Oct(ober) 13, 2020
    YMD: 2020 Oct(ober) 13
    ISO: 2020-10-13


    # Finish Docstrng Here

    Returns:
        results (list): A list with all the dates found in Y/M/D format
    """

    return results
```

Feel free to create helper functions, if it helps you organize your code. Steps that you likely will need to cover within this task are the following

- get html
- use `re.findall` to extract a list of dates in the formats DMY, MDY, YMD, ISO
- convert the date with `re.sub`

Feel free to divide your regular expressions into small building blocks containing a day, month, and year part. The month december could be a building block represented like this matching dec or december with optional capitalization.

```
dec = r"\b[dD]ec(?:ember)?\b"
```

To check for the month, you might want to define all the months in such a pattern and match these like this for december and november

```
months = rf"(?:{nov}|{dec})"
```

You also have to consider matching the ISO format, where months are represented as digits Take into account that months represented by a single digit have a leading zero, e.g. 06 for june.

```
iso_month_format = r"\b(?:0\d|1[0-2])\b"
```

Using the building blocks you created you can find the DMY format for example using the following expression:

```
# defining DMY format
dmy = rf"{day}\s{months}\s{year}"

# finding all dmy format matches using re.findall
re.findall(rf"{dmy}", html_text)
```

This may not be the most efficient way nor the only possible solution, but it might help defining the whole regular expression you are about to create.

For the "year" you can assume that years will have at least 4 digits, e.g. 1000 and later.

For converting the date with regular expressions from DMY, MDY, YMD, ISO to YYYY/MM/DD, you can split the conversion into two steps. Assuming you have a list of dates you extracted you can first reorder all formats using `re.sub`. This could look like this for the DMY format:

```
# reformat DMY as Y/M/D
date_element = re.sub(rf"({day})\s({month})\s({year})", r"\3/\2/\1
    ",
                      date_element)
```

In the second step you can replace the months names by the number that represents that month.

One option to replace the string for the month with the digit would be using the `startswith()` method. An example snippet is shown below.

```
# replace december string with digits
if month.lower().startswith("dec"):
    # Your Code
```

Save your implementation to `collect_dates.py`.

Files to Deliver in this Subtask

Create a folder `collect_dates_regex` where you put all output files from your test runs created for solving this subtask.

- `collect_dates.py` containing the function `find_dates`
- Three files inside the `collect_dates_regex` folder containing a list of found dates in sorted order for each website given.

Note: You should not use Beautiful Soup or any HTML parser in this task, only regex.

5.4 Making your Life easier with Soup for finding dates (IN3110 & IN4110 8 Points)

Need to plan your watch parties for the upcoming skiing season? Why not send out all the dates and times to your friends that are as well into (watching)

skiing? In this task you will use the Python tool BeautifulSoup to parse HTML. You will extract the datetime objects representing the event “date”, a regular expression fetching the ”venue” and the discipline ”type”.

You can install Beautiful Soup via:

```
python3 -m pip install beautifulsoup4
```

Make sure that you are running python3 and your pip points to the right python version as well. If you are running into issues we highly recommend setting up a `virtualenv` or a `conda env`.

Before starting with the fun coding part, it is recommended to take some time to get familiar with the html tags of the website we are extracting information from.

Note: It will really help for this task if you just take a few minutes to familiarize yourself with the HTML structure of the page.

We recommend to navigate to the website using your favorite browser, right click and select ‘Inspect element’. Get familiar with the elements used. Alternatively, right click on the web page and view the page source. Since we are interested in a table, search for the table class:

Figure 1: Table class in the html. You get to this view using “View Source Page” mode.

We would like to access the table of soups now. To do so we need to first grab the HTML from the web page, so that we have something to parse through. Then we will extract the soup table.

```python
from bs4 import BeautifulSoup
import requests as req

url = "https://en.wikipedia.org/wiki/List_of_soups"

# request url as we have already learned - yeah!
request = req.get(url)

soup = BeautifulSoup(request.text, "html.parser")

#check the title of the wikipedia page
print(soup.title)

# get the soup table
soup_table = soup.find('table', {"class":'wikitable sortable'})
```

Now we need to know how to navigate to the table. To figure out which column holds which information, we can look at the header. We will use the html `<th>` tag (short for "table header"), which defines the header cell in an html table. An html table has two kinds of cells: header cells created with `<th>` elements and data cells created with `<td>` elements.

To iterate through the data in the table, we first need to access the table rows. Table rows are defined by the `<tr>` tag. A `<tr>` element contains `<td>` or `<th>` elements. The table headers will be extracted via `<th>` elements,

Write a script `time_planner.py` that first requests the url from `https://en.wikipedia.org/wiki/202122_FIS_Alpine_Ski_World_Cup`. The request can be done with a function created in earlier tasks.

Then parses through the html using `Beautiful Soup` and finds the main table in the calendar section for either Women or Men (see figure below).

Figure 2: Main table in calendar section.

Write a function `extract_events` that extracts the data in the date, venue and discipline column. The function will live in the script `time_planner.py`.

Below you can find some pseudo-code. This code is not finished, but can give you an inspiration how to set up your implementation of this task.

```
1
2  import re
3  from bs4 import BeautifulSoup
4
5
6  def extract_events(url):
7      """Extract date, venue and discipline for competitions.
8      Your documentation here.
9      Args:
10         url (str): The url to extract events from.
11     Returns:
12         table_info (list of lists): A nested list where the rows
       represent each
13             race date, and the columns are [date, venue,
       discipline].
14     """
15
16     disciplines = {
17         "DH": "Downhill",
18         "SL": "Slalom",
19         "GS": "Giant Slalom",
20         "SG": "Super Giant Slalom",
21         "AC": "Alpine Combined",
22         "PG": "Parallel Giant Slalom",
23     }
24
25     # get the html
26     html = get_html(url)
27
28     # make soup
29     soup = BeautifulSoup(html, "html.parser")
30
31     # Find the tag that contains the Calendar header span
32     calendar_header = soup.find(id="Calendar")
33
34     # Find the following table
35     calendar_table = calendar_header.find_all_next("table")[0]
36
37     # Find the rows of the first table
38     rows = calendar_table.find_all("tr")
39
40     # try parsing the row of ‘th‘ cells to identify the indices
41     # for Event, Venue, and Type (discipline)
42
43     found_event = None
44     found_venue = None
45     found_discipline = None
46     # Saving all necessary values in the list under
47     events = []
48
49     # how many columns does a full row have?
50     full_row_length = 10 # This is wrong! Can you find the right
       value?
51     # some rows have fewer because the 'venue'
52     # spans multiple rows,
```

```
    # short_row_length means a repeated venue, which should be re-
    used
    # from the previous iteration
    short_row_length = full_row_length - 2

    for row in rows:
        cells = row.find_all("td")

        # begin debug: to help figure out what to write,
        # show the contents of each row
        print(f"new row: {len(cells)} cells")
        for idx, cell in enumerate(cells):
            print(f"  cell {idx}: {cell}")
        # end debug: remove when it works!

        # some rows have one number of columns,
        # if it's a different number (usually 0 or 1),
        # ignore it
        if len(cells) not in {full_row_length, short_row_length}:
            # skip rows that don't have most columns
            continue
        # Hard-coding indexes works for now (you should find them
    using the Header!)
        event = cells[1]
        # An event seems to always be a 1-3 digit number, so we
    can check that we have an event with a simple regex
        if re.match(r"\d{1,3}", event.text.strip()):
            found_event = event.text.strip()
        else:
            found_event = None

        if len(cells) == full_row_length:
            # If event is cancelled, the index below might need to
     be shifted.
            venue_cell = cells[3]
            found_venue = venue_cell.text.strip()
            discipline_index = 5
        else:
            # repeated venue, discipline is in a different column
            # where is the discipline column?
            discipline_index = ?

        discipline = cells[discipline_index]
        # find the discipline id
        # can you make a regex to find only the keys of the
    disciplines dictionary?
        # (DH|...)
        discipline_regex = YOUR_CODE_HERE
        # this can also be done with just HTML parsing
        discipline_match = re.search(discipline_regex, discipline.
    text.strip())
        if discipline_match:
            # look up the full discipline name
            found_discipline = YOUR_CODE_HERE
        else:
            found_discipline = None

```

```
        if found_venue and found_event and found_discipline:
            # if we found something
            events.append((found_event, found_venue,
    found_discipline))

    return events
```

Since you would like to gamble with your friends beforehand you will create a betting slip. That slip will contain and a table which columns represent the date, venue and discipline as well as a column for the tip of which athlete or country wins that competition. The empty betting slip should be created automatically by your script and saved to a new file using Markdown [7] or HTML formatting. If you choose Markdown, `https://markdownlivepreview.com` is a handy tool for previewing your markdown rendering, to make sure it's correct.

Here is an example of a function you could use to create the betting slip in Markdown format.

```
def create_betting_slip(events, save_as):
    """Saves a markdown format betting slip to the location
        './datetime_filter/<save_as>.md'.
        Args:
            events (list): takes a list of 3-tuples containing
    date, venue and
                           type for each event.
            save_as (string): filename to save the markdown
    betting slip as.
    """
    # ensure directory exists
    os.makedirs("datetime_filter", exist_ok=True)

    with open(f"./datetime_filter/{save_as}.md", "w") as out_file:
        out_file.write(f"# BETTING SLIP ({save_as})\n\nName:\n\n")
        out_file.write("Date | Venue | Discipline | Who wins?\n")
        out_file.write(" --- | --- | --- | --- \n")
        for e in events:
            date, venue, type = e
            out_file.write(f"{date} | {venue} | {type} | \n")
```

Files to Deliver in this Subtask

Create a folder `datetime_filter` where you put all output files from our test runs created for solving this subtask.

Files Required in this Subtask

- `time_planner.py`
- `datetime_filter/betting_slip_empty.md` - a nicely formatted table for your bets, containing date, venue and discipline, but with an empty "who wins" column.

An example betting slip could look like this:

[7] `https://github.com/adam-p/markdown-here/wiki/Markdown-Cheatsheet#tables`

BETTING SLIP

Name:

DATE	VENUE	DISCIPLINE	Who Wins?
01/01/2021	nowhere	sitting	

Figure 3: Betting Slip.

5.5 NBA Player Statistics Season 2020/2021 (IN3110 & IN4110 15 Points)

Go Milwaukee Bucks! Let's imagine you are into basketball. After this unpredictable season, you really want to dive into the player statistics. Lucky you! In this task you are going to write a script `fetch_player statistics.py` which visits the "2021 NBA playoffs" website on wikipedia (this one: `https://en.wikipedia.org/wiki/2021_NBA_playoffs`) and creates some player statistics.

This task can be broken down into three subtasks:

1. Get the list of teams.
2. Given a team url, get the list of players.
3. Given a player url, get their statistics.

As in task `5.4` we will use `BeautifulSoup` for parsing.

5.5.1 Get the List of Teams.

As always, you first need to make a url request using your function `get_html`.

Then you want to navigate, using `BeautifulSoup` to the main table in the "Bracket" section shown below.

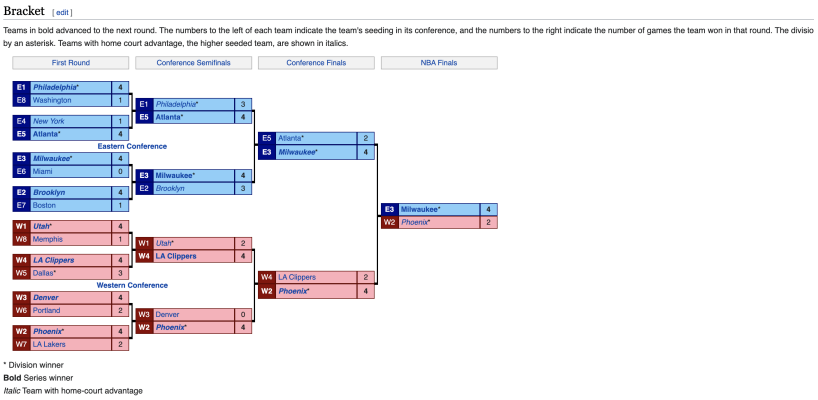


Figure 4: Bracket Section.

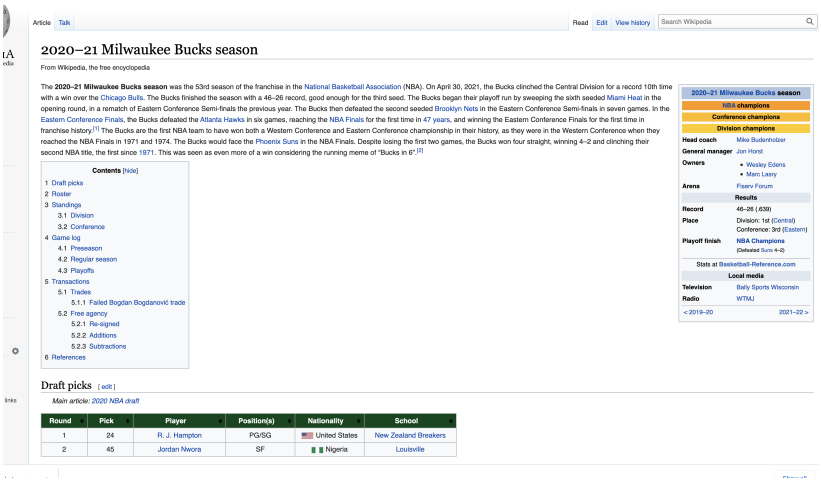
There you will extract the names of the teams which made it to the conference semifinals (This is shown in the section "Bracket"). [8]. You will also create a function `extract_url` which will allow you to extract the team urls in this table.

5.5.2 Get the List of Players, given a Team URL.

You will follow the urls to the wikipedia websites of the corresponding teams in the Bracket section.

The next figure shows the website you get to when following the Milwaukee Bucks link in the conference semifinals.

[8] Hint: It should be 8.



2020–21 Milwaukee Bucks season

From Wikipedia, the free encyclopedia

The **2020–21 Milwaukee Bucks season** was the 53rd season of the franchise in the National Basketball Association (NBA). On April 30, 2021, the Bucks clinched the Central Division for a record 10th time with a win over the Chicago Bulls. The Bucks finished the season with a 46–26 record, good enough for the third seed. The Bucks began their playoff run by sweeping the sixth seeded Miami Heat in the opening round, in a rematch of Eastern Conference Semi-finals the previous year. The Bucks then defeated the second seeded Brooklyn Nets in the Eastern Conference Semi-finals in seven games. In the Eastern Conference Finals, the Bucks defeated the Atlanta Hawks in six games, reaching the NBA Finals for the first time in 47 years, and winning the Eastern Conference Finals for the first time in franchise history.[1] The Bucks are the first NBA team to have won both a Western Conference and Eastern Conference championship in their history, as they were in the Western Conference when they reached the NBA Finals in 1971 and 1974. The Bucks would face the Phoenix Suns in the NBA Finals. Despite losing the first two games, the Bucks won four straight, winning 4–2 and clinching their second NBA title, the first since 1971. This was seen as even more of a win considering the running meme of "Bucks in 6".[2]

2020–21 Milwaukee Bucks season

NBA champions	
Conference champions	
Division champions	
Head coach	Mike Budenholzer
General manager	Jon Horst
Owners	• Wesley Edens • Marc Lasry
Arena	Fiserv Forum
Results	
Record	46–26 (.639)
Place	Division: 1st (Central) Conference: 3rd (Eastern)
Playoff finish	NBA Champions (Defeated Suns 4–2)
Stats at Basketball-Reference.com	
Local media	
Television	Bally Sports Wisconsin
Radio	WTMJ

< 2019–20 2021–22 >

Contents [hide]

1 Draft picks
2 Roster
3 Standings
3.1 Division
3.2 Conference
4 Game log
4.1 Preseason
4.2 Regular season
4.3 Playoffs
5 Transactions
5.1 Trades
5.1.1 Failed Bogdan Bogdanović trade
5.2 Free agency
5.2.1 Re-signed
5.2.2 Additions
5.2.3 Subtractions
6 References

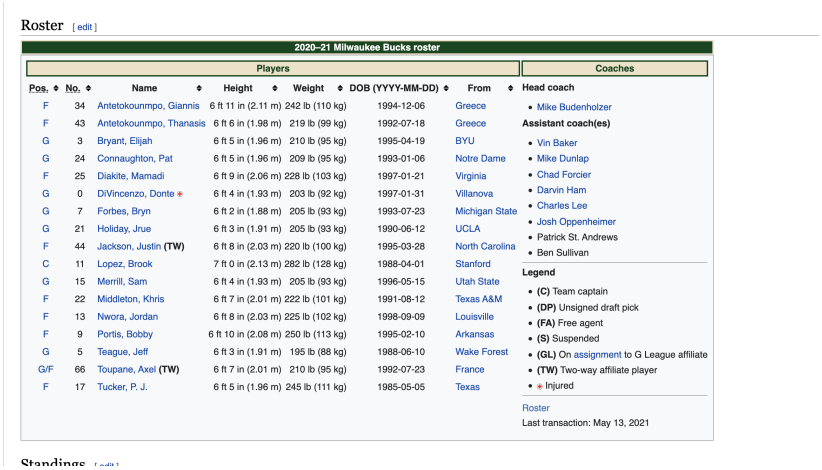
Draft picks [edit]

Main article: 2020 NBA draft

Round	Pick	Player	Position(s)	Nationality	School
1	24	R. J. Hampton	PG/SG	United States	New Zealand Breakers
2	45	Jordan Nwora	SF	Nigeria	Louisville

Figure 5: Milwaukee Bucks Page.

In the next step you need to identify all the players that played for the specific team in that season. In your script this could be done by a function `extract_player` which will allow you to extract the player urls and names based on the team url. The url to each player can be found in the roster. Therefore you need to navigate to the table holding the team roster. For the Milwaukee Bucks the roster section looks like this:



Roster [edit]

2020–21 Milwaukee Bucks roster

Players							Coaches
Pos.	No.	Name	Height	Weight	DOB (YYYY-MM-DD)	From	**Head coach**
F	34	Antetokounmpo, Giannis	6 ft 11 in (2.11 m)	242 lb (110 kg)	1994-12-06	Greece	• Mike Budenholzer
F	43	Antetokounmpo, Thanasis	6 ft 6 in (1.98 m)	219 lb (99 kg)	1992-07-18	Greece	**Assistant coach(es)**
G	3	Bryant, Elijah	6 ft 5 in (1.96 m)	210 lb (95 kg)	1995-04-19	BYU	• Vin Baker
G	24	Connaughton, Pat	6 ft 5 in (1.96 m)	209 lb (95 kg)	1993-01-06	Notre Dame	• Mike Dunlap
F	25	Diakite, Mamadi	6 ft 9 in (2.06 m)	228 lb (103 kg)	1997-01-21	Virginia	• Chad Forcier
G	0	DiVincenzo, Donte ✳	6 ft 4 in (1.93 m)	203 lb (92 kg)	1997-01-31	Villanova	• Darvin Ham
G	7	Forbes, Bryn	6 ft 2 in (1.88 m)	205 lb (93 kg)	1993-07-23	Michigan State	• Charles Lee
G	21	Holiday, Jrue	6 ft 3 in (1.91 m)	205 lb (93 kg)	1990-06-12	UCLA	• Josh Oppenheimer
F	44	Jackson, Justin **(TW)**	6 ft 8 in (2.03 m)	220 lb (100 kg)	1995-03-28	North Carolina	• Patrick St. Andrews
C	11	Lopez, Brook	7 ft 0 in (2.13 m)	282 lb (128 kg)	1988-04-01	Stanford	• Ben Sullivan
G	15	Merrill, Sam	6 ft 4 in (1.93 m)	205 lb (93 kg)	1996-05-15	Utah State	**Legend**
F	22	Middleton, Khris	6 ft 7 in (2.01 m)	222 lb (101 kg)	1991-08-12	Texas A&M	• **(C)** Team captain
F	13	Nwora, Jordan	6 ft 8 in (2.03 m)	225 lb (102 kg)	1998-09-09	Louisville	• **(DP)** Unsigned draft pick
F	9	Portis, Bobby	6 ft 10 in (2.08 m)	250 lb (113 kg)	1995-02-10	Arkansas	• **(FA)** Free agent
G	5	Teague, Jeff	6 ft 3 in (1.91 m)	195 lb (88 kg)	1988-06-10	Wake Forest	• **(S)** Suspended
G/F	66	Toupane, Axel **(TW)**	6 ft 7 in (2.01 m)	210 lb (95 kg)	1992-07-23	France	• **(GL)** On assignment to G League affiliate
F	17	Tucker, P. J.	6 ft 5 in (1.96 m)	245 lb (111 kg)	1985-05-05	Texas	• **(TW)** Two-way affiliate player
							• ✳ Injured

Roster

Last transaction: May 13, 2021

Standings [edit]

Figure 6: Roster Milwaukee Bucks.

5.5.3 Given a Player URL, get Their Statistics.

Fantastic, let's start on the player statistic section! In order to filter the statistics for one specific player you need the output the player name and url to this players wikipedia page, which you extracted in the last step. The player url can be used as an input for the function `extract_player_statistics` which you will create in this subtask.

You will request the `url` to that player. If we follow the link to Giannis Antetokounmpo the figure below shows the part of the webpage showing the player statistics.

NBA

Regular season

Year	Team	GP	GS	MPG	FG%	3P%	FT%	RPG	APG	SPG	BPG	PPG
2013–14	Milwaukee	77	23	24.6	.414	**.347**	.683	4.4	1.9	.8	.8	6.8
2014–15	Milwaukee	**81**	71	31.4	.491	.159	.741	6.7	2.6	.9	1.0	12.7
2015–16	Milwaukee	80	79	35.3	.506	.257	.724	7.7	4.3	1.2	1.4	16.9
2016–17	Milwaukee	80	**80**	35.6	.522	.272	**.770**	8.7	5.4	**1.6**	**1.9**	22.9
2017–18	Milwaukee	75	75	**36.7**	.529	.307	.760	10.0	4.8	1.5	1.4	26.9
2018–19	Milwaukee	72	72	32.8	**.578**	.256	.729	12.5	**5.9**	1.3	1.5	27.7
2019–20	Milwaukee	63	63	30.4	.553	.304	.633	**13.6**	5.6	1.0	1.0	**29.5**
2020–21†	Milwaukee	61	61	33.0	.569	.303	.685	11.0	**5.9**	1.2	1.2	28.1
Career		589	524	32.5	.532	.287	.717	9.1	4.5	1.2	1.3	20.9
All-Star		4	4	26.8	.653	.231	.667	8.8	3.0	1.3	1.0	27.3

Figure 7: Giannis Antetokounmpo.

We are interested in the NBA Regular season table. Therefore we need to navigate to this one. We want to extract for the row **Year 2020-21** and the columns points per game, blocks per game and rebounds per game.

For your statistics you are going to compare the best players from the teams in the conference semifinals. **"Best"** is defined by the highest count of points per game in our case.

The three best players of each team make it into our comparison pool. Since we take the 3 best players of each team, we will end up comparing the abilities of **24 players in total**.

If statistics for a player is missing it is fine to ignore this player. Since you are only selecting the top 3 from each team you could just give these people the lowest possible score (this way they are not included).

We want to compare these selected players with respect to points per game, blocks per game, and rebounds per game.

Therefore, we will plot the player over the points/blocks/rebounds. You can choose your favorite plotting tool for this. We would like to have players of each team grouped together (this can be color-coded or with a bracket, or another visualization).

Your implementation should be saved to a file called `fetch_player_statistics.py`.

The produced plots should be saved.
An example plot is shown below.

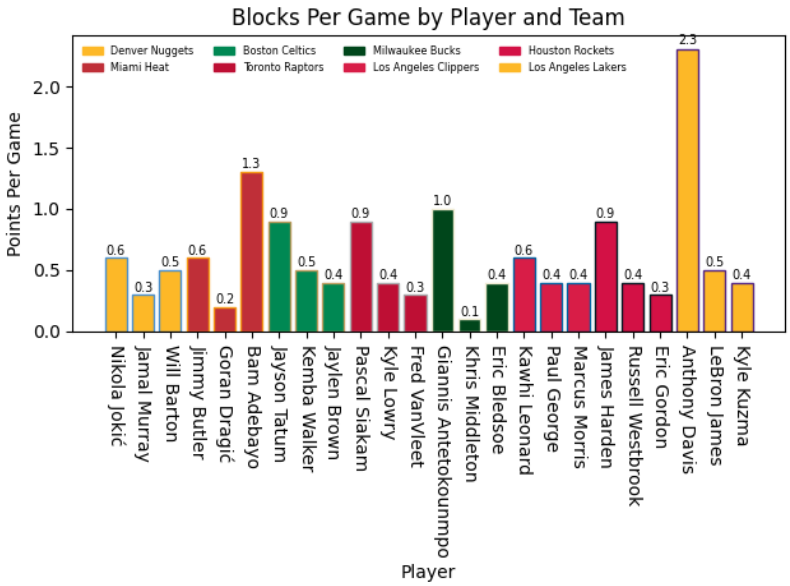


Figure 8: Example Plot.

Steps for creating the script

- visit `https://en.wikipedia.org/wiki/2021_NBA_playoffs`
- crawl through the team and player wikipedia websites via the internal urls as described above
- define the best 3 players of each team in the conference semifinals based on the "Points per game" in 2020/2021
- fetch their statistics in the categories points per game, blocks per game and rebounds per game
- create three plots (players of each team grouped together in the plots):
  - Players over points per game
  - Players over blocks per game
  - Players over rebounds per game
- Save the plots!

You are free to structure your script the way you think is best. However, we have outlined below an example of how you could structure your implementation:

```
from bs4 import BeautifulSoup

from requesting_urls import get_html


def extract_teams():
    """Extract team names and urls from the NBA Playoff 'Bracket' section table.

    Returns:
        team_names (list): A list of team names that made it to the conference
            semifinals.
        team_urls (list): A list of absolute Wikipedia urls corresponding to team_names.

    """

    # get html using for example get_html from requesting_urls
    html = get_html(url)

    # create soup
    soup = BeautifulSoup(html, "html.parser")
    # find bracket we are interested in
    bracket_header = soup.find(id="Bracket")
    bracket_table = bracket_header.find_next("table")
    rows = bracket_table.find_all("tr")

    # create list of teams
    team_list = []

    for i in range(1, len(rows)):
        cells = rows[i].find_all("td")
        cells_text = [cell.get_text(strip=True) for cell in cells]

        # Filter out the cells that are empty
        cells_text = [cell for cell in cells_text if cell]

        # Find the rows that contain seeding, team name and games won
        if len(cells_text) > 1:
            YOUR_CODE

    # Filter out the teams that appear more than once, which means they made it
    # to the conference semifinals
    team_list_filtered = YOUR_CODE

    # create lists of team names and urls to the team website
    team_names = []
    team_urls = []

    # your code
```

```
49
50      return team_names, team_urls
51
52
53  def extract_players(team_url):
54      """Extract players that played for a specific team in the NBA
        playoffs.
55
56      Args:
57          team_url (str): URL to the Wikipedia article of the season
         of a given
58              team.
59
60      Returns:
61          player_names (list): A list of players names corresponding
         to the team whos URL was passed.
62              semifinals.
63          player_urls (list): A list of Wikipedia URLs corresponding
         to
64              player_names of the team whos URL was passed.
65
66      """
67
68      # keep base url
69      base_url = "https://en.wikipedia.org"
70
71      # get html for each page using the team url you extracted
        before
72      html = get_html(team_url)
73
74      # make soup
75      soup = BeautifulSoup(html, "html.parser")
76      # get the header of the Roster
77      roster_header = soup.find(id="Roster")
78      # identify table
79      roster_table = roster_header.find_next("table")
80      rows = roster_table.find_all("tr")
81
82      # prepare lists for player names and urls
83      player_names = []
84      player_urls = []
85
86      for i in range(0, len(rows)):
87          cells = rows[i].find_all("td")
88          cells_text = [cell.get_text(strip=True) for cell in cells]
89
90          if len(cells_text) == 7:
91              rel_url = cells[2].find_next("a").attrs["href"]
92              # Use e.g. regex to remove information in parenthesis
        following the name
93              YOUR_CODE
94              # create urls to each player
95              # need to create absolute urls combining the base and
        the relative url
96              player_urls.append(base_url + rel_url)
97
98      return player_names, player_urls
```

```python


def extract_player_statistics(player_url):
    """Extract player statistics for NBA player.

    # Note: Make yourself familiar with the 2020-2021 player statistics wikipedia page and adapt the code accordingly.

    Args:
        player_url (str): URL to the Wikipedia article of a player.

    Returns:
        ppg (float): Points per Game.
        bpg (float): Blocks per Game.
        rpg (float): Rebounds per Game.

    """
    # As some players have incomplete statistics/information, you can set a default score, if you want.

    ppg = 0.0
    bpg = 0.0
    rpg = 0.0

    # get html
    html = get_html(player_url)

    # make soup
    soup = BeautifulSoup(html.text, "html.parser")

    # find header of NBA career statistics
    nba_header = soup.find(id="NBA_career_statistics")

    # check for alternative name of header
    if nba_header is None:
        nba_header = soup.find(id="NBA")

    try:
        # find regular season header
        # You might want to check for different spellings, e.g. capitalization
        # You also want to take into account the different orders of header and table
        regular_season_header = nba_header.find_next(id="Regular_season")

        # next we should identify the table
        nba_table = regular_season_header.find_next("table")

    except:
        try:
            # table might be right after NBA career statistics header
            nba_table = nba_header.find_next("table")

        except:
```

```
            return ppg, bpg, rpg

    # find nba table header and extract rows
    table_header = nba_table.find_all("th")
    # YOUR CODE

    # find the columns for the different categories
    ppg_column = YOUR_CODE_HERE
    # YOUR CODE HERE

    # Extract the scores from the different categories
    scores = YOUR_CODE

    # Convert the scores extracted to floats
    # Note: In some cases the scores are not defined but only
    shown as '-'. In such cases you can just set the score to zero
     or not defined.
    try:
        scores[i] = float(scores[i])
    except ValueError:
        scores[i] = 0.0

    return ppg, bpg, rpg
```

There are lots of ways to do the plotting, but here is one example using matplotlib, assuming one possible way to store your collected player data:

- `teams` is a dictionary with team names as keys and player lists as values
- each player in the list is a dictionary of player attributes, such as `name` or `ppg`

```
import matplotlib.pyplot as plt

teams = {
    "UiO": [
        {
            "name": "Lisa",
            "ppg": 10.0,
        },
        {
            "name": "Vegard",
            "ppg": 9.2,
        },
    ],
    "Simula": [
        {
            "name": "Ingeborg",
            "ppg": 11.2,
        },
        {
            "name": "Min",
            "ppg": 4.5,
        },
    ],
}
```

```
25
26 # a matplotlib color for each team name (could be a name or a #
       rrggbb web color string)
27 color_table = {
28     "UiO": "red",
29     "Simula": "orange",
30 }
31
32
33 def plot_NBA_player_statistics(teams):
34     """Plot NBA player statistics. In this case, just PPG"""
35     count_so_far = 0
36     all_names = []
37
38     # iterate through each team and the
39     for team, players in teams.items():
40         # pick the color for the team, from the table above
41         color = color_table[team]
42         # collect the ppg and name of each player on the team
43         # you'll want to repeat with other stats as well
44         ppg = []
45         names = []
46         for player in players:
47             names.append(player["name"])
48             ppg.append(player["ppg"])
49         # record all the names, for use later in x label
50         all_names.extend(names)
51
52         # the position of bars is shifted by the number of players
       so far
53         x = range(count_so_far, count_so_far + len(players))
54         count_so_far += len(players)
55         # make bars for this team's players ppg,
56         # with the team name as the label
57         bars = plt.bar(x, ppg, color=color, label=team)
58         # add the value as text on the bars
59         plt.bar_label(bars)
60
61     # use the names, rotated 90 degrees as the labels for the bars
62     plt.xticks(range(len(all_names)), all_names, rotation=90)
63     # add the legend with the colors  for each team
64     plt.legend(loc=0)
65     # turn off gridlines
66     plt.grid(False)
67     # set the title
68     plt.title("points per game")
69     # save the figure to a file
70     plt.savefig("ppg.png")
71
72
73 plot_NBA_player_statistics(teams)
```

Files to Deliver in this Subtask Create a folder `NBA_player_statistics` where you store all the plots created in this task.

Files Required in this Subtask

- `fetch_player statistics.py`

- `NBA_player_statistics/players_over_ppg.png`
- `NBA_player_statistics/players_over_bpg.png`
- `NBA_player_statistics/players_over_rpg.png`

5.6 Challenge - Wiki Race with URLs (5 bonus points and a prize for the winner!)

Everyone has probably heard of golf. You try to get the ball into the hole with the least amount of hits. Let us play some Wikipedia golf.

Write a script using your previous functions that finds the shortest way (in number of urls to visit) from `https://en.wikipedia.org/wiki/Parque_18_de_marzo_de_1938` to `https://en.wikipedia.org/wiki/Bill_Mundell` using only urls in Wikipedia articles. The script should work with any wikipedia url.

The main objective is to find the shortest path. You can expect to work on the english wiki only for this task. The websites given will be your test case.

Note: Since the simplest approach might technically work, but not be the fastest finding the solution, we would like you to still be able to provide a solution for bonus points, therefore you can find the shortest path lengths between these two wikipedia articles: `https://en.wikipedia.org/wiki/Nobel_Prize` and `https://en.wikipedia.org/wiki/Array_data_structure`.

In order to assign a winner, we will evaluate this for 2 undisclosed urls. The most efficient (and correct) script will win a prize :)

Your chances for winning are even higher if your script is fast.

Note: You are going to be on english wikipedia en.wikipedia.org.

You have to use python ;)

Files to Deliver in this Subtask

Create a folder `wiki_race_challenge` where you put all output files created for solving this subtask.

Files Required in this Subtask

- `wiki_race_challenge`.py
- `wiki_race_challenge/shortest_way.txt` containing the list of URLs along the shortest path

You finished another assignment! Congrats!