HW#3 - Ranking Webpages

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03/12/2023

Q1

Download the content of the 1000 unique URIs you gathered in HW2

Answer

We will use the same file that contain 1000 unique links which was generated in HW 2 using IO operation, all the links will be retrieved and stored into the separate list. We will iterate over each link and perform below mention steps,

1 - Retrieving the html-tags and html text

When the link is retrieve, it is encoded as ut-8 and then converted into hashed text. For this we have used *hashlib* library.

```
import requests
import os
from bs4 import BeautifulSoup
import hashlib

def download_html(uri):
    response = requests.get(uri)
    if response.status_code == 200:
        return response.content
    else:
        return None

def generate_hash(uri):
    md5_hash = hashlib.md5(uri.encode())
    return md5_hash.hexdigest()

with open('clean.txt', 'r') as f:
    uri_list = f.readlines()

output_folder = 'output'
if not os.path.exists(output_folder):
```

```python
    os.makedirs(output_folder)

batch_size = 10000

for batch_index in range(0, len(uri_list), batch_size):
    batch_uri_list = uri_list[batch_index:batch_index+batch_size]
    print("Processing URIs {}-{} out of {}: ".format(batch_index+1,
    batch_index+len(batch_uri_list), len(uri_list)))

    for index, uri in enumerate(batch_uri_list):
        uri = uri.strip()
        uri_hash = generate_hash(uri)
        print("Processing URI {}/{}: {}".format(index+1, len(
    batch_uri_list), uri))

        main_text_file = os.path.join(output_folder, 'main_text_{}.txt'
    .format(uri_hash))
        html_tags_file = os.path.join(output_folder, 'html_tags_{}.txt'
    .format(uri_hash))
        if os.path.exists(main_text_file) and os.path.exists(
    html_tags_file):
            print("Files already exist for URI: {}".format(uri))
            continue

        html_content = download_html(uri)
        if html_content is not None:
            soup = BeautifulSoup(html_content, 'html.parser')

            main_text = soup.get_text()

            with open(main_text_file, 'w', encoding='utf-8') as f:
                f.write(main_text)

            with open(html_tags_file, 'w', encoding='utf-8') as f:
                f.write(str(soup))

        else:
            print("Failed to download URI: {}".format(uri))
```

Listing 1: Converting url to hash text

2 - Clean the name of the output files

Next step we have written a separate function to change the file names of output folder corresponding to their hash values .

```python
import os

folder_path = "main_text"

for filename in os.listdir(folder_path):

    if "main_text_" in filename:

        new_filename = filename.replace("main_text_", "")

        os.rename(os.path.join(folder_path, filename), os.path.join(
    folder_path, new_filename))
```

Listing 2: function to get response from each URI

```python
import os

folder_path = "html_tags"

for filename in os.listdir(folder_path):

    if "html_tags_" in filename:

        new_filename = filename.replace("html_tags_", "")

        os.rename(os.path.join(folder_path, filename), os.path.join(
    folder_path, new_filename))
```

Listing 3: function to get response from each URI

These file will be store in separate folders. As we have one more step to perform on these files.

3 - Clean the content of maintext files

We will utilize the same content obtained from Step 2 and apply a cleaning process to it. To achieve this, we have developed a dedicated function that assists in cleaning the content. During this process, we will identify all the text files that include the stopword ”coronavirus”.

```python
import os
import shutil

root_folder = "main_text"

output_folder = "stopword_coronavirus"

keyword = "coronavirus"
```

```python

def file_contains_keyword(file_path, keyword):
    with open(file_path, "r", encoding="utf-8") as f:
        content = f.read()
        if keyword in content:
            return True
    return False

for dirpath, dirnames, filenames in os.walk(root_folder):
    for filename in filenames:
        if filename.endswith(".txt"):
            file_path = os.path.join(dirpath, filename)
            if file_contains_keyword(file_path, keyword):
                output_file_path = os.path.join(output_folder, filename
    )
                shutil.move(file_path, output_file_path)
                print("Moved file:", filename)
```

Listing 4: function to clean the html content

After parsing the content through this function, we will write the clean content into separate file with the file name using the same hashed text and store it into stopword ”coronavirus” document.

4 - Save the hashed mapping of URIs

Once the iteration is completed, we will save the hash mapping to separate csv file that will be used in question 3 to create ranking tables.

```python
import hashlib

with open('clean.txt', 'r') as f:
    uri_list = f.readlines()

def generate_hash(uri):
    md5_hash = hashlib.md5(uri.encode())
    return md5_hash.hexdigest()

uri_hash_map = {}

for i, uri in enumerate(uri_list):
    uri_hash_map[uri.strip()] = (i+1, generate_hash(uri))

with open('uri_hash_map.csv', 'w') as f:
    f.write("serial_number,uri,hash_value\n")
    for uri, values in uri_hash_map.items():
        f.write(f"{values[0]},{uri},{values[1]}\n")
```

Listing 5: Hash mapping conversion to csv

Q2

Rank with TF-IDF

Answer

1 - Choose the term and select 10 document from processed folder

Our task is to go through the documents in the processed folder and search for the term 'coronavirus' in each one. Those that contain this term will be moved to a separate folder. We will select and copy 10 such documents to the new folder.

```
import os
import numpy as np

from pandas import DataFrame

idf = np.round(np.log2(60000000000 / 3730000000), 3)

rows = []
count = 0
for item in os.listdir('stopword_coronavirus/'):
    if count == 10:
        break
    with open('stopword_coronavirus/' + item, 'r', encoding='utf-8') as
    filehandle:
        file_content = filehandle.read().lower()

    word_count = len(file_content.split())
    term_count = file_content.count('coronavirus')

    term_freq = np.round(term_count / word_count, 3)
    tf_idf = np.round(term_freq * idf, 3)

    rows.append([item, term_freq, idf, tf_idf])
    count += 1

result = DataFrame(rows, columns=['File', 'TF', 'IDF', 'TF-IDF'])
result.to_csv('rank-tf-idf.csv')
print(result)
```

Listing 6: Copy files that contain the term to separate folder

2 - Calculate TF, IDF and TF-IDF for each link

During this stage, our objective is to compute TF, IDF, and TF-IDF values for each document. To obtain TF scores, we will analyze each document and retrieve the number of occurrences of the term ’coronavirus’ in addition to the total word count of the document.

We will employ the following formula to determine Term Frequency:

$$Term\_Frequency = \frac{Term\_count\_in\_document}{Total\_word\_in\_document} \tag{1}$$

We have lowered case all the content before searching the term to get the count accurate. Also we have count the total word by splitting up the text by space in content file which return the array of word and using *len* python string function to count the length.

To calculate IDF, we will use google search to find the total count in corpus for the term *coronavirus*. As we are using google the total document index will be 60B. Refer figure 1.

Figure 1: Chart from worldwidewebsize.com

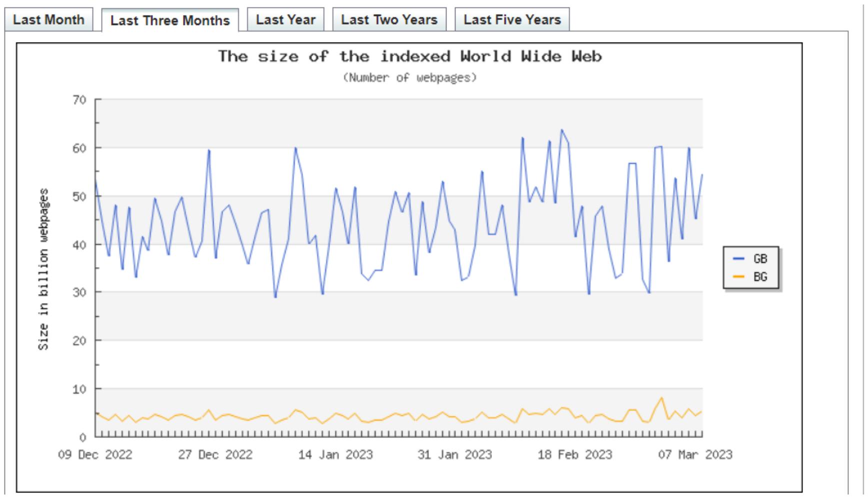
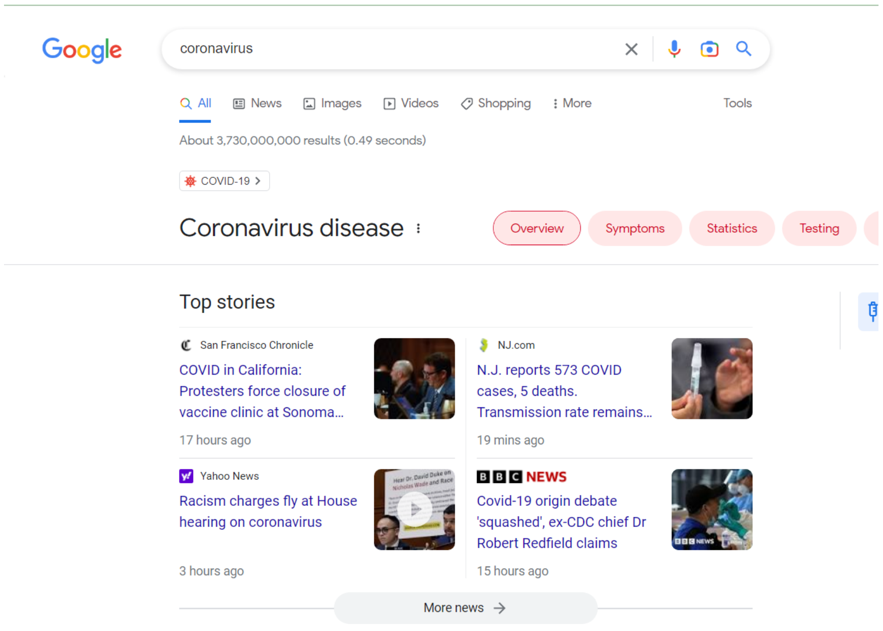


Figure 2, represent the result of the term coronavirus in google.com. You can see that the size of the search term in corpus is *3,730,000,000*

We will use these values and calculate the IDF by the following equation,

$$IDF = \log_2(\frac{Total\_docs\_in\_corpus}{Total\_docs\_with\_terms}) \tag{2}$$

Figure 2: Searching results for the term coronavirus in google.com



About 3,730,000,000 results (0.49 seconds)

Coronavirus disease

Top stories

San Francisco Chronicle
COVID in California: Protesters force closure of vaccine clinic at Sonoma...
17 hours ago

NJ.com
N.J. reports 573 COVID cases, 5 deaths. Transmission rate remains...
19 mins ago

Yahoo News
Racism charges fly at House hearing on coronavirus
3 hours ago

BBC NEWS
Covid-19 origin debate 'squashed', ex-CDC chief Dr Robert Redfield claims
15 hours ago

Once the TF and IDF is calculated, we will use the following equation to calculate TFIDF,

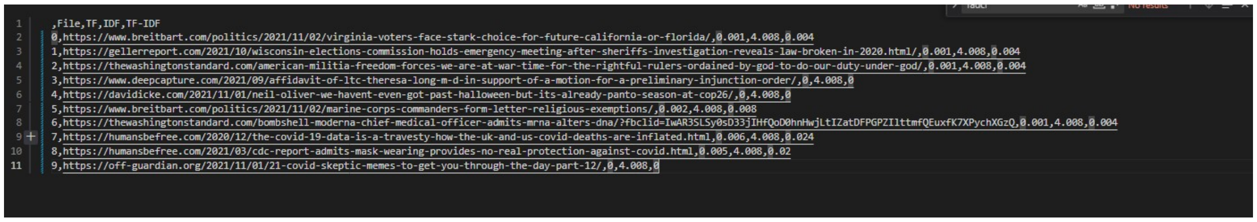
$$TF\_IDF = TF * IDF \tag{3}$$

```python

import os
import numpy as np

from pandas import DataFrame

idf = np.round(np.log2(60000000000 / 3730000000), 3)

rows = []
count = 0
for item in os.listdir('stopword_coronavirus/'):
    if count == 10:
        break
    with open('stopword_coronavirus/' + item, 'r', encoding='utf-8') as
    filehandle:
        file_content = filehandle.read().lower()

    word_count = len(file_content.split())
    term_count = file_content.count('coronavirus')

    term_freq = np.round(term_count / word_count, 3)
    tf_idf = np.round(term_freq * idf, 3)

    rows.append([item, term_freq, idf, tf_idf])
    count += 1

result = DataFrame(rows, columns=['File', 'TF', 'IDF', 'TF-IDF'])
result.to_csv('rank-tf-idf.csv')
print(result)
```

Listing 7: Complete implementation for calculating TF IDF and TFIDF

Figure 3, shows the result ,

Figure 3: Print result of the calculated table



```
,File,TF,IDF,TF-IDF
0,https://www.breitbart.com/politics/2021/11/02/virginia-voters-face-stark-choice-for-future-california-or-florida/,0.001,4.008,0.004
1,https://gellerreport.com/2021/10/wisconsin-elections-commission-holds-emergency-meeting-after-sheriffs-investigation-reveals-law-broken-in-2020.html/,0.001,4.008,0.004
2,https://thewashingtonstandard.com/american-militia-freedom-forces-we-are-at-war-time-for-the-rightful-rulers-ordained-by-god-to-do-our-duty-under-god/,0.001,4.008,0.004
3,https://www.deepcapture.com/2021/09/affidavit-of-ltc-theresa-long-m-d-in-support-of-a-motion-for-a-preliminary-injunction-order/,0,4.008,0
4,https://davidicke.com/2021/11/01/neil-oliver-we-havent-even-got-past-halloween-but-its-already-panto-season-at-cop26/,0,4.008,0
5,https://www.breitbart.com/politics/2021/11/02/marine-corps-commanders-form-letter-religious-exemptions/,0.002,4.008,0.008
6,https://thewashingtonstandard.com/bombshell-moderna-chief-medical-officer-admits-mrna-alters-dna/?fbclid=IwAR3SLSy0sD33jIHfQoD0hnHwjLtIZatDFPGPZIlttmfQEuxfK7XPychXGzQ,0.001,4.008,0.004
7,https://humansbefree.com/2020/12/the-covid-19-data-is-a-travesty-how-the-uk-and-us-covid-deaths-are-inflated.html,0.006,4.008,0.024
8,https://humansbefree.com/2021/03/cdc-report-admits-mask-wearing-provides-no-real-protection-against-covid.html,0.005,4.008,0.02
9,https://off-guardian.org/2021/11/01/21-covid-skeptic-memes-to-get-you-through-the-day-part-12/,0,4.008,0
```

The result is shared in the table 1,

Table 1: TF, IDF and TFIDF table

URIs	**TF**	**IDF**	**TFIDF**
`https://www.breitbart.com/`	0.001	4.008	0.004
`https://gellerreport.com/`	0.001	4.008	0.004
`https://thewashingtonstandard.com`	0.001	4.008	0.004
`https://www.deepcapture.com`	0	4.008	0
`https://davidicke.com`	0	4.008	0
`https://www.breitbart.com/politics`	0.002	4.008	0
`https://thewashingtonstandard.com`	0.001	4.008	0.004
`https://humansbefree.com/2020/12`	0.006	4.008	0.024
`https://humansbefree.com/2021/03/`	0.005	4.008	0.002
`https://off-guardian.org/`	0	4.008	0

Q3

Now rank the domains of those 10 URIs from Q2 by their PageRank.

Answer

For this we have used `https://www.checkpagerank.net/check-page-rank.php` to found the ranks of the processed web pages.

Result of the ranks have been shared in below table,

Table 2: Web pages ordered with respect to their ranks

URIs	**Ranks**
`https://www.breitbart.com`	0.8
`https://www.breitbart.com/politics`	0.8
`https://davidicke.com`	0.7
`https://off-guardian.org/`	0.6
`https://gellerreport.com`	0.5
`https://humansbefree.com/2020/12/`	0.5
`https://humansbefree.com/2021/03`	0.5
`https://www.deepcapture.com`	0.5
`https://thewashingtonstandard.com`	0.5
`https://thewashingtonstandard.com`	0.5

After analyzing and comparing the ranking with the tables displaying TF, IDF, and TF-IDF results, we can conclude that the frequency of terms used in web pages with high rankings is generally low. This suggests that other factors, such as meta tags, site references, etc., have a significant impact on the ranking of web pages.

Q4

Compute the Kendall Tau-b score

Answer

Now we will calculate the Kendall Tau score for the lists from Q2 and Q3

```python
from scipy.stats import kendalltau

# Define the two lists
list1 = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
list2 = [1, 5, 9, 8, 3, 2, 10, 6, 7, 4]

# Compute the Kendall Tau_b score and p-value
tau, p_value = kendalltau(list1, list2)

# Print the results to a file
with open("kendalltau_results.txt", "w") as f:
    print("Tau_b score: ", tau, file=f)
    print("p-value: ", p_value, file=f)
```

Listing 8: Code for creating local corpus

The Tau-b score is 0.1111111111111111 and p-value: 0.7274895282186948

Q5

Build a simple (i.e., no positional information) inverted file (in ASCII) for all the words from your 1000 URIs

Answer

We generated an inverted index file using the processed folder. To do this, we accessed the files from the processed folder, iterated through each file, and extracted the content. We then used the split function to break down the content by space, in order to retrieve all the words. After retrieving all the words, we cleaned the data by removing special characters from each word and stored them in a separate list.

As there must be a chance of word repetition, we used python data structure *set* to make the list of word unique. After the final list is generated, we write the result to file.

```python
import os
from shutil import copy
import numpy as np

inverted_index = []

for file_name in os.listdir('main_text/'):
    with open(os.path.join('main_text', file_name), 'r', encoding='utf-8') as f:
        content = f.read().lower()
        tokens = content.split()

        clean_tokens = [token.strip('''!()-[]{};:'"\, <>./?@#$%^&*_~''') for token in tokens]

        unique_tokens = set(filter(None, clean_tokens))

        inverted_index.extend(list(unique_tokens))

unique_tokens = list(set(inverted_index))

with open('inverted_file.txt', 'w', encoding='utf-8') as f:
    f.write('\n'.join(unique_tokens) + '\n')
```

Listing 9: Implementation for creating inverted index file

References

- Hashlib library, `https://docs.python.org/3/library/hashlib.html`
- Page Rank, `http://www.prchecker.info/check_page_rank.php`
- Request Documentation, `https://requests.readthedocs.io/en/master/user/quickstart/#response-content`
- Boilerpy3 reference, `https://pypi.org/project/boilerpy3/`
- Github, `https://github.com/odu-cs432-websci/spring23-hw3-Badjedi04`